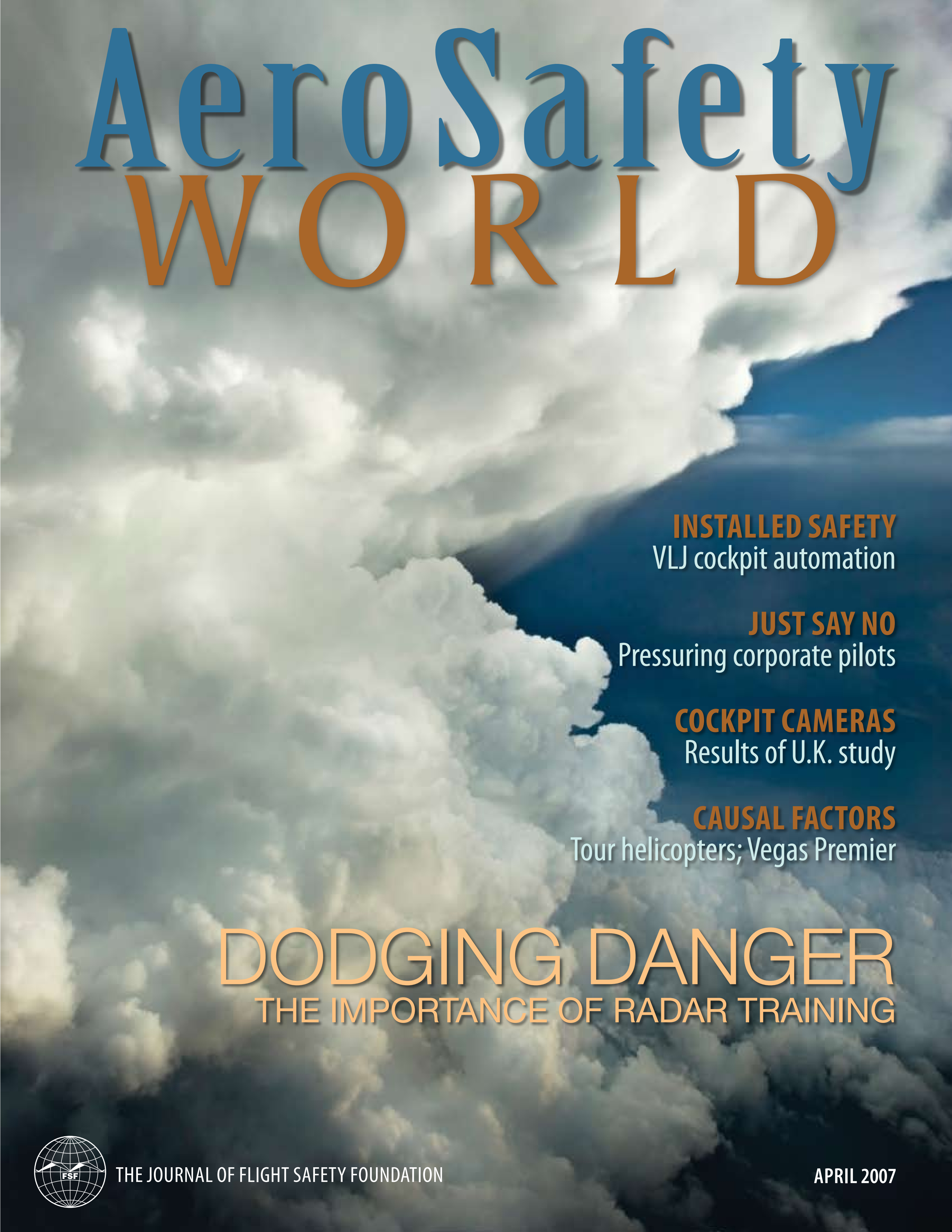

AeroSafety WORLD

INSTALLED SAFETY
VLJ cockpit automation

JUST SAY NO
Pressuring corporate pilots

COCKPIT CAMERAS
Results of U.K. study

CAUSAL FACTORS
Tour helicopters; Vegas Premier

DODGING DANGER
THE IMPORTANCE OF RADAR TRAINING

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

APRIL 2007

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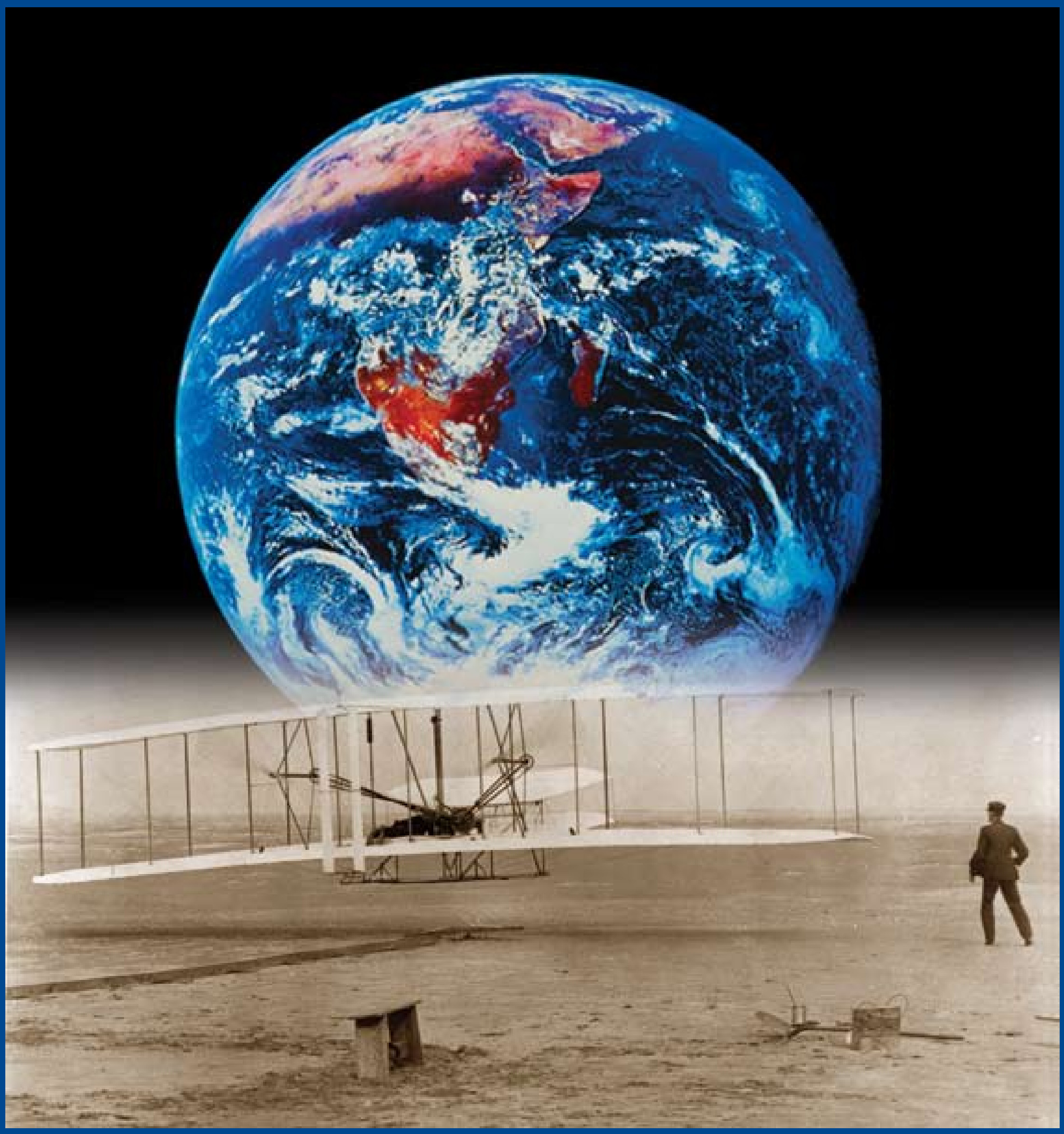

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CROSSING Boundaries

My particular safety preoccupation these days is with that special type of human error that flows freely through the remaining gaps in our system. We have done a pretty good job trapping errors, but in a couple of places we are going to have to step up our game.

Recently, Flight Safety Foundation brought airlines, pilots, manufacturers, air traffic control (ATC) organizations, regulators and airports together for a runway safety health check (*ASW*, 3/07, p. 5). The resulting discussions made it clear that plenty of the old gaps are being filled. On runway incursions, cross-cutting runway safety action teams are being organized around the world, and so many training aids are being produced that we could hardly list them all. Things are also positive in the area of runway confusion, where the U.S. Commercial Aviation Safety Team is helping airports, ATC and pilots work together to avoid this dangerous trap.

But what is really surprising is the state of play in the age-old problem of runway excursions. These events have always accounted for a large percentage of commercial jet accidents. Everybody can help avoid this type of accident but, so far, everybody has been playing his or her role pretty much in isolation. The end result is that pilots don't get a lot of help figuring out if they can stop on the runway or not, so sometimes they don't. The good news is that with everybody now aware of this problem, we should be able to come up with an end-to-end solution.

It isn't just the old gaps we have to worry about. Lots of long-awaited ATC technologies finally are being implemented. As beneficial as these technologies are, they can lead to new human errors and new consequences. For example, improved navigational capabilities that reduce the chance of collision due to random navigation errors can increase the risk of a collision when a human error occurs. This difficult problem looks very different, depending on which side of the microphone you are sitting on, and clearly must be mitigated end-to-end. We had better get it right because the situation will get even more complicated as we start dealing with things like automatic dependent surveillance-broadcast, airborne separation and so on.

There is hope. U.K.'s National Air Traffic Services (NATS) has shown us how to reach across an old divide to mitigate human error. They put in place systems using the Mode S transponder to tell them if a pilot has selected an altitude other than what the controller expects. NATS has spent a lot of time and money putting a system in place that helps trap an error they wouldn't even be blamed for. They didn't do it because it was their job but because it was the best way to reduce the risk of an accident. If we all follow this example, reaching across boundaries to stop human error, we can look forward to a positive and exciting future.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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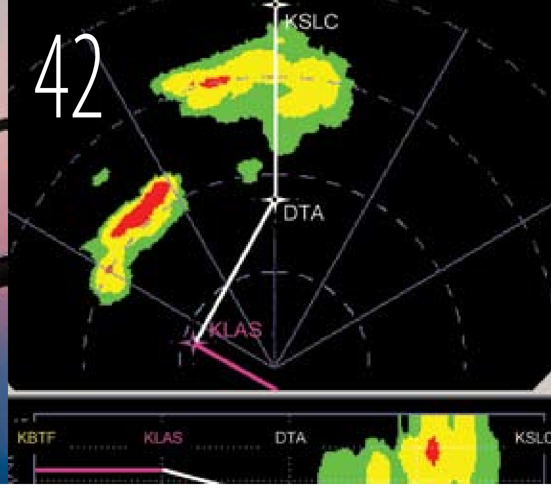

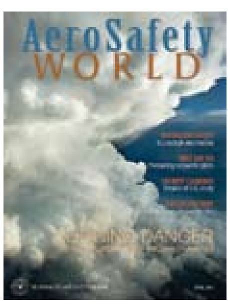

About the Cover
Properly used, radar shows the way around hazardous weather.
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If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about aviation safety, we will be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

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NOT NEWER, Better

Sadly, there are times when we have no need to read the statistical tea leaves to predict developing safety hazards. Data tools, designed for an environment in which accident rates have fallen to such a low level that accidents are almost statistical anomalies, become unnecessary when airplanes actually crash and people are killed. Accidents in Africa spotlighted the huge needs of that region, and now we are seeing a similar cry for help from Indonesia.

A populous nation of many islands, Indonesia must rely on aviation to a much greater degree than nearly all other developing nations to allow its inhabitants free movement and to facilitate economic growth. While the nation's rather healthy economic development and new airline competition have increased traffic, its aviation system may not have not kept pace.

The two most recent fatal crashes have, at this writing, undetermined causes. The investigation of the first, that of new entrant airline Adam Air, awaits the retrieval of cockpit voice and flight data recorders from the ocean floor, a wait that grows longer as the parties involved refuse to accept the financial responsibility for that expensive operation.

There should be no delay. The government should move quickly to secure the recorders so that the cause of the accident can be determined with a greater certainty, leaving the financial wrangling for the aftermath, when the time spent no longer threatens the development of a safety response.

Investigation of the second accident, involving national flag carrier Garuda Indonesia, is moving ahead at a good speed, leading to hope that a well-considered report will be forthcoming in the near future.

However, it is disturbing that Indonesian officials, who have proposed that aircraft over 10 years of age be replaced, are grasping at false solutions in a bid to quickly answer the public outcry. It may very well be that these older airplanes have been ill-maintained and need to be grounded, but a comprehensive inspection of the fleet is not, to our knowledge, the basis for the decree. Rather, the move relies on a public misconception that older aircraft are more dangerous than new aircraft in the same way dilapidated cars and trucks are more hazardous than new vehicles.

Aviation people know quite well that a well-maintained aircraft can fly safely for many decades, especially if its avionics are kept up to state-of-the-art standards.

In fact, the consequences of a blanket requirement to eliminate older aircraft in the name of improving safety are likely to be more bad than good. None of the region's airlines are rich; in fact, many are struggling, including debt-ridden, government-owned Garuda, as it faces new low-cost competition throughout the region. The forced replacement of older aircraft with newer aircraft will, at the very least, reduce air service capacity — unpopular and economically devastating for a nation so dependent on air travel. However, attempts to use other resources to soften the capacity crunch raise the possibility that something, somewhere, that is essential for safe operations will be cut.

In the long run, governments are better served by investing in their own staff and agencies to ensure that existing rules are enforced and guidelines are adopted, rather than micromanaging the commercial decisions of operators.

J.A. Donoghue

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

More on Center of Gravity

In "One Size Fits All: The Danger of Average Weights," by Keith Glasscock [*ASW*, 7/06, p. 55], a statistical analysis is made of possible errors in determining the center of gravity of, among other things, the passenger load in the cabin of an airplane resulting from the use of so-called average passenger weights rather than the actual passenger weights. It is concluded that such errors in the center of gravity position could, in extreme cases, lead to exceedance of the certified forward and aft center of gravity limits.

However, I do agree with most comments and observations made by Patrick Chiles "Filling the Envelope: How Risky Are Average Weights?" [*ASW*, 12/06, p. 24].

I'd like to add some explanatory notes on the position of the center of gravity of the passenger load in some examples of hypothetical cabins with uniformly distributed seats, varying in size between say four (two rows of two seats) and 400 (50 rows of eight seats). It is obvious that if all seats are taken, the center of gravity will be located in the middle of the cabin. This applies to the "four-seater" and to the "400-seater" as well as to all "in-between" cabins. If we look at a passenger load factor less than 100 percent, the same applies, provided the passengers are distributed uniformly over the length of the cabin.

It will also be clear that the greatest possible center of gravity deviation will occur at a passenger load factor of 50 percent, if all passengers are either seated in the front half of the cabin or in the rear half. In these extreme cases, the center of gravity (of the passenger load) will be located at either the one-quarter position or the three-quarters position of the cabin length.

An important observation is that in case the passengers are free to select their seats, such extreme passenger distributions are very improbable on a 400-seater or even on a 40-seater, but very probable on a four-seater. This explains why small aircraft are much more sensitive to non-uniform passenger distributions than larger aircraft. For similar reasons, the use of average passenger weights on small aircraft may easily lead to large center of gravity errors and are, therefore, not acceptable on those aircraft. It is suspected that uncontrolled free seating (uniform passenger distribution not enforced in one way or another) probably occurs in the day-to-day routine many places in the world.

Both papers make reference to the recent FAA Advisory Circular 120-27E, which contains detailed directives on acceptable weight and balance procedures for U.S. operators. Many of the operators in the world, however, have to comply with different criteria that are not necessarily equivalent. It might be desirable for *AeroSafety World*, the journal of the international Flight Safety Foundation, to draw attention to this aspect.

Joop Wagenmakers
KLM Royal Dutch Airlines (retired)
Former consultant, Netherlands Civil Aviation Authority and Joint Aviation Authorities Performance Subcommittee

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

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

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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. *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/seminars.html#cass>, +1 703.739.6700, ext. 101.

MAY 13–17 ➤ Aerospace Medical Association 78th Annual Scientific Meeting. New Orleans. Dr. Russell B. Rayman, <rrayman@asma.org>, <www.asma.org/meeting/index.php>, +1 703.739.2240, ext. 103.

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 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 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.

JUNE 4–7 ➤ SimTecT 2007: Simulation Conference and Exhibition. Simulation Industry Association of Australia. Brisbane. <simtect2007@consec.com.au>, <www.siaa.asn.au/simtect/2007/2007.htm>, +61 2 6251 0675.

JUNE 5–6 ➤ 5th Annual Regional Airline Industry Flight Technology Conference. Regional Airline Association. Washington, D.C. <www.raa.org>, +1 202.367.1170.

JUNE 6–7 ➤ 13th Annual Asia Pacific Airline Engineering & Maintenance Conference. Aviation Industry Conferences. Bangkok, Thailand. <ruthm@aviation-industry.com>, <www.aviationindustrygroup.com>, +44 (0)207 931 7072.

JUNE 8–10 ➤ 2007 Regional Air Safety Seminar. Australian and New Zealand Societies of Air Safety Investigators. Wellington, New Zealand. Peter Williams, <p.williams@taic.org.nz>, +64 4 473 3112.

JUNE 10–13 ➤ 79th Annual AAAE Conference and Exposition. American Association of Airport Executives. Washington. <AAAEmeetings@aaae.org>, <www.aaae.org>, +1 703.824.0500.

JUNE 12–14 ➤ 2007 Flightscape Users Conference. Flightscape. Ottawa. Christine Fernandes, <christine.fernandes@flightscape.com>, <www.flightscape.com/about/conferences.php>, +1 613.225.0070, ext. 231.

JUNE 18–24 ➤ 47th International Paris Air Show. Le Bourget, Paris. <exposants@salon-du-bourget.fr>, <www.paris-air-show.com/en/index.php>.

OCT. 1–4 ➤ 60th annual International Air Safety Seminar. Flight Safety Foundation, International Federation of Airworthiness, and International Air Transport Association. Seoul, Korea. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org/seminars.html#iass>, +1 703.739.6700, ext. 101.

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If you have a safety-related conference, seminar or meeting, we'll list it. Get the information to us early — we'll keep it on the calendar 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

NTSB Issues New Icing Recommendations

Training for pilots of Cessna Citation 560s should be altered to emphasize requirements for increasing airspeed and operating deice boots during approaches when ice is on the wings, the U.S. National Transportation Safety Board (NTSB) says.

The proposal was one of six NTSB safety recommendations to the U.S. Federal Aviation Administration as a result of the NTSB investigation of a Feb. 16, 2005, accident in which a Cessna 560 operated by Martinair for Circuit City Stores crashed near Pueblo, Colorado, U.S. The six passengers and two crewmembers were killed in the accident, which destroyed the airplane.

© Comstock Images

The NTSB said that the probable cause of the crash was the crew's "failure to effectively monitor and maintain airspeed and comply with procedures for deice boot activation on the approach." The result was an aerodynamic stall and the crash.

NTSB recommendations also called for changes in pilot training to "emphasize monitoring skills and workload management," changes in manuals and training programs to emphasize that leading-edge deice boots be activated as soon as an airplane enters icing conditions, and a requirement that deice boot systems on airplanes certified for flight in known icing conditions be equipped with a mode to automatically continue cycling the deice boots after the system has been activated.

Other recommendations were for a review of the icing certification of airplanes with pneumatic deice boots to ensure that the airplanes comply with requirements for recommended revised certification standards, and modification of the Cessna 560 stall-warning system "to provide a stall-warning margin that takes into account the size, type and distribution of ice, including thin, rough ice on or aft of the protected surfaces.

Black List Revisions

The European Commission has updated its so-called black list of airlines banned in the European Union (EU), removing two carriers — Phuket Air of Thailand and DAS Air Cargo/Dairo Air Services of Uganda and Kenya — that "have proved … that they have now rectified the serious safety deficiencies" that placed them on the list, the commission said.

The names of 49 carriers have been removed from the list of those whose operations are banned within the EU because they are no longer operating; names of 10 others have been added, the commission said. About 100 airlines are on the list. In addition, Pakistan International Airlines is permitted to operate within the EU only with its Boeing 777s.

Other actions at a March 5 commission meeting included acknowledgement of actions by Bulgaria to temporarily block five Bulgarian carriers from operating into other EU member nations, pending implementation of remedial measures, and by Russia to prohibit nine carriers from operating charter flights and some other flights into the EU, except under "exceptional circumstances," the commission said.

Susan Reed

U.S. Army

Night Vision Trial

Pilots in some civilian helicopter operations in Australia will participate in a year-long trial of night vision goggles (NVGs) as part of an assessment of proposed NVG standards for eventual incorporation into the Australian Civil Aviation Safety Regulations.

Participants in the trial are specialized operators that already have approval to use NVGs on emergency medical services, search and rescue, marine pilot transfer, police and aerial fire fighting flights. Private helicopter operators are prohibited from using the devices until the trial and a subsequent evaluation have been completed; then holders of air operator certificates may submit applications to the Civil Aviation Safety Authority for approval to use NVGs.

World's Largest LOSA

Japan Airlines (JAL) plans to implement a line operations safety audit (LOSA) beginning in April to help reduce human error in flight operations and improve operational quality. The airline says this will be the largest LOSA ever performed at a single airline.

JAL
JAPAN AIRLINES

The International Civil Aviation Organization recommends the use of LOSA, which involves the collection of data by trained observers during routine flights to determine how flight crews detect, manage and mismanage threats and errors.

The JAL program will place LOSA observers on 435 domestic and international flights. Their human factors observations will be analyzed by TLC, a LOSA operating company; based on the analysis, JAL will implement any necessary corrective actions.

Aging Aircraft

The average age of many aircraft fleets in Australia is increasing, but the Australian Transport Safety Bureau (ATSB) says this should not adversely affect safety "if quality maintenance systems are in place."

An ATSB report said that, as of the end of 2005, the average age of turbofan aircraft with maximum takeoff weights between 50,000 kg and 100,000 kg (110,230 lb and 220,460 lb) used in regular public transport in Australia was six years — two years newer than the average age in 1995. Turbofan aircraft with maximum takeoff weights of more than 100,000 kg had an average age of 11 years, compared with eight years in 1995.

The ATSB said that the relatively new age of the aircraft and the manufacturers' continuing airworthiness support "provide a double defense to ensure the safety of the Australian multi-engine turbofan aircraft fleet."

Turboprop aircraft, typically used in low-capacity airline service, had an average age of 18 years at the end of 2005, two years older than the 1995 average, the ATSB said.

The oldest airplanes are those in the piston-engine fleet, with an average age of 30 years, largely because manufacturing output has declined in recent years, the ATSB said.

"Aging of an aircraft can be a safety issue, but with adequate maintenance, the consequences of aging can be mitigated," the ATSB report said.

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CRJ Flap Failures

Citing concerns over a number of flap failures on Bombardier Canadair Regional Jets (CRJs), the Transportation Safety Board of Canada (TSB) has called on the Canadian Minister of Transport to act to "substantially decrease the number of flap failures."

The TSB statement was issued after preliminary investigation of a Nov. 21, 2006, incident in which the flaps failed to retract on an Air Canada Jazz CRJ during a missed approach at Prince George, British Columbia. The flight crew diverted to Fort St. John, tried unsuccessfully to correct the problem during the flight and landed the airplane without further incident at Fort St. John. No one was injured, and the airplane was not damaged in the incident, which is still being investigated.

There were 20 reports of flap failures on CRJ airplanes in 2005, 24 reports in 2006 and 24 reports in just the month of January 2007 — data that suggest that the frequency of the problem may be increasing, the TSB said. A search of a joint Canadian-U.S. service difficulty report database found that, of 751 reports of flap problems in 2006, 381 (51 percent) occurred on CRJ series aircraft.

"The [TSB] is concerned that, despite best efforts by the industry and regulators alike to reduce the number of flap failures in the CRJ fleet, that number is increasing," the TSB said. "A CRJ flap failure clearly has the potential to lead to a much more serious incident or an accident."

Published reports said Bombardier had determined that the problem was associated with extreme cold weather and that the company was developing methods of correcting the problem.

© Bombardier

Legislating Safety

Canadian airline pilots are urging approval of legislation in Canada's House of Commons that would require establishment of safety management systems (SMS) throughout that nation's aviation industry.

The proposal would establish accountability for safety "at the highest levels within a company" and provide for the establishment of confidential and non-punitive safety programs for the reporting of safety information "without fear of retribution," said Capt. Dan Adamus, president of the Canada Board of the Air Line Pilots Association, International (ALPA).

"Rather than depending on increasingly rare airline accidents to identify safety risks, our industry needs a proactive approach to identifying hazards before accidents occur," Adamus said. "Safety data must be collected within a safety-centered and non-punitive culture where pilots and other aviation employees feel comfortable reporting emerging risks."

In Other News …

The **U.S. Government Accountability Office** says the Federal Aviation Administration is facing "data and human resource challenges" that could complicate implementation of its risk-based, data-driven safety programs to oversee the aviation industry. … The **Civil Aviation Safety Authority of Australia** plans to establish an Office of Airspace Regulation, to be responsible for reviewing airspace classification and designation; the tasks currently are performed by Airservices Australia.

Compiled and edited by Linda Werfelman.

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ON THE VERGE

With the first very light jets making their way toward the flight line, analysts foresee a spate of accidents — and features likely to yield safety benefits in the long run.

BY LINDA WERFELMAN

As very light jets (VLJs) enter flight lines around the world, analysts expect accident rates at levels that — initially — will exceed those of other business aircraft.

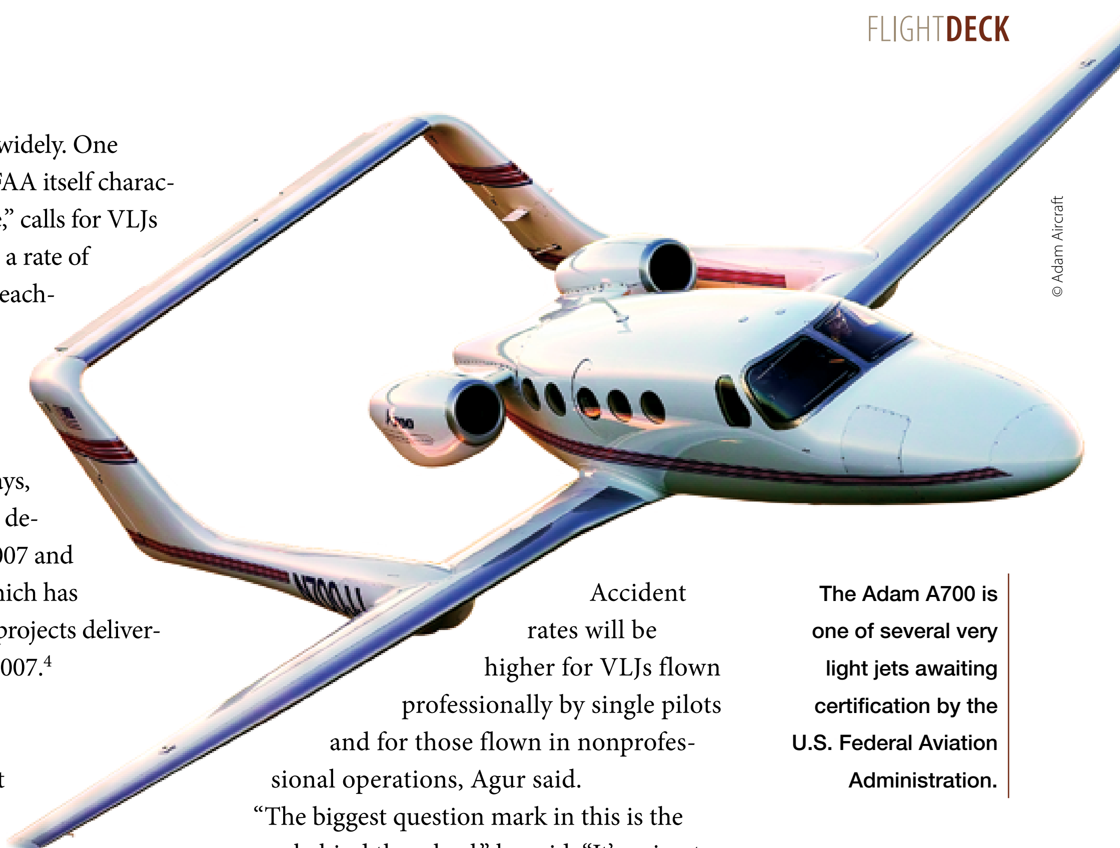
Increases in accident rates historically have followed the introduction of new aircraft types. However, for the VLJs, several factors — notably their avionics and automation systems — are expected not only to help mitigate the increases but also to be the impetus for industry-wide safety improvements.

VLJs — defined as turbofan-powered airplanes weighing 10,000 lb (4,360 kg) or less and sometimes called "microjets" or "personal jets" — have begun to trickle into the business jet fleet. The first production certificate for a VLJ was issued Nov. 22, 2006, by the U.S. Federal Aviation Administration (FAA) to Cessna Aircraft for its Citation Mustang; the same day, the first Mustang was delivered to a customer. The only other VLJ manufacturer to deliver an aircraft is Eclipse Aviation, whose first Eclipse 500 was turned over to a customer in January.

Plans for most VLJ models are for twin-engine aircraft with four to six seats, typically capable of being flown at speeds of 300 kt or more and at altitudes up to 41,000 feet. Most are priced from about US$1 million to nearly $3 million. Most also are equipped with systems designed to reduce pilot workload and increase safety, including traffic-alert and collision avoidance systems, terrain awareness and warning systems (TAWS), real-time weather data and weather displays, and integrated electronic flight bags.

Many of these aircraft are expected to be flown by professional pilots in unscheduled commercial operations and corporate operations; some will be flown by nonprofessionals, typically pilots with considerable experience in turboprops or piston airplanes with highly integrated cockpits — that is, cockpits in which flight guidance, airplane systems and situational awareness control and display functions are combined into a minimum number of interdependent electronic displays.

Production projections vary widely. One forecast, by the FAA, which the FAA itself characterized as "relatively conservative," calls for VLJs to enter the active aircraft fleet at a rate of about 400 to 500 aircraft a year, reaching nearly 5,000 by 2017.[1] Other forecasts have predicted 15,000 VLJs by 2020.[2] However, Eclipse Aviation CEO Vern Raburn has said that, despite production delays, he expects that Eclipse alone will deliver about 400 Eclipse 500s in 2007 and nearly 1,000 in 2008.[3] Cessna, which has recorded sales of 250 Mustangs, projects deliveries of about 40 of the aircraft in 2007.[4]



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The Adam A700 is one of several very light jets awaiting certification by the U.S. Federal Aviation Administration.

Unavoidable Accidents

As these new-generation aircraft enter the fleet, accidents will be unavoidable, analysts say.

"You can look at a number of new-generation aircraft, compared to those same aircraft in later years, and accident rates start out relatively high," said Robert Matthews, senior aviation safety analyst at the FAA Office of Accident Investigation. "Then you have kind of a learning curve, and after that, the accident rate comes down. The learning curve gets shorter with every generation of aircraft. … The real point is that, after the ever-shorter learning curve passes, the accident rate for a new generation of aircraft reaches a stable state that is well below [the accident rates] of preceding generations."

The shortening of the learning curve is a result of the knowledge accumulated by pilots and operators during the introductory phases of earlier aircraft generations, Matthews said.

Eventually, he and other analysts said, the accident rates for VLJs will differ little from accident rates for other business aircraft.

"Professionally flown VLJs will have an accident rate that's comparable to the business jet fleet," said Peter v. Agur Jr., president of The VanAllen Group, a business aviation consulting group, and a member of the FSF Corporate Advisory Committee.

Accident rates will be higher for VLJs flown professionally by single pilots and for those flown in nonprofessional operations, Agur said.

"The biggest question mark in this is the person behind the wheel," he said. "It's going to take a substantial mind-set change for some of them to realize that they can't fly a VLJ like they would fly a Cirrus or a Bonanza."

Training should help to accomplish that mind-set change, he said, referring to the partnerships that have developed between manufacturers and training vendors — often with encouragement from insurance companies — to craft training programs specific to each type of VLJ. Some of these training programs will rely, in part, on "mentor pilots" with experience in the aircraft to accompany the new VLJ pilots during their initial time in the cockpit.

The U.S. National Business Aviation Association (NBAA) has recommended a rigorous training process for single pilots of VLJs to address the areas of greatest risk, including many that touch on insufficient skills for use of a flight management system, autoflight equipment or another elements of the avionics and/or automation system. Among the areas emphasized for single pilots is single pilot resource management (SRM), the single-pilot version of crew resource management. SRM training discusses "the process of managing resources available to the single pilot, [including]

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Representatives of Avidyne say simplification of cockpit instrumentation was a primary consideration for designers of the Entegra.

© Avidyne

the pilot's resource of preflight planning, personal knowledge, materials and personnel on board the aircraft, and additional resources beyond the cockpit," NBAA says.[5]

Safety Influences

In the long run, some of the VLJs' own attributes may have the greatest influence on safety — not just for VLJ pilots and operators but also for other elements of the aviation industry.

"Some of it is pretty obvious — flying at high altitudes will keep these airplanes above much of the weather and high above terrain," Matthews said, noting that altitude should provide some protection against en route weather-related problems and controlled flight into terrain. In addition, their higher power-to-weight ratios will give pilots an ability to at least maintain a safe altitude after an engine failure, he said.

Perhaps the most influential safety factor, however, may prove to be the advanced avionics and automation systems installed in VLJ cockpits.

"There is no question that these systems will constitute the greatest in-flight resource" for VLJ pilots — especially single pilots, said Capt. Richard J. Walsh, vice president of flight operations and business continuity for Cardinal Health and former director of operations and training for United Airlines.[6]

Agur said that the highly sophisticated avionics installed in VLJs will "improve the quality of information, and the simplicity of the automation of the system will be beneficial" in safe operations of the aircraft.

Mark Sandeen, vice president of sales and marketing for Avidyne — whose Entegra integrated avionics system will be in the cockpits of the Adam 700 and Spectrum VLJs — said that simplification of cockpit instrumentation and automation was a primary consideration for Entegra designers.

"A simpler flight deck is a safer flight deck," he said.

The Entegra system will present standard flight instrumentation — attitude director indicator, horizontal situation indicator, altimeter, airspeed indicator and vertical speed indicator, as well as a moving map and weather, terrain and traffic information —simultaneously on high-resolution, flat-panel, liquid crystal displays and coupled with the autopilot.

"Having all of this information displayed at one time on one page … is probably one of the biggest changes in 10 years," Sandeen said.

Among the Entegra's features is an integrated air data computer that provides a continuously

The Cessna Citation Mustang was the first very light jet to receive production certification from the U.S. Federal Aviation Administration.

updated on-screen display of wind speed and direction, "taking the guesswork out of finding the right altitude to optimize … flight time," the company says.

In addition, six-second trend indicators for airspeed, altitude and heading — typically installed on air transport jets — can help reduce pilot workload associated with changing or maintaining airspeeds or altitudes, the company says.

Garmin's G1000 integrated avionics suite is being installed in the Cessna Citation Mustang. In the Mustang, the avionics suite includes two 10-in (25-cm) primary flight displays and one 15-in (38-cm) multi-function display (MFD) — to present primary flight, navigation and communication information, as well as information on terrain, traffic, weather, engine instrumentation and crew-alerting system data. The all-glass avionics suite is designed to "simplify operation, enhance situational awareness and increase flight safety," Garmin said.[7]

The integrated GFC 700 automatic flight control system includes roll, pitch and yaw control, and automatic pitch trim and Mach trim control, using data available to the G1000 to maintain airspeed references, Garmin said.

The Mustang was the first aircraft with an integrated flight deck to receive wide area augmentation system (WAAS) certification, enabling pilots to use global positioning system (GPS) information for precision instrument approaches. The primary benefit of WAAS navigation is that it provides pilots with highly accurate information about their aircraft's latitude, longitude and altitude. A 2003 Flight Safety Foundation study concluded that use of WAAS-based instrument approaches could prevent 141 accidents and 250 fatalities over a 20-year period.[8]

Among other features on the G1000 is the Garmin SafeTaxi program, which helps pilots navigate at unfamiliar airports by providing a graphical representation of airport runways,

Eclipse Aviation calls the Avio NG avionics system on its Eclipse 500 a "virtual copilot."

taxiways and hangars, along with the position of the aircraft on the ground. The program will include information on more than 700 U.S. airports; information on other U.S. airports and international airports will be added in the future.

The G1000 also includes ChartView, an electronic version of Jeppesen approach charts and airport diagrams that can be viewed on the MFD, thereby reducing the amount of paper in the cockpit, and FliteCharts, an electronic version of the U.S. National Aeronautical Charting Office (NACO) *U.S. Terminal Procedures Publication*, which includes departure procedures, standard terminal arrival routes, approach charts and airport diagrams.[9] About 17,500 approach plates for 2,916 airports are included.

Garmin's G1000 with many of the same features, and a new name — the Prodigy flight deck — will be installed in the eight-seat Embraer Phenom 100, expected to enter service in 2008.

'Virtual Copilot'

Eclipse Aviation characterizes its Avio NG avionics system as a "virtual copilot" designed to reduce pilot workload in the Eclipse 500 by "simplifying tasks, generating useful information, managing systems and assisting with troubleshooting."[10] The Avio NG will be produced with Innovative Solutions and Support, Honeywell, Chelton Flight Systems, Garmin International and PS Engineering — a partnership that was announced after Eclipse and Avidyne ended their working relationship in February.

The system, which uses integral, redundant computer systems to apply integration technology throughout the aircraft, "goes to work as soon as power is applied to the Eclipse 500 jet, bringing all aircraft systems to life and confirming normal operation," the company says. "Avio NG prompts electronic checklists and walks the pilot through FMS entry, and calculates weight and balance, and performance."[11]

During approach, the system "helps simplify this critical stage by maintaining approach speed with autothrottle, slowly bringing cabin pressure down and automatically keeping fuel balanced between the tanks," the company says. Later, Avio NG verifies that the landing gear is down and locked and that flaps are set.

Accident Avoidance

In a 2006 analysis of VLJ safety benefits and risks, Matthews said that their advanced avionics and real-time weather displays and flight monitoring — combined with other factors such as pilot training and increased engine reliability — would have helped avoid half of all fatal accidents that occurred in the past 10 years among airplanes operating under U.S. Federal Aviation Regulations Part 135, *Commuter and On-Demand Operations*.[12]

"With first-class avionics, with TAWS and terrain displays, it would be a whole lot easier for these aircraft to avoid flying into terrain," Matthews said.

Agur said that the avionics and automation features being incorporated into VLJs eventually will lead to improvements in larger aircraft, including airliners.

"The development of integrated avionics technologies will be driven by the need for automation in single-pilot operations in VLJs, but it will affect the equipment in cockpits across the board," Agur said. "These developments designed for VLJs will stimulate advances system-wide, driving safety improvements for the entire industry.

"In the long run, what's coming for VLJs now will be tremendously beneficial to the rest of the industry." ●

Notes

1. U.S. Federal Aviation Administration (FAA). *FAA Aerospace Forecast, Fiscal Years 2006–2017*.
2. Baxter, Mary Pat. "So What's All This About VLJs?" *FAA Aviation News*. July–August 2006.
3. Trautvetter, Chad. *A Better Brain for the Eclipse 500*. <www.avweb.com/avwebflash/news/Better_Brain_Eclipse_500>.
4. Cessna Aircraft Co. *Cessna Delivers First Citation Mustang, Gains FAA Production Certificate*, Nov. 22, 2006. *Cessna Citation Mustang Wins Full FAA Certification*, Sept. 8, 2006. <www.cessna.com/news/archives.chtml?year=2006>.
5. U.S. National Business Aviation Association (NBAA). *NBAA Training Guidelines: Single Pilot Operations of Very Light Jets and Technically Advanced Aircraft*. January 2005.
6. Walsh, Richard J. "Risk Management for Very Light Jets." In *Aviation Safety — Contemporary Challenges: Proceedings of the 50th Annual Corporate Aviation Safety Seminar*. Alexandria, Virginia, U.S.: Flight Safety Foundation, 2005.
7. Garmin. *Cessna Selects Garmin's Integrated Avionics System for Citation Mustang*. March 31, 2003. <www.garmin.com/pressroom/corporate/033103.html>. *Garmin G1000 Enhancements Provide New Capabilities and Added Safety*. <www.garmin.com/pressroom/aviation/101706.html>.
8. Dodd, Robert; Jobanek, Jan M.; Li, Guohua; Barnett, Arnold. "Safety Benefits of the Wide Area Augmentation System During Instrument Approaches." *Flight Safety Digest* Volume 22 (May–June 2003): 22–46.
9. This U.S. National Aeronautical Charting Office (NACO) information is more commonly associated with a NACO sister agency, the National Ocean Service (NOS).
10. Eclipse Aviation. *Eclipse Aviation Partners With World-Class Suppliers to Deliver Next-Generation Avio Total Aircraft Integration System*. March 5, 2007.
11. Eclipse Aviation. *The Next Generation of Avio Total Aircraft Integration*. <www.eclipseaviation.com/eclipse_500/avio>.
12. Matthews, Robert. "Corporate Aviation Safety: The Year in Review." In *Aviation Safety — Supporting the Corporate Mission: Proceedings of the 51st Annual Corporate Aviation Safety Seminar*. Alexandria, Virginia, U.S.: Flight Safety Foundation, 2006.

Further Reading From FSF Publications

Werfelman, Linda. "Sidestepping the Airway." *AeroSafety World* Volume 2 (March 2007): 40–45.

FSF Editorial Staff. "Here Come the Very Light Jets." *Flight Safety Digest* Volume 24 (July 2005).

FSF Editorial Staff. "Increased Reliance on Automation May Weaken Pilots' Skills for Managing System Failures." *Human Factors & Aviation Medicine* Volume 52 (March–April 2005).

FSF Editorial Staff. "RVSM Heightens Need for Precision in Altitude Measurement." *Flight Safety Digest* Volume 23 (November 2004).

FSF Editorial Staff. "Global Implementation of RVSM Nears Completion." *Flight Safety Digest* Volume 23 (October 2004).

"The development of integrated avionics technologies will be driven by the need for automation in single-pilot operations in VLJs."

Four Frames Per Second

Cockpit image recording tests show many issues remain unresolved.

BY WAYNE ROSENKRANS

Proposals to enhance accident investigation with imagery from cameras in the cockpit show a combination of strengths and weaknesses, according to U.K. Civil Aviation Authority (CAA) research. "The results of the research were mixed," the CAA's report said. "Although image recorder systems do provide some benefits, this research has not found them to be as effective as has been postulated by some accident investigation agencies. … Image recording systems can gather large amounts of data that may assist accident investigation without providing explicit identification of the flight crew."[1]

Accident investigators have imagined many benefits if cameras continuously captured action on the flight decks of large commercial jets to supplement flight data recorders (FDRs) and cockpit voice recorders (CVRs), or to see what preceded an event involving a small turbine-powered airplane or helicopter not equipped with an FDR or CVR.

Guesswork about the technical feasibility has been reduced by the CAA report. However, the long-running controversy about these proposals has not been resolved to the satisfaction of airline pilot associations, aircraft operators or regulators.

Anyone familiar with video camcorders and digital cameras — but not closely following this issue — readily could become lost in the semantics. For example, what some proponents now envision is not full-motion video but sequences of still photos.

A March 2003 European Organisation for Civil Aviation Equipment (EUROCAE) specification — adopted by the U.S. Federal Aviation Administration (FAA) for a technical standard order in July 2006 — actually calls for color images more like those from intermittent closed-circuit surveillance at a bank than the approximately 30 frames per second required for full-motion video in the United States. The minimum EUROCAE-specified data — effectively 12,600 compressed images in two hours — requires about three gigabytes of crash-protected solid-state storage per camera, a much greater amount than required by current-model CVRs and FDRs. The specification also calls for dual-password encryption of images, designed to prevent unauthorized viewing.[2]

The specification essentially calls for installing cameras only behind and/or above the flight crew and facing forward so that instruments, flight controls and the pilots' hands can be seen clearly but the pilots' heads and shoulders are not recorded while they are in their normal seating positions.

EUROCAE said that key factors affecting visual quality include frame rate, resolution, camera position, ambient lighting, lens type and the software algorithm used to compress data output by an imaging sensor. Its specification describes five uses of cameras, called Type A, B, C, D and E. In a Boeing 737 simulator, the CAA study used one Type A camera (Figure 1), covering a general area, including workstations, instruments and controls; and four Type C cameras covering instruments and control panels, including the forward instrument panel, overhead panel, center pedestal and displays. Types B, D and E would record datalink messages, head-up displays and non-cockpit images such as cabin or cargo views, respectively. The Type A camera would be "required to capture data supplemental to conventional flight recorders" at a rate of four images per second for the most recent 30 minutes and one image per second for the period 30 minutes to two hours older. The Type C camera would provide a "means for recording flight data where it is not practical or [is] prohibitively expensive to record on an FDR, or where an FDR is not required." This camera

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would capture one image per second for the most recent 30 minutes and one image per two seconds for the period 30 minutes to two hours older.

In each simulator scenario, the researchers induced system failures, problems and excessive workload intended to lead to a serious incident. FDR-equivalent data and recordings from CVR equipment installed in the simulator were studied by a German accident investigator from the Bundesstelle für Flugunfalluntersuchung/Federal Bureau of Air Accident Investigation (BFU), while images from a cockpit image recording system were studied by a French accident investigator from the Bureau d'Enquêtes et d'Analyses (BEA); neither initially had access to the other investigator's data. The investigators then compared all sources to determine if their conclusions would change.

Images showed that instruments had gone blank, the presence of smoke, and hand movements reflecting attempts and failures by the crew to resolve a problem — actions that might not be discernible from FDR and CVR data. They could intrude into flight crew privacy, however, if cameras were not installed in accordance with the EUROCAE specification. The images also could be misleading when seen in isolation.

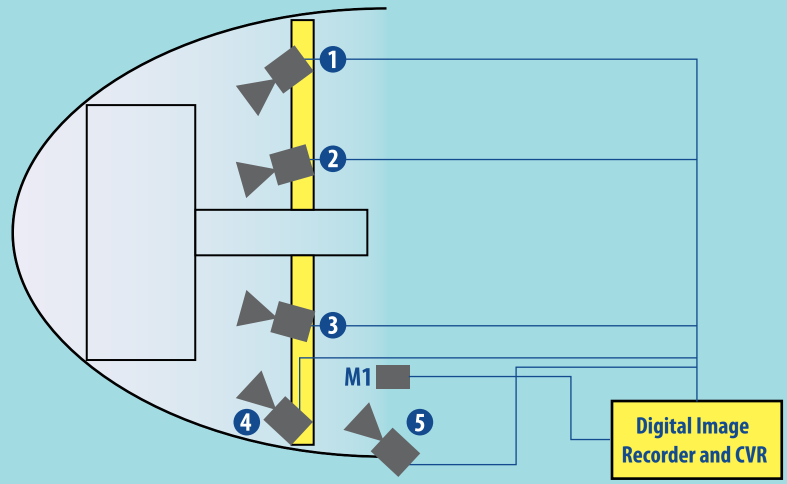
In the study, images also successfully showed pilot adherence to checklist procedures; checklist actions and silent communication, such as hand gestures; and visible aircraft motions caused by simulated turbulence. Some images did not show the desired information, such as "status of systems which have no display."

Reports by the investigators varied in describing crewmember actions — one omitting mention of the preflight checks seen in images. "The differing analyses of the image data clearly show that the investigator's focus or 'slant' has a definite effect on the amount of useful information that can be obtained from an image recorder," the report said. For example, one investigator concentrated more on describing what was observed without explanation, and the other explained why actions occurred with less descriptive detail.

In one scenario, investigators could see what alerts were displayed to the flight crew and that pilots had attempted to perform physical tasks without success, such as trying but failing to deploy thrust reversers. "This means that it may be possible to determine that a flight crew were unable to perform necessary mitigating actions rather than simply failing to take them," the report said. Another scenario showed that the investigators could substantiate each other's observations of a hydraulic system failure with images and the FDR/CVR data. Similar corroboration occurred for an electrical system failure. "It is also interesting to note that this scenario shows that there are some forms of information that cannot be obtained using any type of flight recorder (e.g., what the flight crew are looking at)," the report said.

Analysis of one scenario raised the possibility that information normally displayed to the flight crew and recorded on the FDR actually was not displayed to them. "As this may lead to a reduction in the number of accidents that are deemed to result from pilot error, it is a significant result," the report said.

Camera Placement in Boeing 737 Simulator



CVR = Cockpit voice recorder   M1 = Cockpit area microphone for CVR

Notes:

1. Type C camera with 8-mm lens covering pilot main displays
2. Type C camera with 6-mm lens covering engine instruments
3. Type C camera with 6-mm lens covering throttles and center panel
4. Type C camera with 8-mm lens covering copilot main displays
5. Type A camera with 3.5-mm lens covering cockpit general area

Cameras were mounted on a bar, just behind and above the pilot seats.

Camera uses (types) are specified by the European Organisation for Civil Aviation Equipment.

Source: U.K. Civil Aviation Authority

Figure 1

Smoke Could Be Overlooked

Smoke particles dense enough to be visible to the crew also were visible in images. But one investigator identified smoke in images while the other did not. "Whether or not the investigators see it will depend upon how dense the smoke is and whether another source of information has led them to look for it," the report said. "[Researchers] agreed [that] … guidance needs to be drafted for the analysis of image data."

The report concluded that investigator training would be just as important as the technological solution proposed. "As images can be especially compelling — and this research has shown that image data can be misleading, even when analyzed by specialists in accident investigation — it is recommended that the analysis and interpretation of image data should only be performed by those specifically trained in this discipline," the report said.

Imaging Technology Evolves Quickly

In the EUROCAE specification, the cameras covering a general area would have sufficient resolution to enable accident investigators to study "ambient conditions on the flight deck (smoke, fire, lighting, etc.); general crew activities such as use of checklists, charts, etc.; health and well-being of the crew; nonverbal communications (hand signals, pointing, etc.); [and] cockpit [control] selections within crew reach while seated at duty station (switch/throttle/flight controls, etc.)."

Manufacturers of other types of digital imaging systems — already used by hundreds of airlines for purposes such as remotely viewing cabins and cargo areas, cockpit-door security and simulator training — say that the key enabling technology for the proposed systems is crash-protected solid-state storage modules. Modules holding 48 gigabytes, for example, would enable time-stamped sequences from multiple cameras to be stored in compressed data formats. Systems would have bulk-erase capability and independent power supply.

Around 2003, EUROCAE expected cameras either to be able to take a series of still photos comparable to a six-megapixel digital camera or to convert a stream of digital video data into a series of still photos. According to Mike Horne, managing director of AD Aerospace and a contributor to the EUROCAE specification, imaging technology already has advanced farther. Significantly higher-resolution charge-coupled device (CCD) sensors and complementary metal oxide semiconductor (CMOS) sensors, the types commonly used now in consumer cameras, are available to consider, he said. The EUROCAE specification intentionally limited the image recording required to match digital cameras available at that time, but the level of detail possible in newly designed cameras would require even more storage to take advantage of their sensors.

International Context

The origins of the CAA study can be traced to a fatal Boeing 737 accident at Kegworth, United Kingdom, in 1989. As a result of the investigation, the U.K. Air Accidents Investigation Branch (AAIB) recommended rapid research into cameras for cockpits because of accident investigators' difficulty determining the crew's interpretation of engine instruments. The U.S. National Transportation Safety Board (NTSB) has said that it "first formally dealt with the issue of crash-protected image recorders in February 2000, following … investigation of the 1997 crash of a Cessna 208B Caravan near Montrose, Colorado, that resulted in nine fatalities."[3]

Accident-investigation agencies generally began proposing cameras for cockpits during the 1990s, based on the occasional insufficiency of information from FDRs and CVRs and the financial cost, delay and uncertainty of some investigations. Defining, in engineering and regulatory terms, exactly what gaps a cockpit image recording system should fill has been difficult despite the EUROCAE specification. Airline pilot associations have said that they will not support proposed systems without acceptable safeguards on data use and evidence that cameras would reduce accident risk more effectively than increasing FDR parameters and funding more programs for routine flight data monitoring.

During the March 2006 conference of the world's directors general of civil aviation, NTSB discussed U.S. consideration of mandatory cockpit image recording systems. After a 2004 NTSB hearing on this issue, some opponents said that retrofitting these systems probably could not be cost-justified; recommended efforts to strengthen international safety data protection laws; urged a shift of focus to aircraft for which little or no objective accident data sources exist; doubted that objective data could be provided by proposed systems; and said that current protections against potential misuse and abuse of images remained unsatisfactory.

The AAIB, BEA, BFU, Transportation Safety Board of Canada (TSB) and other counterparts have continued their advocacy of cameras in the cockpit.[4] But the FAA has said, "Recorder recommendations present unique challenges, including difficulties in cost/benefit analysis, technical hurdles, retrofit problems, issues about use of data and privacy concerns." FAA has not initiated rule making to mandate the installation of cockpit image recording systems.

Most recently, the agency has been analyzing its own proof-of-concept test, conducted in June 2005, to determine if a cockpit image recording system could be used to collect specific parametric data — details of operating parameters shown on instruments — and other flight information before considering performance-based regulatory requirements like those applied to FDRs and CVRs. During the test, several imaging systems were installed in an FAA-operated Raytheon King Air and in a flight simulator; the aircraft was flown in various operational and environmental conditions to determine if operating parameters such as altitude, attitude and airspeed derived from images would be accurate, compared with FDR data. The TSB said that Transport Canada has been anticipating results of this FAA study, and that harmonization of proposed regulations by the Flight Recorder Panel of the International Civil Aviation Organization was necessary before rule making.

The FAA's other related action was to publish the 2006 Technical Standard Order TSO-C176, *Aircraft Cockpit Image Recorder Systems.* The agency said, "Should an applicant, either an aircraft operator or original equipment manufacturer, wish to install a camera or video recording system voluntarily either in the cockpit or in the aircraft cabin, the FAA would work with the applicant to approve such an installation."

So the industry remains in a holding pattern on this issue. The research by the CAA and the FAA could rekindle discussions around a narrower scope of technically feasible proposals that — combined with investigator training, technology to aid interpretation of digital images and relevant procedures — still might depend on overcoming the remaining global deficiencies in image protection. "The goal is to develop a balance between the legitimate security, privacy and confidentiality concerns of labor and operators with the needs of investigators and regulators," said the final report issued in December 2001 by the RTCA Future Flight Data Collection Committee. "The committee recommends that issues regarding security, privacy and confidentiality be resolved and acceptable protections be put in place prior to any action mandating image recording." ●

During research and development, prospective manufacturers of airline cockpit image recording systems have difficulty excluding pilots' heads and shoulders.

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Notes

1. Safety Regulation Group, U.K. Civil Aviation Authority. *CAA Research Project: The Effectiveness of Image Recorder Systems in Accident Investigations.* Civil Aviation Publication (CAP) 762. Nov. 10, 2006.

2. European Organisation for Civil Aviation Equipment (EUROCAE). ED-112, *Minimum Operational Performance Specification for Crash Protected Flight Recorder Systems.* March 2003. Cited in CAP 762.

3. For commercial aircraft operators, the U.S. National Transportation Safety Board in 2006 reiterated its recommendation that "all aircraft operated under [U.S. Federal Aviation Regulations] Part 121, 125 or 135 and currently required to be equipped with a cockpit voice recorder and digital flight data recorder be retrofitted by Jan. 1, 2005, with a crash-protected cockpit image recording system. The cockpit image recorder system should have a two-hour recording duration, as a minimum, and be capable of recording, in color, a view of the entire cockpit including each control position and each action … taken by people in the cockpit. The recording of these video images should be at a frame rate and resolution sufficient for capturing such actions."

4. The Transportation Safety Board of Canada (TSB) said, "While Canada treats [sensitive cockpit] recordings as privileged, all nations do not. If image recordings are to be universally accepted, worldwide protections need to be put in place for all cockpit voice and image recordings. … [TSB recommends that] regulatory authorities harmonize international rules and processes for the protection of cockpit voice and image recordings used for safety investigations."

Valuable insights can be gleaned from an examination of operational data from numerous flights over a period of time. Multiple deviations from approved procedures of the same sort are a strong indication of a previously hidden operational glitch that has the potential, should other factors line up, to increase the risk of an accident.

When these glitches are revealed, pilot behavior can be modified by embedding corrections in training programs, modifying checklists, changing standard operating procedures and implementing other intervention techniques.

This is why one of the cornerstones of a program to improve flight safety is the introduction of flight operations quality assurance (FOQA), also known as flight data monitoring (FDM). These FOQA/FDM programs use analysis of recorded flight data from routine operations to identify safety issues in a non-punitive environment and, where they have been introduced, have made significant improvements in the safety of operations.

The best way to illustrate what these systems can do is by example. Flight Data Services (FDS), a FOQA/FDM service provider and member of the Foundation, has provided three case studies which show how FOQA/FDM can be used to improve safety and provide some useful safety lessons for us all to think about. FDS works with both airline and business aviation operators; Flight Safety Foundation provides a corporate FOQA program of its own.

Search for the Lurking Glitch

Flight data monitoring case studies provided by Flight Data Services, with permission of the operators concerned.

J.A. Donoghue

Case Study #1: Low Speed After Takeoff

The Events

Not long after the start of operations with a new aircraft type, an FDS customer realized that there were a notable number of low-speed-after-takeoff events. Some of these involved a significant loss of airspeed and excessive pitch attitudes.

Investigation

Checking the facts, Flight Data Services verified the aircraft weight, and confirmed that the calculated V_2 speed[1] was in accordance with the aircraft flight manual and that the airspeed and attitude indications were valid.

Next, the analyst set out to determine how this operation compared with that used by other operators to gauge the severity of the problem and to identify the cause. It was found that while the subject operator was experiencing low-speed events on many flights, other FDS customers had far fewer low-speed events. This was a significant difference, and a comparison highlighted the different experiences in the early stages of the climb.

Typical takeoff data from another operator (Figure 1) show the airspeed increase during the takeoff roll to the 20-second mark, when the aircraft rotates. The 15-degree nose-up attitude in the initial climb ensures the climb-out is at about V_2 plus 15 kt, before the nose is lowered and the aircraft accelerates.

Data from the operator with the speed loss problem, however, create a far different speed/pitch plot (Figure 2). As the pitch attitude passes 15 degrees nose-up, the airspeed is beginning to fall, but the nose continues to rise to more than 20 degrees while the airspeed slows to V_2 minus 15 kt.

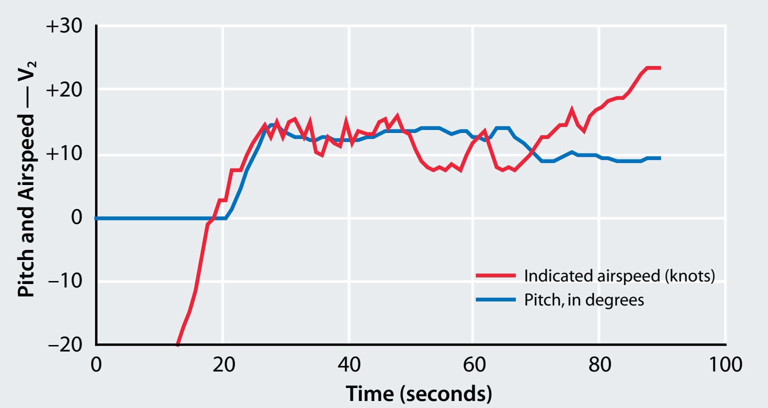
While it might be suggested that the aircraft was not being flown correctly, the flight path modelling work undertaken by FDS demonstrated that the technique described in the training manual was being followed. In fact, the pilots who followed the flight director slavishly and without reference to other instruments were most likely to experience this problem.

The investigation was documented and sent to the operator, who then forwarded the report to the aircraft manufacturer.

Solution

Ultimately, the aircraft manufacturer issued a software update, stating, "It has been reported that the takeoff crossbar was moving instead of standing still at the desired pitch during rotation and subsequent takeoff. Changes have been made to avoid this pitch guidance

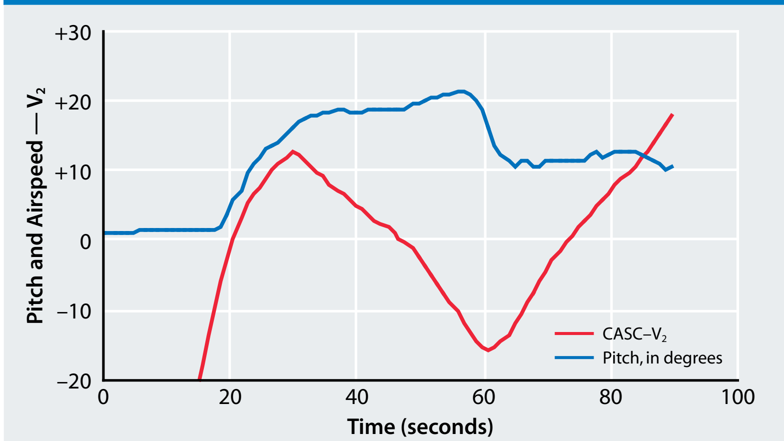
Sample Takeoff Plot



Source: U.S. Federal Aviation Administration

Figure 1

Low Speed After Takeoff



Source: U.S. Federal Aviation Administration

Figure 2

These meetings ... were held in confidence and quite informally because the objective was to identify why the pilots delayed flap retraction, and to help them avoid this mishandling of the aircraft.

movement." For the operator concerned, this change, together with training that reinforces the need to maintain scan of all of the flight instruments, has nearly eliminated this sort of event.

Discussion

The advantage of using a third party to analyze FDM results is shown in this case. If the original FDM event data had been observed in isolation, without comparison with other experiences, it might have taken much longer to appreciate the severity of the events. Indeed, the operator may even have doubted the warnings.

In this case FDM, or flight operations quality assurance, alerted an operator to an unexpected quirk in its new aircraft. Training refinements allowed it to operate the new type safely while the manufacturer developed a long-term solution.

Case Study #2: Takeoff Flap Retraction

The Events

Soon after their FDM service began, a new FDM user received reports of "flap altitude exceeded" events, highlighting flap retractions occurring later than recommended during takeoff.

The original data were checked. The criteria establishing when a reportable event occurs were confirmed to meet the specifications, and the analyst could see normal flap movement during the landing phase, indicating that the system was operational, so the events were considered valid. Retraction of flaps from the takeoff setting usually occurs within the first few thousand feet of climb. On two flights, however, takeoff flap was retracted at 16,000 ft and 21,000 ft; during the first 30 monitored flights there were five cases of late flap retraction.

Investigation

The flight safety officer (FSO) for this airline had introduced an FDM system before, and so was aware that in the early stages of FDM it is fairly common to identify abnormal operations that previously had gone unnoticed. The FSO assumed that this probably was the result of a behavior that had existed for some time. Looking for a systematic cause for these events, he met with the flight crews from some of these flights and discussed the operation of the flap controls. These meetings were in no way disciplinary or accusatory, but were held in confidence and quite informally because the objective was to identify why the pilots delayed flap retraction, and to help them avoid this mishandling of the aircraft.

In the interviews, the FSO found that the pilot monitoring made the post-takeoff checks alone and that his check sequence often was interrupted by other tasks, such as operating the radios. Sometimes he would return to the checks; but at other times he would omit part of the checklist and forget to raise the flap lever. In these cases, the climb progressed with takeoff flaps set until one of the pilots noticed the position of the lever. The handling characteristics of this aircraft type were not significantly affected by takeoff flaps because the aerodynamic cues were weak.

Discussion

Two issues here are worthy of closer examination. First, this problem had been missed by all the normal flight safety procedures. Crew training, line checks and air safety reporting were all in place, yet none of the normal mechanisms had revealed that the crews were failing to retract the takeoff flap in a timely manner.

Second, the action of the FSO was aimed purely at identifying the cause of the problem, and none of the pilots involved was criticized or reprimanded. The airline management was not told who had flown the event flights, and made no effort to find out.

Solution

Once the FSO had identified the gap in the procedure, he took immediate action to bring this to the attention of the flight crews. The second step was to change the company standard operating procedures (SOPs) to make all checks a cooperative challenge-and-response routine. This event has not recurred.

Epilogue

The FSO knew of a local operator with the same type of aircraft but without an FDM program. In the spirit of improving flight safety, he took his findings about flap retraction to the flight safety manager of this nearby airline. Although both operators were using the same checklists, the other manager denied that this problem could occur on his fleet.

Case Study #3: Go-Around Procedure

The Events

A well-established operator uses Flight Safety Foundation's Approach-and-Landing Accident Reduction (ALAR) Tool Kit to train their crews about the importance of a stabilized approach. In part, the ALAR Toolkit stresses the importance of initiating a go-around if an approach does not meet the airline's SOPs for stability, and this practice was accepted by the pilots. However, in one instance during a go-around, a crew experienced an enhanced ground proximity warning system (EGPWS) "pull up" warning during the climb-out.

Investigation

At the end of an unsatisfactory approach that failed to meet the airline's stability conditions the crew made the correct decision to initiate a go-around. This should have led to a safe climb-out without subsequent warnings. Therefore, investigation of the flight concentrated on the operation of the aircraft following the decision to reject the landing.

It quickly became apparent that full power had been applied on both engines, but the aircraft had not climbed as it should have. Although the flaps had been retracted in accordance with the procedure, the speed brakes had remained deployed. Consequently, the aircraft climbed too slowly and rising terrain led to the EGPWS warning. At that point the crew realized the mistake and stowed the speed brakes.

When the airline's FSO discussed the circumstances of the go-around with the crew, he found that they had correctly followed the SOP. The problem was that there was no reference to the speed brakes on the go-around procedure.

The Solution

As soon as the data were analyzed and the FSO completed his interview with the crews, an e-mail was sent to all pilots reminding them of the importance of retracting the speed brakes and explaining that this was not in the written SOPs. Urgent action was taken to correct this SOP omission and issue updated procedures.

Discussion

As far as we know, the crew in this case simply followed the SOP, which omitted an instruction to retract the deployed speed brakes. However, the investigation also highlighted the fact that some aircraft automatically stow their speed brakes when a go-around is initiated, while others do not. Although this potential source of confusion is not applicable to this specific case, there is a risk that a pilot who has been trained on a type with automatic speed brake stowage may forget the speed brakes after converting to a type with manually operated speed brakes.

Consequently, Flight Data Services developed an algorithm that identifies through the FDM process when an aircraft has been flown with the speed brakes out but climb power applied, and provided it to all FDS customers operating aircraft with manually stowed speed brakes. Such an algorithm is not called for in U.K. Civil Aviation Publication (CAP) 739 or in the Joint Aviation Authorities advisory material.

Since developing this algorithm, FDS has identified numerous cases where aircraft have been flown using climb power with speed brakes deployed. This new class of event ensures that all these cases have been brought to the attention of the operators' flight safety departments. This is a good example of how flight data monitoring must evolve to reflect the hazards of airline operation.

Conclusion

Incident investigation identified a missing checklist item for stowing speed brakes after initiating a go-around. This led to correction of the procedure and development of a new FDM event. Subsequent monitoring of other operators with the new algorithm revealed that failure to stow the speed brakes during go-arounds was found to be occurring with more often than anticipated.●

Notes

1. V_2 is defined by the U.S. Federal Aviation Administration as the takeoff safety speed, but it also is known operationally as the second segment speed.

when push

Corporate pilots are strongly self-motivated to get the job done, and much more often than not they do the job safely. But there are times in every pilot's career when the risks are too great and only fools are flying. Killer thunderstorms that cannot be circumvented. Widespread severe icing. Critical equipment problems. A nonprecision circling approach at night to a remote airport in a nonradar environment in foul weather.

Whatever the reason, the pilot must break the news to the passengers, who are anxiously waiting to board the aircraft, eager to get under way. They have been doing their own risk analysis, and the consequences of not getting to that meeting at Point B on time are weighing heavily on their minds.

In the world of on-demand operations, the pilot is likely to be dealing with unfamiliar passengers who may have an even greater sense of entitlement in making decisions about the flight.

In these situations, facing bad weather might seem easier than coping with mad passengers. They may plead the importance of the trip and at least getting under way and taking a look at

comes to shove

How to say no when the boss says go.

BY MARK LACAGNINA

the situation in the air. They may subtly or bluntly question the pilot's judgment. Even worse, the lead passenger may be the type who does not take no for an answer.

Whether the pilot stands by the decision or caves in to pressure not only will affect safety but will reflect vividly on his or her professionalism.

"If you start making exceptions and say, 'Well, I can probably sneak by that cell that's two miles off the end of the runway,' or, 'I can't get a clearance and I'm in mountainous terrain, but I'm going to take off in marginal weather and get a clearance while I'm airborne because the boss wants to go,' … if you start doing things like that — making exceptions that make you uncomfortable and go against what you've been taught and against your basic value systems for safety — you're on a slippery slope," said John Sheehan, president of Professional Aviation, a corporate aviation consultancy.

That Indefinable Something

A specialist in corporate flight operations safety, Sheehan believes that the quality that makes true professionals stand out among professional pilots is their personal commitment to a well-defined set of standards. "They view their standards as living standards," he said. "They do not make exceptions or cut corners."

Dan Gurney, a member of the Flight Safety Foundation (FSF) CFIT/ALAR Action Group and European Advisory Committee, calls it *airmanship*. "Airmanship is a personal mindset, that indefinable something that separates the superior pilot from the average pilot," he said.

In a paper prepared for the Society of Experimental Test Pilots, Gurney wrote, "Pilots with good airmanship will politely but firmly decline and resist the urge to press on when the weather, equipment, crew health, mission demands, fuel supply and support services go sour. Even when every marginal condition is within limits, pilots who exercise airmanship will judge the cumulative effects, analyze the big picture and refuse to be pressured into a situation that reduces the overall margins of safety."

Keep Sheehan's and Gurney's thoughts in mind while reading the following summaries of recent reports to the U.S. National Aeronautics and Space Administration's Aviation Safety Reporting System:

- There were thunderstorms in the vicinity when the captain of a regional airliner observed failure indications for the radio altimeter, ground-proximity warning system and wind shear warning system while holding for departure. He radioed maintenance control and was told that because the flight had left the gate, it was considered to be en route and that he should record the malfunctions and have them dealt with at the destination. The captain refused, and the flight was canceled.
- A business jet remained on the ground for six hours while the captain and maintenance personnel debated minimum equipment list (MEL) provisions applicable to inoperative indicator lights for an unspecified switch on the first officer's panel. The captain maintained that the aircraft could be flown with one light inoperative, but not with both lights inoperative. Maintenance argued that the aircraft could be flown by meeting MEL provisions for the switch itself. Although he believed this was improper, the captain complied under protest after disciplinary action was threatened by the chief pilot and assistant director of operations.

Pilot-pushing is not a problem peculiar to the United States, of course. The following are summaries of reports submitted recently to the U.K. Confidential Human Factors Incident Reporting Programme:

- After conducting a walk-around inspection of the airplane during a turn-around, the captain returned to the flight deck to find the first officer, the pilot flying the next sector, "fiddling the figures" on the load sheet. Additional passengers had

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been transferred to the flight, causing the maximum zero fuel weight to be exceeded by 1,400 kg (3,086 lb). Asked why he was amending baggage weights, the first officer replied, "That's what Operations want us to do." The captain then informed Operations that he would not conduct the flight unless the excess payload was offloaded. "Once my position was expressed, there was no argument," he said.

- The previous crew had pulled the circuit breaker for the inoperative cut-out button for the landing gear warning horn and noted on the technical log that the inoperative button was an acceptable deferred defect. The incoming captain found no reference to the button in the MEL and discussed the situation with the chief pilot, who ultimately told him to accept the aircraft or be relieved of his command. "Cowed and angry, both with him for applying such pressure and myself for failing to stand up and make my point for fear of my position/job, I went ahead and flew the aircraft," the captain said.

A charter customer pushed a G-III captain to land at the mountainous Aspen airport. The airplane was seen emerging from a snow shower and banking steeply left soon before it crashed.

Hard to Prove

In a paper presented at the 2005 Corporate Aviation Safety Seminar, Robert Matthews,

U.S. National Transportation Safety Board

senior aviation safety analyst in the U.S. Federal Aviation Administration (FAA) Office of Accident Investigation, said, "Corporate operators have become very safe as a class but still have some issues remaining with crew performance, decision making, flight procedures, possible pressure on crews and the challenge of diverse destinations."

Accident analyst Robert Breiling of Robert Breiling Associates, said, "I think that pressure on pilots to fly is one of the most pressing issues in our industry. It's lessened over the years as companies have learned about the dangers, but you know darn well that pilots are still being pushed, or are pushing themselves, to go. Very few accident reports point directly to it — it's hard to prove — but if you read between the lines in a lot of them, real or perceived pressure is there."

One report that does point directly to pilot-pushing came from the U.S. National Transportation Safety Board (NTSB) investigation of the Gulfstream III accident in Aspen, Colorado, on March 29, 2001. The circumstances bear retelling.

The flight was chartered by a customer who needed transportation for himself and 14 other people from Los Angeles to a dinner party he was hosting in Aspen. The schedule gave the flight crew less than one hour after landing in Aspen to deplane the passengers, refuel the airplane and depart before the airport's nighttime noise curfew began.

However, two passengers, including the charter customer, had not arrived by the scheduled departure time from Los Angeles. During a conversation with some of the passengers who had arrived on time and had boarded the airplane, one of the pilots — the report does not say which — mentioned that if the other passengers did not arrive soon, they might not be able to land at Aspen because of the curfew.

"The charter customer, upon learning of this conversation, instructed his business assistant to call Avjet [the charter provider] and relay a message to the pilot that he should 'keep his comments to himself,'" the report said. The business assistant said that his employer was irate about the possibility of not landing in Aspen. "He was told to call Avjet and tell the company that the airplane was not going to be redirected," the report said. "Specifically, he was told to say that his employer had flown into [Aspen] at night and was going to do it again."

Behind Schedule

The G-III departed from Los Angeles about 43 minutes later than scheduled. The forecast had called for visual meteorological conditions (VMC) at Aspen, and as the airplane neared the airport, the automatic terminal information system reported VMC at the airport.

The airport is at 7,815 ft and is surrounded by mountainous terrain. There was one instrument approach available, a VOR/DME (VHF omnidirectional radio/distance measuring equipment) approach with circling minimums only. Although the final approach course, 164 degrees, met alignment criteria for a straight-in approach to Runway 15, the required descent gradient exceeded the maximum authorized by the FAA. The minimum descent altitude (MDA) was 10,200 ft, 2,385 ft above airport elevation.

The captain told the first officer that they would conduct a visual approach if possible or the nonprecision approach if necessary. "We're not going to have a bunch of extra gas, so we only get to shoot it once and then we're going to Rifle," he said. The pilots did not brief the approach or missed approach procedures. Rifle, Colorado, the crew's alternate airport, is about 54 nm (100 km) from Aspen.

Weather conditions deteriorated as the G-III neared the airport. Three other airplanes, a Cessna Citation and two Canadair Challengers, were ahead of the G-III. The Citation crew gained visual contact with the airport at 10,400 ft and conducted a visual approach to Runway 15.

Are We Clear?

The G-III was being vectored to the final approach course for the VOR/DME approach when a passenger came forward and occupied the jump seat. Investigators were unable to determine if this passenger was the charter customer, but the report said, "The presence of a passenger on the jump seat, especially if it were the charter customer, most likely further heightened the pressure on the flight crew to land at [Aspen]."

A pilot in the lead Challenger reported a missed approach. Data from the G-III's cockpit voice recorder (CVR) indicated that the captain said, "The weather's gone down. They're not making it in." The passenger said, "Oh, really?" Soon thereafter, a pilot in the other Challenger reported a missed approach.

"Are we clear?" the passenger asked. "Not yet," the captain replied. "The guy in front of us didn't make it either." Again, the passenger said, "Oh, really?"

The report said that CVR data indicated that the pilots might have seen the runway briefly but that they did not have the runway in sight when the airplane descended below the MDA. They attempted to locate a highway to the right of the final approach course that leads to the airport. The first officer made none of the required callouts during the approach, and the airplane was deviating right of the final approach course and descending through 8,300 ft near the missed approach point.

The tower controller saw the G-III emerge from a snow shower and bank steeply left about five seconds before impact. The pilots, flight attendant and passengers were killed by blunt force trauma when the airplane struck sloping terrain about 2,400 ft (732 m) from the runway.

Aftermath

NTSB concluded that the probable cause of the G-III accident was "the flight crew's operation of the airplane below the [MDA] without an appropriate visual reference for the runway." Among the contributing factors was the charter customer's pressure on the captain to land.

In a memorandum issued after the accident, Avjet's director of operations told company pilots and charter schedulers that diversions to suitable alternate airports must be made if landings cannot be conducted before sunset at the Aspen airport or three other mountain airports — Eagle and Telluride, both in Colorado, and Haily, Idaho.

"All passengers for these destinations must be informed of this policy," the memo said. "Flight crewmembers must report any violation of this policy or pressure from passengers to violate this policy to the director of operations or chief pilot."

The company also revised its standard operating procedures (SOPs) to prohibit anyone other than an assigned crewmember, check airman or FAA observer from occupying a jump seat.

On Borrowed Time

Company pressure to continue flights in marginal weather was cited by NTSB as a factor in the crash of a Eurocopter AS 350BA in a mountain pass near Juneau, Alaska, on June 9, 1999.

The pilot, who was not instrument-rated, became spatially disoriented and lost control of the helicopter after encountering adverse weather conditions during an air tour flight. All seven occupants were killed.

"The pilot had expressed to a previous employer and a previous instructor that he was uncomfortable with company pressure to fly tours in bad weather," the report said. The instructor told investigators that, a few days before the accident, the pilot had expressed the belief that he was "living on borrowed time" and had inquired about employment opportunities at the instructor's company.

My Way or the Highway

"There is no safety culture in some companies," said Roger Baker, president of the Safety Focus Group and a member of the FSF Corporate Advisory Committee (CAC). "The mindset is: It's my way or the highway." In other words: Do what I tell you to do or find another job.

"Unfortunately, I see more companies that profess to have safety as their core value but don't operate that way than companies that value safety as number one and operate that way," Baker said. "They do things safely when it's convenient, when it's cheap, when it's easy or when they're showing off for somebody. It's just not the first thing they think about."

During his 20 years as an aviation consultant, John Sheehan has seen improvement in the quality of aviation department managers and SOPs. "We have become more professional, but are pilots still being pressured to fly? Absolutely," he said. "We still have pilots doing improbable things that they would not normally do."

Sheehan warns of what he calls the "entrepreneurial boss" who has achieved success in the business world by bending and breaking the rules. "They made their fortune doing that, and the mindset is: Why shouldn't I do that with my airplane? That's the one you have to watch out for." That's the one who will launch you down the slippery slope if you let your professionalism slip.

"About 98 percent of the time, you and that entrepreneurial boss are going to get along just fine with how you operate the airplane, where you go and when you go," Sheehan said. "But maybe 2 percent of the time, you're going to play what I call 'you bet your job.' That's when there's a big squall line to the west — and guess which way you want to go? — or the visibility is down to 1,800 RVR [runway visual range] in blowing snow, and the boss wants to go."

He related the following incident: A blizzard was raging when the first officer arrived at the airport and found it closed for snow removal. Unable to contact the captain, who was stuck in a traffic jam, he took it upon himself to inform the lead passenger that the flight had to be canceled because of the weather. The captain and the aviation department manager concurred with his decision, but the vice president to whom the manager reported was furious. He told the captain, "I make all decisions about what goes and what doesn't." The captain later learned that the vice president had arranged a charter flight from a nearby airport to transport the company president and his party to the destination. The incident resulted in the dismissal of the first officer, an unpaid two-week vacation for the captain and early retirement of the department manager.

A Page of Protection

Edward (Ted) Mendenhall, vice chairman of the CAC and a member of the FSF aviation safety audits team, said that auditors look for indications of pilot-pushing during confidential interviews of company pilots. "From my perspective, there are some CEOs, some personalities, who think their decisions are irreversible," he said. "Despite what a pilot will tell them about safety, they'll say that they want to go."

The best way to protect flight crews from pressure exerted by these individuals is to have an introductory letter, signed by the CEO, in the aviation department's flight operations manual (FOM), Mendenhall said.

Darol Holsman, manager of FSF aviation safety audits, said, "The introductory letter to the FOM specifically mentions that undue pressure must not be exerted on the pilot-in-command and that his decision making is final with respect to cancellations, diversions, etc." Figure 1 shows the sample letter recommended by the audits team.

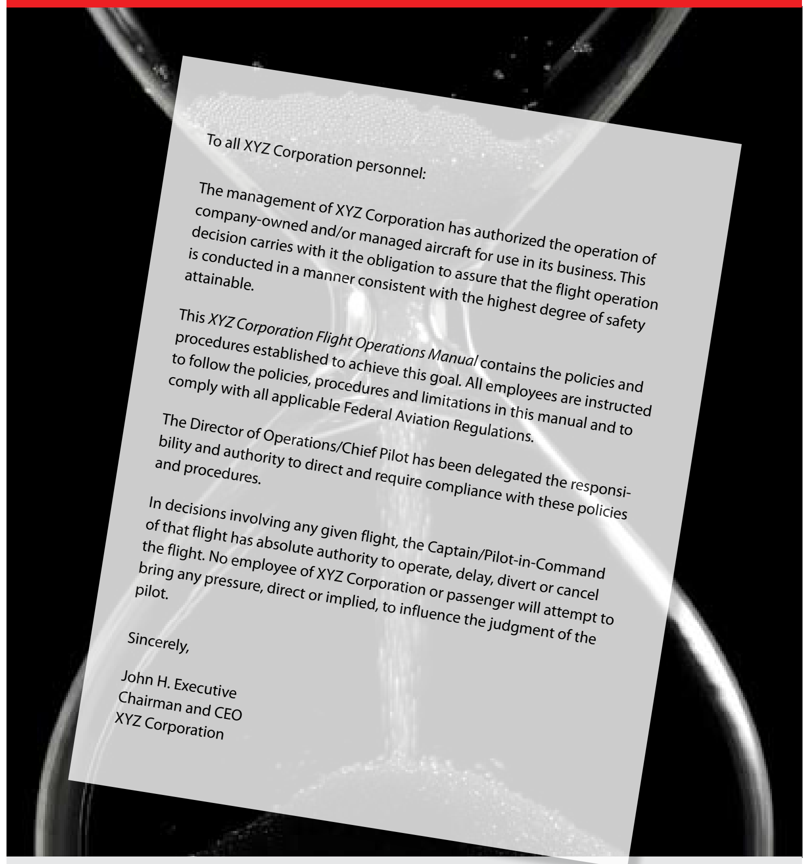
CEOs who sign such a letter typically are adamant in enforcing it. "I don't think we hear about pilot-pushing in more than one in maybe as many as 10 audits that we do," Holsman said. "In those cases, there's usually someone in senior management who is bringing pressure on pilots to go. When the CEO is made aware of it, either by the department manager or by us, that individual usually gets a stern lecture."

In at least one case, a pushy passenger's employment was terminated. "The airplane was in flight when the pilot informed the passengers that they would not be able to land at the destination airport but that arrangements had been made to have a car waiting at the alternate airport to transport them to their meeting," said Roger Baker. "One passenger came forward and was irate in telling the pilot that ground transportation would take too long, etc. The pilot held his ground and said that there were safety reasons for not landing at the destination.

"Apparently, it was a very ugly exchange. But when that story got back to the executive of the company, he terminated the senior manager for trying to unduly influence the pilot against his better judgment. There could have been some extenuating circumstances, but that was certainly the straw that broke the camel's back."

Baker noted that some companies have published the policy on their passenger-safety-briefing cards. "It's another way to remind employees that the pilot-in-command always has the last say," he said. "When it's written down, it takes away a lot of those pressures."

Sample Flight Operations Manual Introductory Letter



To all XYZ Corporation personnel:

The management of XYZ Corporation has authorized the operation of company-owned and/or managed aircraft for use in its business. This decision carries with it the obligation to assure that the flight operation is conducted in a manner consistent with the highest degree of safety attainable.

This *XYZ Corporation Flight Operations Manual* contains the policies and procedures established to achieve this goal. All employees are instructed to follow the policies, procedures and limitations in this manual and to comply with all applicable Federal Aviation Regulations.

The Director of Operations/Chief Pilot has been delegated the responsibility and authority to direct and require compliance with these policies and procedures.

In decisions involving any given flight, the Captain/Pilot-in-Command of that flight has absolute authority to operate, delay, divert or cancel the flight. No employee of XYZ Corporation or passenger will attempt to bring any pressure, direct or implied, to influence the judgment of the pilot.

Sincerely,

John H. Executive
Chairman and CEO
XYZ Corporation

Source: Darol Holsman, manager of FSF aviation safety audits

Figure 1

Standards to Live By

Pilots can protect themselves from pressure by explaining the situation to the passengers, having written standards in the FOM to point to and offering alternatives, if possible.

"You can't just go into the lounge with a glum face and say, 'We can't go,'" said Sheehan. "You have to make sure they understand that the reason they're not going is for their safety more than anything else, and give them some alternatives — a limousine or a one- or two-hour delay for the storm to pass."

Decisions are far more easy to communicate and to defend when they are backed up by standards published in the FOM.

"You have to make the boss and your passengers aware, and keep reminding them, that you have these standards," Sheehan said. "You have to create the expectation in their minds that when we bump up against these standards, we don't go."

Development and review of FOM standards should be a collaborative effort involving everyone in the aviation department. The FSF audits team strongly recommends that they conform with IS-BAO standards, said Darol Holsman. IS-BAO, the *International Standard for Business Aviation Operations*, was developed in 2002 and is described by the International Business Aviation Council as a "code of best practices." IS-BAO includes a generic FOM.

Having written standards is effective in protecting pilots not only from passenger pressure but also from internal pressure.

"Documentation takes away the ambiguities," Roger Baker said. "Written standards and guidelines leave less to the discretion of the PIC and less to be questioned by passengers. If the PIC has followed the standards and guidelines in the FOM, he can defend himself when the Monday-morning quarterbacks come out and start asking why he did or didn't do something." ●

Misreading the Weather

Accident investigators say flight into adverse weather conditions factored in the crashes of two helicopters during sightseeing flights in the Hawaiian Islands — an area known for challenging weather patterns.

BY LINDA WERFELMAN

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The fatal crashes of two helicopters during Hawaiian sightseeing flights have led to safety recommendations calling for improved pilot training on hazardous weather phenomena, rest breaks for air tour pilots and accelerated development of automatic dependent surveillance-broadcast (ADS-B) technology.

The recommendations are among a dozen that were generated by the U.S. National Transportation Safety Board (NTSB) investigation of the two accidents, which killed a total of eight people. Issuance of the recommendations coincided with the publication by the U.S. Federal Aviation Administration (FAA) of new safety standards for the air tour industry — standards prompted by a series of crashes in the early and mid-1990s.

The accidents that prompted the new recommendations involved two helicopters that departed from airports on the Hawaiian island of Kauai (Figure 1):

- On Sept. 24, 2004, a Bell 206B operated by Bali Hai Helicopter Tours crashed in a mountainous area in Kalaheo. The pilot and all four passengers were killed, and the helicopter was destroyed; and,
- On Sept. 23, 2005, a Eurocopter AS 350BA operated by Heli-USA plunged into the Pacific Ocean near Haena. Three of the five passengers died of drowning or related factors, and the two other passengers and the pilot received minor injuries; the helicopter was destroyed.

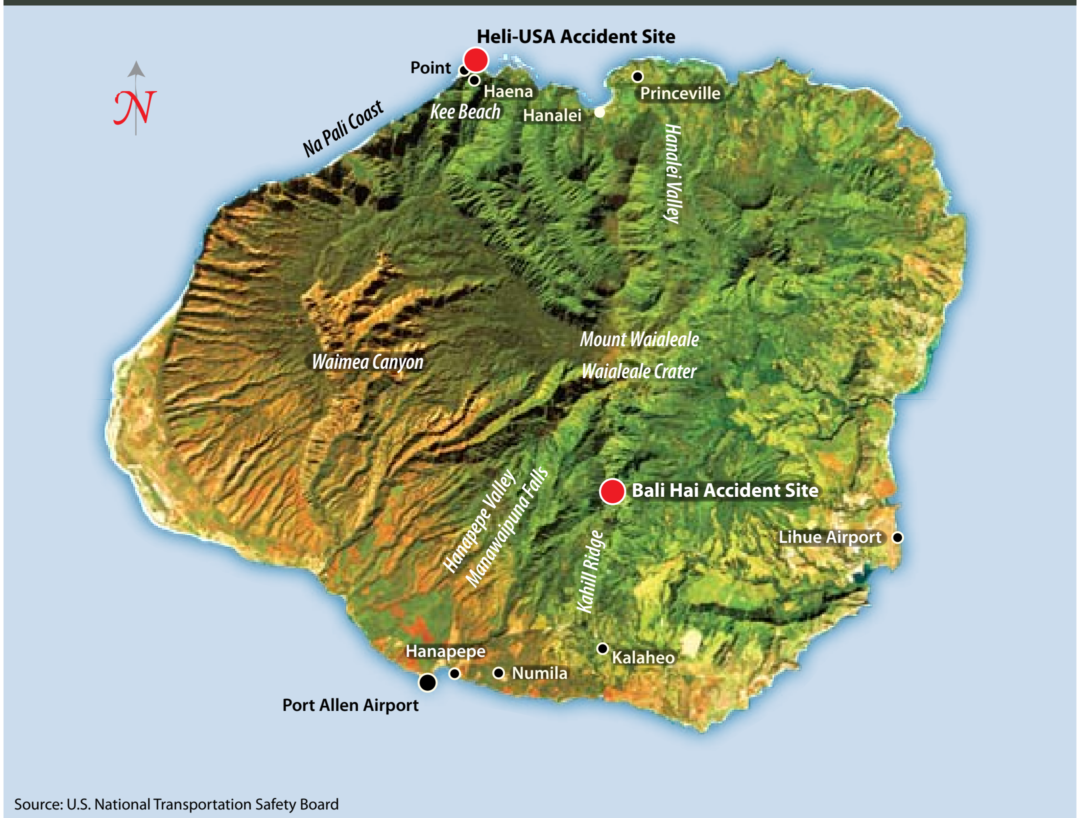
The NTSB report on the 2004 accident said that the flight was operating without a flight plan as a visual flight rules (VFR) flight under provisions of U.S. Federal Aviation Regulations (FARs) Part 91, *General Operating and Flight Rules*, and under Special Federal Aviation Regulation (SFAR) 71, *Special Operating Rules for Air Tour Operators in the State of Hawaii.*

Instrument meteorological conditions prevailed near the accident site at the time of the crash, 1642 local time.

The flight — planned as the pilot's eighth and final flight of the day — departed from Port Allen Airport (PAK) in the Kauai community of Hanapepe about 1600. The air tour was to have lasted about 45 minutes before the helicopter's return to PAK.

"Digital, time-stamped still images recovered from a passenger's camera showed that, when the helicopter departed, the weather near PAK appeared sunny, with good visibility," the report said. "Subsequent images taken during the tour showed low clouds and precipitation near some site-specific locations."

Kauai Accident Sites



Source: U.S. National Transportation Safety Board

Figure 1

After the helicopter failed to return on schedule to PAK, Bali Hai notified authorities. Helicopters and crew from Bali Hai, other air tour operators and the U.S. Coast Guard conducted aerial searches, but, because of obscuring clouds, they were unable to locate the accident site until the following day. Recovery of the victims and wreckage from the crash site, about 200 ft (61 m) below the ridge on a steeply sloping mountainside, was conducted over 10 days because of terrain and weather conditions, including downdrafts and low clouds.

Spatial Disorientation

The NTSB, in its final report on the accident, said that the probable cause was "the pilot's decision to continue flight under visual flight rules into an area of turbulent, reduced-visibility weather conditions, which resulted in the pilot's spatial disorientation and loss of control of the helicopter." Contributing factors were "the pilot's inexperience in assessing local weather conditions, inadequate [FAA] surveillance of SFAR 71 operating restrictions and the operator's pilot-scheduling practices that likely had an adverse impact on pilot decision making and performance," the report said.

Investigators found no indication of any pre-existing problems involving the helicopter's engine, airframe or systems that contributed to the accident. Helicopter weight and balance were within acceptable limits.

There was no indication that the pilot had any medical condition that might have interfered with his conduct of the flight, the report said.

The pilot — a former Indian air force helicopter pilot who said he had experience in mountain and coastal flying — had flown commercial air tours for less than two months. He had "limited knowledge of Kauai's weather patterns … and he began conducting tour flights after accruing just 6.7 hours of flight training from company personnel, none of which included specific training on Kauai weather," the NTSB said in the safety recommendation letter.

The helicopter's flight path — an "increasingly erratic" descending spiral — was "consistent with pilot spatial disorientation," the accident report said. "The pilot's inexperience with Hawaii weather conditions affected his ability to make appropriate in-flight decisions when faced with deteriorating weather."

The NTSB said that Bali Hai helicopter pilots typically had no scheduled breaks and remained at the flight controls "nearly continuously for up to eight hours per day." Their schedules and the lack of restroom facilities at the staging area "probably discouraged consumption of food and liquids during the workday" — factors that increased the risk of dehydration and were conducive to fatigue, the NTSB said.

The safety recommendation letter noted that the accident pilot had been seen leaving the cockpit once the day of the accident, about 1500, and that passengers on the 1500 flight said that he appeared fatigued.

The accident report also said that the FARs "do not adequately address the pilot fatigue issues associated with the continuous, repetitive, high-frequency flight operations that are unique to commercial air tour helicopter operations." Bali Hai's scheduling practices were in compliance with FAA regulations.

In addition, investigators found "evidence that Bali Hai managers had inappropriately pressured some pilots to fly in poor weather conditions and to avoid late returns"; nevertheless, the report said, "The extent to which management pressure might have influenced the pilot's decision making during the accident flight could not be determined."

The report said that the FAA had not allocated adequate resources for its flight standards district office (FSDO) in Honolulu to conduct surveillance of air tour operations. As a result, pilots violated SFAR 71 and related requirements "either intentionally or unintentionally, thus placing themselves and their passengers at unnecessary risk for accidents, particularly in marginal weather conditions," the report said.

The safety recommendation letter said that the FSDO manager had estimated that, at the time of the accident, the FSDO was "about 10 inspectors short"; he was not authorized to hire new inspectors.

Interviews with air tour pilots found that they sometimes did not understand the altitude restrictions discussed in SFAR 71 or the waivers that allowed some operations below those altitudes, the letter said. "Thus, these pilots likely crossed ridgelines in some locations during tour flights at altitudes lower than what is permitted under SFAR 71 or their respective authorizations, and without FAA surveillance and

Bell 206B JetRanger

U.S. National Transportation Safety Board

The Bell Helicopter (now Bell Helicopter Textron) 206B JetRanger is a general-purpose light helicopter powered by a 400-shaft-horsepower (298-kilowatt) Allison 250-C20 engine. The 206B was developed as a more powerful version of the 206A, which had a 317-shaft-horsepower (236-kilowatt) engine. The first deliveries of the 206B were in early 1971.

The 206B is configured with two seats in front and a rear bench seat for three people.

Empty weight is 1,455 lb (660 kg); maximum takeoff weight is 3,200 lb (1,451 kg).

Source: *Jane's All the World's Aircraft* intervention, they probably believed that such practices were permissible and safe."

FSDO surveillance before the accident might have "detected and corrected the accident pilot's risky flying practices, such as low-altitude, off-route ridge crossings and flight into clouds and reduced visibility," the report said.

As a result of the investigation, the NTSB recommended that the FAA, "in cooperation with Hawaii commercial air tour operators, aviation psychologists and meteorologists," develop a training program for Hawaiian commercial air tour pilots that addresses hazardous local weather phenomena and related in-flight decision making. Hawaiian air tour operators should be required to provide this training to all newly hired pilots, the report said.

The safety recommendation letter said that experienced air tour pilots on Kauai told investigators that VFR operations in the area are "unusually challenging because of the rugged terrain, mountain winds and rapidly changing visibility and cloud conditions." As a result, the usual sources of pilot weather information — including automated reporting stations and flight service station briefings — are "not very useful," according to the pilots; instead, pilot skills in evaluating changes in weather during tour flights are crucial.

However, the accident pilot and others with limited experience flying in the island's weather conditions may be "hindered in their ability to make appropriate in-flight decisions when faced with deteriorating weather," the letter said, recommending development of specialized training on "recognition of local weather cues that are critical for in-flight decision making in the Hawaiian Islands."

The weather conditions and terrain, along with large numbers of air tour flights and limited radar coverage by air traffic control (ATC), make Hawaii "a prime candidate for the national ADS-B program," the letter said.

"ADS-B will support avionics features that enable pilots to see the location, extent and movement of weather systems, thus improving pilot awareness and helping pilots make safer decisions in flight," the NTSB said. "For example, if the accident helicopter had been equipped with avionics capable of displaying ground-based, weather-radar information transmitted via ADS-B infrastructure, the pilot would have been able to see the full extent of the weather converging on the … ridge, and his decision to continue into the weather may have been different."

The NTSB recommended that the FAA accelerate the implementation of ADS-B in Hawaii to aid pilots of low-flying aircraft along commercial air tour routes and require Hawaiian air tour operators to equip their aircraft with ADS-B technology within one year of the installation of ADS-B infrastructure in Hawaii.

The recommendation letter also said that, because existing FARs "do not adequately address the pilot fatigue issues associated with the

Eurocopter AS 350 Ecureuil

© Ivan Nishimura/airliners.net

The Eurocopter AS 350 is a light utility helicopter first produced in October 1977 by Aerospatiale as the AS 350B. The AS 350BA is an upgraded version of the 350B, with larger main-rotor blades and a maximum takeoff weight of 4,630 lb (2,100 kg), or 331 lb (150 kg) more than the AS 350B.

The AS 350BA has two standard buckets seats at the front of the cabin, and two two-place bench seats aft.

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

continuous, repetitive, high-frequency flight operations that are unique to commercial air tour helicopter operations, … the FAA should establish operational practices for commercial air tour helicopter pilots that include rest breaks and that will ensure acceptable pilot performance and safety, and require commercial air tour helicopter operators to adhere to these practices."

Recommendations also called on the FAA to develop a permanent means of providing direct surveillance of commercial air tour operations in Hawaii; to direct the Honolulu FSDO to ensure that annual safety meetings include discussions of air tour accidents, Hawaii weather phenomena and SFAR 71 procedures; to re-evaluate altitude restrictions in Hawaii "to determine if they may have resulted in any unintended degradation of safety with regard to weather-related accidents"; and to develop safety standards for all commercial air tour operators, including pilot training in "local geography and meteorological hazards and special airspace restrictions, maintenance policies and procedures, [and] flight scheduling that fosters adequate breaks and flight periods."

Change in the Weather

The report on the 2005 accident also discussed deteriorating weather conditions and visibility.

The accident helicopter, registered to Jan Leasing and operated by Heli-USA Airways under Part 135, *Commuter and On-Demand Operations*, departed at 1354 from Lihue on a company flight plan in visual meteorological conditions. The pilot described weather as good during the first portion of the sightseeing flight, which was to have lasted 45 minutes.

"However," the report said, "the helicopter entered heavy rain and reduced visibility while flying along the island's northern coast. The pilot decided to turn back, but the helicopter rapidly descended, did not respond to control inputs, entered a hard spin to the left and collided [with] the water."

The helicopter, which was not equipped with flotation equipment, rapidly filled with water, rolled over and quickly sank several hundred feet from the coast — so quickly, the NTSB said, that "some occupants were submerged before they could even undo their seatbelts." The six occupants all wore "waist pouches" that contained life jackets, and all had been instructed in their use; nevertheless, not all were able to don the life jackets and properly inflate them after exiting the helicopter, the report said.

The NTSB report on the accident said that the probable cause was "the pilot's decision to continue flight into adverse weather conditions, which resulted in a loss of control due to an encounter with a microburst." A contributing factor to the accident was the FAA's "inadequate … surveillance of [SFAR] 71 operating restrictions"; a contributing factor to the loss of life was "the lack of helicopter flotation equipment," the report said.

Investigators found no indication of any mechanical problem that could have contributed to the accident.

The NTSB said in a statement accompanying release of the report that typical weather patterns on Kauai bring brief, localized rain showers every day, and air tour pilots often encounter these showers during their flights, relying on their own judgment to determine whether to proceed or to turn back. There is no weather-reporting facility in the area of the island where the accident occurred.

An analysis of meteorological data found that weather conditions at the time of the accident were favorable for the rapid development of cumulus clouds capable of producing heavy rain and microbursts, the report said.

As a result of its investigation, the NTSB recommended that the FAA require that all helicopters used in commercial air tours over water, "regardless of the amount of time over water," be equipped with floats or amphibious landing gear. The NTSB also recommended that the FAA "evaluate the design, maintenance and in-service handling of personal flotation devices" manufactured specifically for use in the event of an aircraft ditching to determine the cause of inflation problems and to ensure that they are manufactured in compliance with standards designed to ensure their effectiveness throughout the manufacturer's inspection interval.

New Regulations

Days before the NTSB issued its recommendations in February 2007, the FAA published new regulations, effective in March, for airplane and helicopter air tour operators nationwide. The regulations include requirements for enhanced pre-takeoff passenger safety briefings and life jackets and helicopter floats for some overwater flights.

The FAA said that the regulations contain reporting requirements that will aid in development of a database to help identify operational trends that could present safety risks and to provide "better oversight of the commercial air tour industry, especially flights previously conducted under the general operating and flight rules section of the regulations." ●

This article is based on U.S. National Transportation Safety Board (NTSB) reports NTSB/AAR-07/03 and NTSB/AAB-07/01, and NTSB Safety Recommendation letters A-07-18 through -26 and A-07-27 through -29.

GLOBALRelations

The work of Flight Safety Foundation has inspired several independent organizations. These "sister" organizations cooperate with the Foundation and focus on aviation safety improvements in specific parts of the world. The Foundation supports the activities of the organizations through technical briefings, logistical assistance, speakers and publications.

The activities and achievements of our sister organizations will be highlighted in future issues of *AeroSafety World*. For contact information for any of the organizations, please visit <www.flightsafety.org/sister_org.html>.

Aviation Safety Foundation Australasia

The Aviation Safety Foundation Australasia (ASFA), based in Melbourne, has consolidated and coordinated safety efforts in all facets of the national aviation industry, from agricultural applicators to major airlines. ASFA activities include safety awards and conferences.

Flight Safety Foundation–Commonwealth of Independent States

Shortly before the breakup of the Soviet Union in the early 1990s, Flight Safety Foundation–International was formed in Moscow. Currently, the organization conducts aviation safety activities in the Commonwealth of Independent States (CIS). FSF–CIS activities include the translation and redistribution of FSF publications.

Flight Safety Foundation–West Africa

Flight Safety Foundation–West Africa (FSF–WA), based in Lagos, Nigeria, was formed in early 2000 to serve the West African subregion. FSF–WA's work includes the identification of priority areas of concern, dissemination of information, participation in industry analyses of safety and development of regional initiatives to improve aviation safety in the context of initiatives elsewhere in the world.

Flight Safety Foundation–Japan

Flight Safety Foundation–Japan was created in the late 1980s, after an FSF seminar in Tokyo, as an association of airline safety officers. Members of FSF–Japan meet to share information, organize safety conferences and support international initiatives of the Foundation.

Flight Safety Foundation–Southeastern Europe, Hellas (FSF–SEE)

FSF–SEE's area of operation initially includes Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Greece, Kosovo, Romania, Serbia and Montenegro, and Slovenia. FSF–SEE advises the Foundation and its allied organizations regarding regional aviation safety and other issues.

Flight Safety Foundation–Taiwan

Flight Safety Foundation–Taiwan for more than 12 years has helped to promote and coordinate aviation safety efforts among all the airlines of Taiwan, China. The organization and its mission have been patterned after the Foundation's work.

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

Streaking into

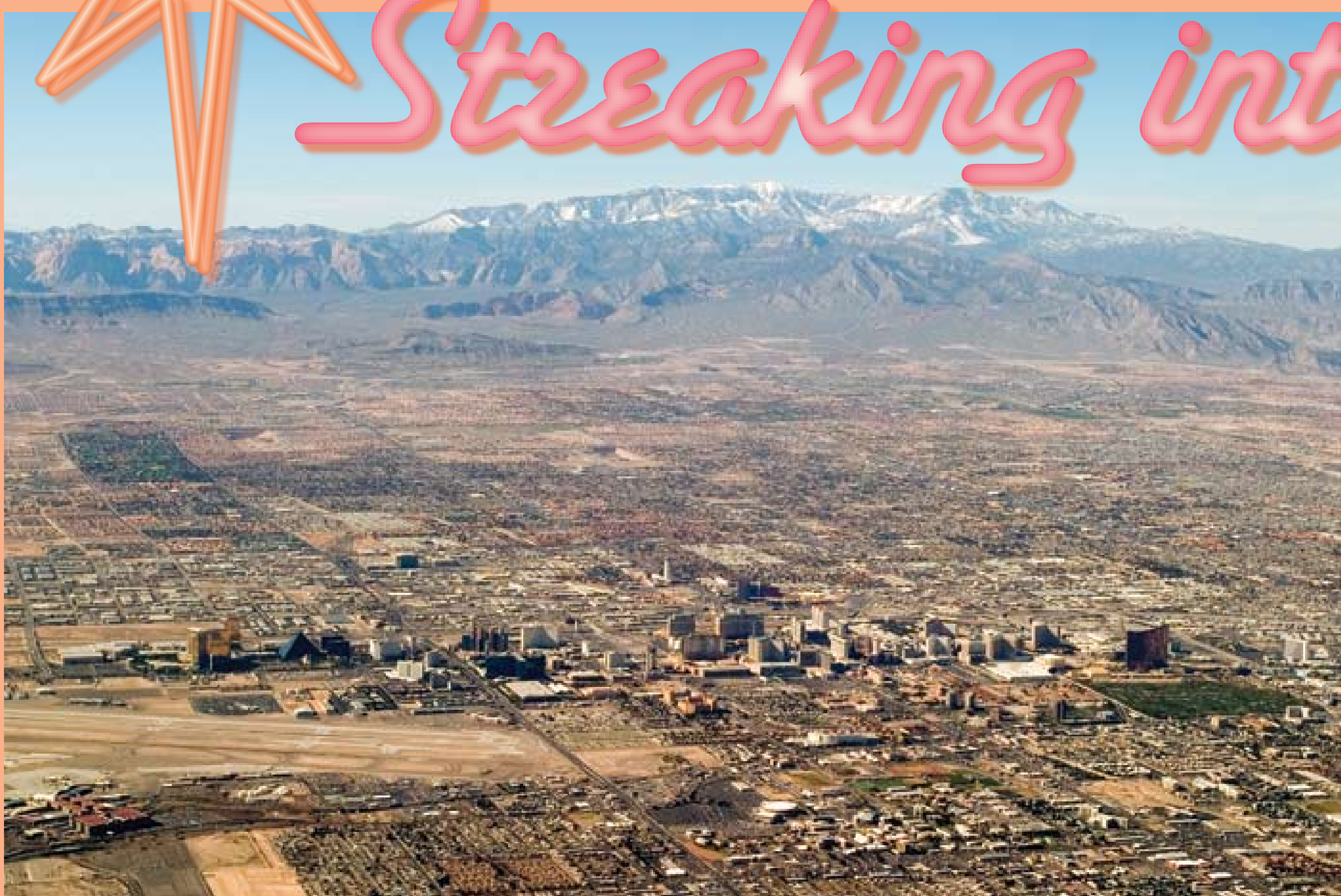
Failure of a business jet's lift-dump system was the last ingredient in a spoiled landing.

BY MARK LACAGNINA

An unstabilized approach and excessive airspeed on touchdown were the probable causes of an overrun that resulted in substantial damage to a Raytheon Premier 1, said the U.S. National Transportation Safety Board (NTSB) in a recent report. A tail wind resulting from a last-minute wind shift was listed as a contributing factor.

The pilot and passenger were not injured in the accident, which occurred during a corporate flight on May 27, 2004, at North Las Vegas (Nevada, U.S.) Airport. The pilot held an airline transport pilot (ATP) certificate and type ratings for the Cessna Citation 500 and Learjet, as well as for the Premier, which is certificated for single-pilot operation under the normal category airplane airworthiness standards of U.S. Federal Aviation Regulations (FARs) Part 23. He had about 9,200 flight hours, including 62 flight hours in type. "Before his job flying the Premier jet, the pilot flew as a first officer of [Boeing] MD-80 and 757 airplanes," the report said.

The passenger also was a pilot, an A320 captain and check airman for an airline. He held an ATP certificate and a type rating for the Citation 500, which he had previously flown in charter operations. The passenger had received no training in the Premier. The report said that he frequently flew in the right cockpit seats of



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business jets operated by several companies. He had made 14 previous flights with the Premier pilot. On the morning of the accident, they had flown the airplane from North Las Vegas to Palm Springs, California, with passengers who required two pilots aboard their flights.

Wind Shift

The return flight was conducted in visual meteorological conditions and under the general operating and flight rules of Part 91. The report said that the pilot had previously flown to North Las Vegas Airport about 30 times.

At 1546 local time, 11 minutes before the accident, the pilot and passenger listened to the automatic terminal information service (ATIS) radio broadcast, which said that the winds at the airport were variable from 100 degrees to 160 degrees at 10 kt to 12 kt and that the temperature was 35 degrees C (95 degrees F). A few minutes later, the passenger, who handled most

radio communications during the flight, established radio communication with the approach controller, who told him to expect clearance for an approach to Runway 12L, which is 4,202 ft (1,282 m) long and has an instrument landing system (ILS) approach procedure.

The report said that the pilot and passenger discussed the reported surface winds and decided to request Runway 07, which is 5,004 ft (1,526 m) long and has precision approach path indicator (PAPI) lights but no straight-in instrument approach procedure. The approach controller cleared the pilot to conduct a visual approach to Runway 07. The quick reference handbook (QRH) indicated that at the airplane's landing weight, 10,200 lb (4,627 kg), landing distance was 3,900 ft (1,190 m).

When the passenger established radio communication with the tower controller, the controller told him that there was a "dust devil crossing the approach end of Runway 07." A dust devil is a whirlwind made visible by the dust, sand or debris that it picks up. About a minute later, the controller told the passenger that the dust devil had moved north of the airport and that the winds now were variable from 140 degrees to 200 degrees at 12 kt, gusting to 18 kt. The wind shift occurred about four minutes before the accident.

The pilot asked the passenger, "What do you think?" The passenger quipped, "Well, we are a little high … but we are fast." The sound of laughter then was recorded by the airplane's cockpit voice recorder (CVR). The passenger said, "I think you're going to be OK if you're happy with the crosswind."

Raytheon Premier 1

The Raytheon Model 390 Premier 1 light business jet was certified under U.S. Federal Aviation Regulations Part 23 for single-pilot operation in 2001. The airplane has seating for a pilot and seven passengers. The Williams FJ44-2A turbofan engines, each producing 2,300 lb (1,043 kg) thrust, are mounted on the rear of the fuselage, which is constructed of graphite/epoxy laminate and honeycomb composites. The wings, which are swept back 20 degrees, are made of aluminum alloy.

Maximum takeoff weight is 12,500 lb (5,670 kg). Maximum landing weight is 11,600 lb (5,262 kg). Maximum operating altitude is 41,000 ft. Maximum operating speed is 0.8 Mach. Range with maximum payload is 826 nm (1,530 km); range with maximum fuel is 1,460 nm (2,704 km).

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

Raytheon Company

Slam Dunk

The pilot told investigators that air traffic control had not issued a descent clearance until the airplane was relatively close to the airport. He described the descent as a "slam dunk," requiring a significant change in altitude over a relatively short distance. The pilot said, however, that the approach was stabilized by the time the airplane was 500 ft above ground level (AGL) and that he maintained 112 kt, the landing reference speed (V_{REF}), from 500 ft AGL to touchdown.

The passenger said that because of the high minimum en route altitudes in the area, such arrivals are typical and the pilot had to "hustle down" during the descent.

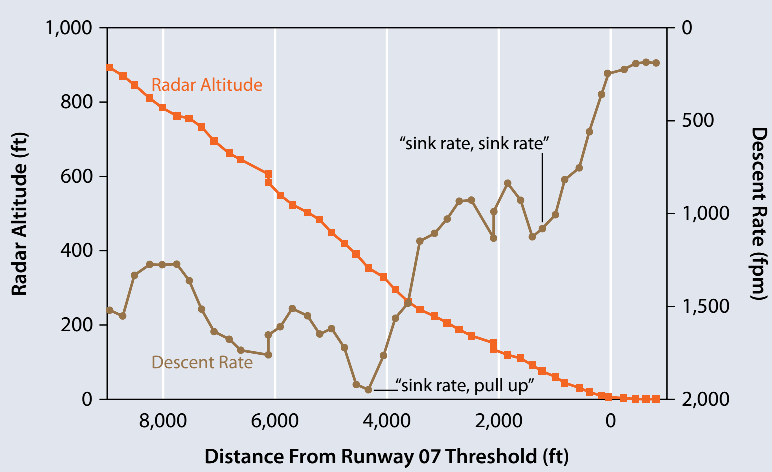
The airplane was descending at nearly 2,000 fpm through about 350 ft AGL when the terrain awareness and warning system (TAWS) generated a "SINK RATE, PULL UP" warning (Figure 1). The CVR did not record a discussion of the warning.

Figure 2, which was derived from TAWS data, shows that the airplane's flight path was above the three-degree glide path indicated by the PAPI until the airplane was about 0.2 nm (0.4 km) from the runway. "The flight's unstabilized approach and excessive speed should have prompted the pilot to initiate a missed approach," the report said.

About 15 seconds before touchdown, the passenger said "Ref and twenty," indicating that airspeed was 20 kt above V_{REF}. The pilot replied, "Slowing." A TAWS "SINK RATE, SINK RATE" warning then was generated. TAWS data indicated that the airplane was about 75 ft AGL and descending at about 1,100 fpm.

About five seconds later, the airplane touched down about 900 ft (275 m) beyond the approach threshold of the runway. The report said that analysis of performance data and other information indicated that airspeed was about 17 kt above the prescribed speed on touchdown.

Descent Rate and TAWS Warnings



TAWS = Terrain awareness and warning system

Source: U.S. National Transportation Safety Board

Figure 1

According to Raytheon Aircraft Co., landing-distance data provided in the airplane flight manual (AFM) and QRH are based, in part, on touchdown speeds 6–7 kt below V_{REF}. TAWS data indicated that the airplane was landed with a tail wind component of 7.5 kt. Maximum tail wind component for the Premier is 10 kt.

The report said that under the conditions that existed, the required landing distance was about 5,500 ft (1,678 m), nearly 500 ft (153 m) greater than the runway length.

Spoilers Did Not Deploy

Investigators concluded that the lift-dump (spoiler) panels did not deploy. There are three panels on each wing; the outer panels also serve as speed brakes and for roll augmentation when the airplane is in the air.

"The pilot stated that he activated the lift-dump switch, but he could not recall if he heard the lift-dump devices extend or if he felt the deceleration he was accustomed to as the devices extend," the report said. "He stated that he did not recycle the lift-dump switch but 'held it back' throughout the rollout. He stated he was not initially concerned about the lift-dump devices because his training had shown that the brakes would stop the airplane even if the lift-dump devices did not extend."

The passenger did not feel any deceleration after touchdown and called out, "Brakes." The pilot responded, "Yeah, I'm standing on them." The passenger said, "You've got to be kidding me. … I'd go around." The pilot said, "I can't." Several seconds later, the CVR recorded sounds similar to increasing then decreasing engine noise.

The airplane overran the runway, struck an airport-perimeter fence and stopped about 735 ft (224 m) beyond the end of the runway at 1557. Portions of the nose landing gear had separated from the fuselage, and the main landing gear struts had been forced through the top of the wings. "The lift-dump panels had mostly separated from their inboard wing attachments," the report said. "However, examination of available wreckage indicated that the spoilers were still locked in placed by the down-lock hook."

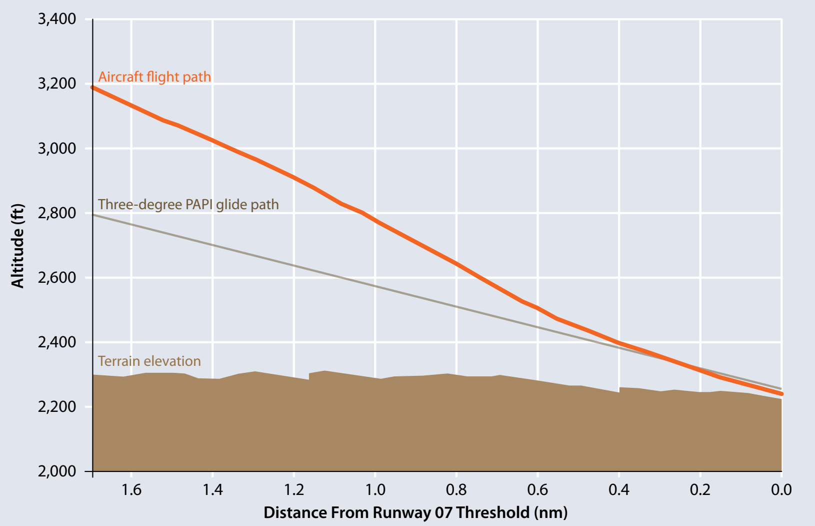
Original System

The accident airplane was equipped with the lift-dump activation system that originally was certified for the Premier. The system includes a switch on the center console that is spring-loaded to the neutral position and must be held in the "EXTEND" position until the lift-dump panels deploy.

"Deployment of the lift-dump [panels] requires that the engine thrust levers be in the idle position and that the weight-on-wheels switches on the nose landing gear and main landing gear be in the 'ground' position," the report said. "There is no indication in the cockpit of lift-dump [panel] extension."

As a result of two previous Premier accidents in which the lift-dump panels failed to deploy, the U.S. Federal Aviation Administration (FAA) in April 2003 issued Airworthiness Directive (AD) 2003-07-09 and AD 2003-10-05, requiring operators of about 57 Premiers to incorporate revised AFM/QRH data that increased landing distances by 53 percent. "[This] represents the airplane's landing performance without the benefits of lift-dump activation," the report said. The pilot had used the revised data for calculating the required landing distance at North Las Vegas Airport.

Flight Path



PAPI = Precision approach path indicator

Source: U.S. National Transportation Safety Board

Figure 2

Raytheon Aircraft Co. subsequently issued Service Bulletin (SB) 27-3608, which announced modifications of the original lift-dump system. The modifications included removal of the weight-on-wheels switch on the nose landing gear, installation of redesigned weight-on-wheels switches on the main landing gear and installation of a lift-dump system lock/unlock switch and engagement handle in front of the center console. The modified system also includes an aural warning if the lift-dump panels fail to deploy.

The FAA accepted compliance with the SB as an alternate means of complying with the ADs — thus eliminating the requirement for use of the increased landing-distance data. The SB modifications had not been incorporated in the accident airplane. NTSB was unable to determine why the lift-dump panels failed to deploy. "No evidence was found of any failures affecting the lift-dump or braking systems," the report said.

During postaccident interviews by investigators, Premier instructors and pilots indicated that activation of the original lift-dump system required a firm landing to compress the nose landing gear and main landing gear and open the weight-on-wheels switches. They said that touching down at speeds above V_{REF} or holding the nose up to make a smooth landing can result in the panels not deploying. One pilot who experienced a failure of the lift-dump panels to deploy "thought his weight-on-wheels was too light, [which] could happen if you were at a light weight and were too fast and the nose was not held forward," the report said. ●

This article is based on NTSB accident report no. DCA04MA049, which comprises five pages, and NTSB public docket 59345, which comprises 95 pages and includes illustrations.

Surveillance

As automated weather radar systems appear on large commercial jets, pilot training on conventional systems may deserve another look.

BY WAYNE ROSENKRANS

Incident investigations, research studies and safety audits recently have challenged longstanding assumptions about how professional pilots — especially corporate and regional airline pilots — should become proficient in using airborne weather radar systems.[1] One assumption is that training only serves to introduce fundamental principles and/or methods of operating specific equipment. Another is that thousands of hours of flight experience must be invested for consistent success in avoiding cumulonimbus clouds and associated hail, severe turbulence, wind shear and other hazards.

Reconsidering such assumptions might be warranted for a number of reasons. First, technology for airborne surveillance and assessment of weather hazards has advanced significantly. Historically, failures to correctly use airborne weather radar have caused serious incidents, and pilots have been unsuccessful in interpreting simulated radar displays while being evaluated by researchers. Finally, some pilots have said that they would welcome recurrent training to validate or improve their practices.

The most widely used systems are conventional types, which require manually setting controls. Their color displays enable pilots to distinguish heavy precipitation from light precipitation, and, by observing the color gradient and shapes, to estimate the severity of convective weather hazards and make timely flight-path deviation decisions. In contrast, systems with fully automatic operating modes, sometimes called "next-generation" radar, have been introduced in the past five years.

Current discussions about training can be traced to serious incidents in Australia that prompted a series of studies sponsored by the Australian Transport Safety Bureau (ATSB) and to human factors research by Honeywell. The importance of training also has been emphasized in documents such as "Adverse Weather Operations: Optimum Use of the Weather Radar," published in 2004 by Airbus as part of its *Flight Operations Briefing Notes* series.

Without Surprises

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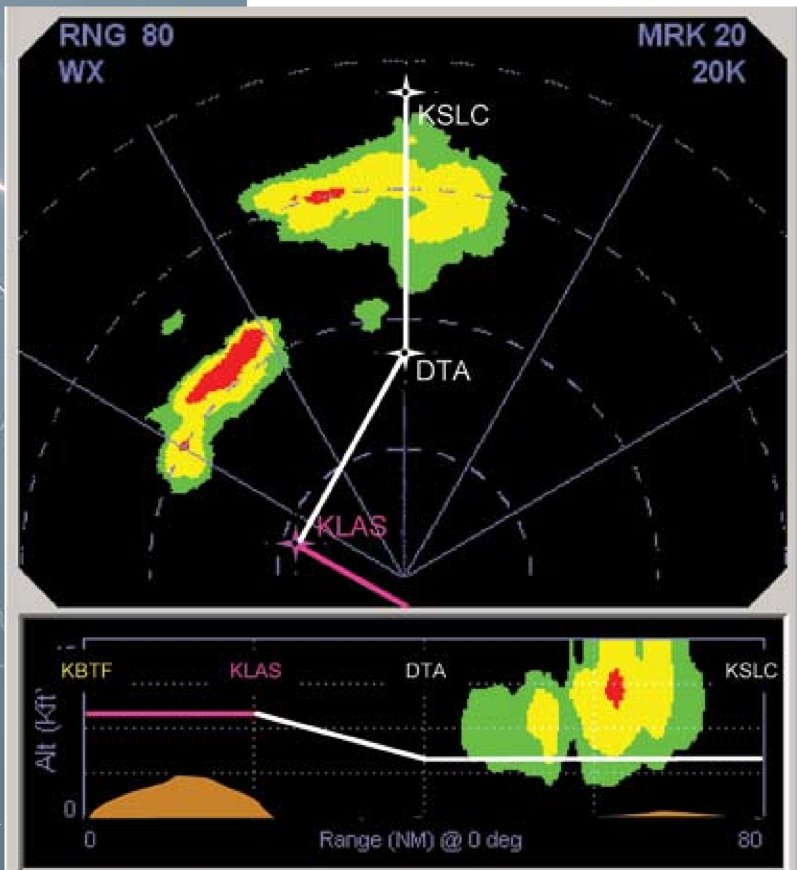
An incident from March 2002 illustrates the potential consequences of incorrect radar operation. A Saab 340A, equipped with a Collins WXR-200 conventional weather radar, was flown inadvertently into an area of severe convective weather activity during a diversion to Canberra, Australia. The aircraft was damaged but no injuries occurred.[2]

The airplane operating manual provided information about pilot control of displayed range; antenna tilt angle, the angle between the center of the radar beam and the horizon; adjustment of gain, the sensitivity of the receiver; and normal interpretation problems that occur when a radar beam is reflected by objects on the ground or by areas of heavy precipitation and hail. Transmitted microwave energy was reflected back to the antenna by precipitation in front of the aircraft, and depending on the type of precipitation and its intensity, typically was displayed as "black (no precipitation), green (minimum detectable moisture), yellow (medium moisture level), to red (strong to extreme moisture level)," the report said.

Heavy precipitation and hail caused attenuation of the radar beam. Before penetrating the thunderstorm cell, the flight crew also had selected maximum gain, with the tilt angle set at approximately three to four degrees up and range set at either the 25 or 50 nm [46 to 93 km] setting. "[The tilt angle used] would have resulted in the radar beam scanning above the level at which the aircraft was flying, and into an area that was above the freezing level," the report said. "It is likely that above that level, the hail was dry. As such, it would have provided a low reflectivity target for the weather radar [the captain saw only green areas and an occasional yellow radar return]."

Mark Wiggins, Ph.D., an associate professor at the University of Western Sydney, published in April 2005 a study based on accident and incident reports, interviews with five professional pilots and a survey of 109 pilots from several world regions. He asked pilots to interpret color images of 12 simulated radar displays, estimate and explain their confidence about proceeding at the same track and altitude for 80 nm [148



© Honeywell

A vertical view — positioned below the conventional plan view — shows the elevation of weather along the selected azimuth from the aircraft nose to the selected display-range distance of the Honeywell RDR-4000 weather radar system.

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km] and rank the level of expected turbulence, updrafts and downdrafts.[3]

"One of the most significant themes that emerged as a result of the interviews was the apparent lack of operational training and experience in the use and interpretation of weather radar," Wiggins said. Sixty percent of these pilots said that they had experienced situations in which the weather radar display appeared to be incorrect, and 53 percent said that during the previous six months, they had detected flight crew errors in use of an airborne weather radar system.

When a human factors specialist at Honeywell studied related issues around the same time, results were similar. Ratan Khatwa, Ph.D., senior fellow of flight deck and flight safety human factors, was surprised by knowledge/performance gaps among 46 professional pilots who interpreted simulated displays of conventional and advanced systems, the pilots' dissatisfaction with their radar training and their desire for recurrent training.

"In some incident reports reviewed prior to the Honeywell study, what we saw was that the pilots' interpretation of some of the weather radar displays and their use of the tilt control were not optimal — that's a fair way to put it," Khatwa said. "In many cases, this was directly a consequence of a lack of appropriate weather training. We decided to conduct a survey, a true-false questionnaire, on weather radar fundamentals to include every pilot who came into our human factors evaluation. We included a good cross section of pilots from around the world currently flying and active in corporate, regional and large airline operations, and using weather radar. One very simple question was: 'Was your weather radar training sufficient?' Sixty-eight percent of these pilots stated 'no.'"

Pilots from only one airline had recurrent training dedicated to weather radar. "What came out of the interviews was a bit of a disturbing picture for me," Khatwa said. "The message was that very little basic or recurrent weather radar training was being provided in this group. A lot of the pilots said, 'I believe that my system knowledge, including limitations of how weather radar works, is not optimal. This is something I need to have.'" Two subjects that repeatedly came up during the interviews were appropriate uses of the tilt and gain controls. Problematic principles included understanding the airspace that the radar beam actually covers; manually adjusting tilt for radar beam coverage that compensates for Earth's curvature; interpretation of weather radar during high-altitude cruise; and calibrated weather and associated range.

The study used a part-task performance simulation with one of three plan-view displays. The first represented the RDR-4000 system — which has no manual tilt control — in automatic weather mode. The second was the same system in its manual weather–constant altitude mode with selectable range and gain. The third was the display and control panel of a conventional 4B weather radar system requiring pilots to select range, tilt and gain. The study required pilots to monitor instruments, make radar-control selections and tell researchers their weather-avoidance

decisions, without use of any aircraft flight controls, during eight operational scenarios.

Eighty percent of pilots in the group using the conventional system detected the simulated convective weather, which was hazardous. "But that means that in a fifth of these cases, they were unable to find the weather of interest," Khatwa said. "What became obvious from recordings of control panel input was that they were mismanaging tilt. Only about 70 percent of those who saw the convective weather made good weather-avoidance decisions while almost a third of the pilots ended up penetrating it." There was no statistically significant correlation among the participants between failure to see the weather cells of interest and the pilot's level of experience, he said.

Detection of significant weather and weather-avoidance strategies were superior among the pilot groups that used the automatic mode or the manual mode of the new system, which also had almost 90-percent pilot acceptance, he said. A fundamental issue for the other pilots was the removal of tilt control. "These pilots felt some uneasiness, that they were missing something that they had known since they started flying," Khatwa said. "But when we examined their performance data, it became clear that they detected all the weather cells of interest and made the right decisions more frequently and quickly than those who used conventional radar."

Specific next-generation capabilities vary among manufacturers; many are proprietary. For air transport aircraft, the RDR-4000 and a current Rockwell Collins system, the WXR-2100 MultiScan, offer capabilities such as continuous scanning vertically and horizontally of all space in front of the aircraft; storing and retrieving reflectivity data in a three-dimensional memory buffer for display of weather areas surrounding the aircraft; automatic compensation for Earth's curvature and aircraft movement; suppression of ground clutter; generation of vertical profile views; independent control of displays by each pilot; elimination of manual tilt or an optional manual tilt; analysis of storm growth rate and estimation of tops of cumulonimbus clouds; weather-assessment intelligence — based on algorithms, regional storm-model databases, calculations using atmospheric temperature, time of day and altitude; reference to the current flight path and flight management system flight path; and visual alerts to pilots when some precipitation becomes invisible because of beam attenuation.

"To address [limitations of earlier systems, we] decided to move weather radar operation from an experience-based skill to a technologically based capability," Rockwell Collins said in a 2006 technical paper. "The goal was to offer flight crews, with the exception of range selection, hands-free operation. In the automatic mode, the imbedded algorithms manage all aspects of radar operation. Tilt angle, gain and all other functions of radar operation occur without intervention by the pilots."[4]

Level Playing Field

One engineering goal has been to support flight crew decision making by simplifying and accelerating their acquisition of relevant data, according to Keith Stover, principal system marketing manager for weather radar at Rockwell Collins. "The biggest thing, from the training aspect, is that it allows pilots with varying degrees of experience and professional training to get a complete picture. The pilot may not know techniques that other pilots have acquired over many years but can get just as good a picture as any pilot with 25,000 hours."

Most questions received from pilots during training are about the automatic mode. "If they are not confident, we may ask them to try to duplicate in manual mode the picture seen in automatic mode, which is impossible because only the automatic mode has ground-clutter suppression," Stover said. "So then they leave the system in automatic mode, and they begin to feel comfortable. The Boeing 747 program manager of one non-U.S. air carrier uses this training technique."

For conventional systems, methods of pilot training have evolved in different directions for airlines versus corporate operators and regional airline operators. "The airlines all provide information in manuals on how the system works, and in many cases, they add information on gain and tilt controls," Stover said. "The airline pilots' primary sources will be a classroom and/or training they get in the air. Most weather radar training — once you explain what switch does what — takes place in the airplane under the supervision of a line check airman or line check captain. A lot of subsequent weather radar operation is self-taught, using the system in real life. If corporate operators buy an airplane with our avionics, we speak with them directly or through FlightSafety International or a similar entity that does their recurrent training. We think there would be a big safety aspect to the MultiScan capability for corporate operators," Stover said. "In our research — which is promising for now — we're looking at how to translate this technology into smaller airplanes, at several ways to bridge the technology gap." Limitations of antenna size and radome shape have been among the performance challenges.

The Flight Safety Foundation (FSF) Audit Team also addresses training strategy, said Darol Holsman, FSF manager of aviation safety audits. "The vast majority of corporate operators are not providing initial and recurrent training on airborne weather radar, and in my estimation, only about 10 percent have provided any training on a consistent basis within the past three to five years," Holsman said. "I'm always amazed at how few companies have this as part of their initial orientation for new pilots. At least 50 percent of corporate operators seem to rely on radar-training video tapes that are 10 to 15 years old and do not contain current information about the newer color digital radar units."

A related finding involves the typical airplane operations manual that says, "Keep clear of thunderstorms." But Holsman responds, "What kind of guidance is 'keep clear'? It's no guidance. When I fly on the jump seat, I sometimes see new copilots … wait until they are five nm [nine km] away and make a steep turn to avoid going into the thunderstorm, but that is way too close. We say you should not come within 20 nm [37 km laterally or 5,000 feet vertically] of a buildup area — you should avoid it at all costs." Chief pilots who take radar courses almost invariably find them valuable, he added.

A Trainer's Perspective

Erik Eliel of Radar Training International said that trainers must convey accurately not only radar system capabilities but limitations that can conceal threats. He has been invited to make a 50-minute presentation on airborne weather radar at the 11th Safety Standdown to be sponsored by Bombardier, the U.S. Federal Aviation Administration and the U.S. National Business Aviation Association in fall 2007.

"Up-to-date, objective training is absolutely critical in reducing operational risks," Eliel said. "Without a solid academic foundation, proficiency is unattainable. Generally speaking, professional pilots are totally on their own when it comes to acquiring proficiency and the necessary knowledge about airborne weather radar."

Dedicated training is more likely to ensure that pilots understand why black areas on a display — commonly considered hazard-free — sometimes indicate the most serious threats, for example. "Dry hail, precipitation attenuation — also called radar shadow — and clear air turbulence are just three of many threats that can be present in areas of black," Eliel said. The relationship of geographic region to radar display interpretation also is essential background. "Every year, a few professional pilots encounter turbulence, dry hail or other hazards when they blunder through the frozen top of a thunderstorm and are confused about why nothing was displayed on the radar. The frozen tops of thunderstorms are virtually invisible to all X-band weather radar systems [8,000–12,500 MHz frequency range, the newer type with a flat antenna] regardless of antenna size or power output, for example."

Guidance via standard operating procedures and informal in-house training is preferable to no guidance on airborne weather radar, so long as aircraft operators do not assume that every professional pilot joining the company brings the same baseline background and proficiency. A knowledgeable, competent in-house trainer with adequate resources and authoritative materials can augment the initial classroom training so that pilots are not expected to "blindly follow techniques they don't fully understand," Eliel said. "Variations to the radar manufacturer's techniques should be backed up by operational experience and based on solid scientific data, consultation and study," he said. ●

Notes

1. Khatwa, Ratan. "Human Factors Evaluation of Next Generation Weather Radar." A presentation to the Flight Safety Foundation European Aviation Safety Seminar in Athens, Greece. March 2006. "Pilot-in-the-Loop Evaluation of Next Generation Weather Radar Displays." A paper presented during ICAS 2006, the 25th International Congress of the Aeronautical Sciences in Hamburg, Germany. September 2006.

2. Australian Transport Safety Bureau. Aviation Safety Investigation Report no. 200201228. Dec. 19, 2002.

3. Wiggins, Mark. "The Interpretation and Use of Weather Radar Displays in Aviation: Final Report." University of Western Sydney, Australia. April 2005.

4. Rockwell Collins. *Rockwell Collins WXR-2100 MultiScan Weather Radar.* 2006.

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SAFEGUARDING the Fuel Supply

BY BART J. CROTTY

Recent safety audits have identified significant problems in the quality control of aviation fuel supplies and services.

Aviation accident databases show that fuel contamination continues to cause accidents. A survey of U.S. National Transportation Safety Board (NTSB) accidents from 2000 through 2005, for example, reveals that fuel contamination was the probable cause of or a contributing factor in 19 accidents.[1]

Through my own safety audits, I know of two charter aircraft accidents, one of them fatal, involving in-flight fuel starvation/engine stoppages caused by contaminated fuel.[2]

I recently conducted on-site safety audits of seven charter/corporate operators worldwide and found significant problems involving defective conditions and inadequate or nonexistent quality control of aviation gasoline and jet fuel services and supplies. These problems were identified at commercial fueling services at airports and helipads, as well as in operator fuel supplies and self-fueling operations.

Among the most common problems identified during the audits was the absence of written records for many fuel-related maintenance procedures, including filter changes and hose replacements; internal cleaning, inspection and painting of storage tanks; completion of daily, weekly and monthly equipment inspections; receipt of fuel by a fuel farm and the required "settling time" before its use; earth ground-resistance checks; grounding/bonding wire-resistance checks; various pressure gauge and flow gauge calibrations; and formal and on-the-job-training.

Manuals and forms for inspections and audits continue to confuse and misuse the word "grounding," instead of the correct term "bonding."[3] In the late 1990s, the U.S. National Fire Protection Association (NFPA), in *Fire Code 407, Aircraft Fuel Servicing*, stopped requiring that fueling vehicles be grounded and then bonded to the aircraft. Instead, the fire code required only that the fueling vehicle be bonded to the aircraft. Bonding provides a pathway for electrical charges in the fuel transfer system to neutralize the accumulated charge differential between the fuel and the aircraft. For overwing refueling, a bonding jumper connection is required between the fueling nozzle and the wing tank port.

Other problems frequently found during safety audits include uncapped or unprotected fuel nozzles; fuel trucks in unsafe mechanical condition; fire extinguisher hoses with deep cracks or without inspection stickers; leaking fuel connections; corrosion of grounding/bonding clamps or broken wires;

absence of inspection checklists; lack of any policy on records retention; absence of personnel training requirements and/or training records; carelessness in overwing fueling that results in damage to the aircraft wing skin; hazardous items such as matches in the pockets of clothing worn by maintenance personnel, static-generating clothing, and metal buttons or zippers on the clothing; reuse of de-fueled supplies with no specific quality control; and disregard of specified fuel-settling times and/or procedures for retaining samples of sumped fuel. In addition, in some cases, visitors were not prohibited from smoking when they were within 50 ft (15 m) of fueling/de-fueling activities, and fire extinguishers of adequate capacity were not available in sufficient numbers.

In one situation — hardly unique — encountered during an audit, charter and corporate helicopter operators at a private heliport used fuel from a 50-gal (189-l) drum, taking on just enough fuel to fly their helicopters to a nearby airport, where the pilots obtained a full fuel load. Each operator believed that one of the others was monitoring fuel quality, but in fact no one had checked the fuel for more than five years.

Many charter operators have policies and procedures on fuel quality in their company operating manuals, but these usually are not detailed and deal only with flight crew monitoring of aircraft refueling. Operator requirements should be written elsewhere in company manuals or documents, especially if the operator has its own fuel farm, fueling equipment and/or fueling trucks.

Most operators designate a ramp or facility supervisor or employee — rather than the aircraft maintenance manager — to be responsible for quality control. Many of the designees have never attended a formal fuel quality control training course; others have attended such courses only infrequently.

Many operators mistakenly believe that if fuel is obtained from a nationally recognized dealer or supplier, the dealer's reputation alone is assurance of safety. However, the operator also should be familiar with the main fuel provider's quality control program and should review the quality control records at least every year. Infrequent or one-time fuel providers would not warrant the same attention as a primary provider; nevertheless, operators still should inquire about their quality control.

Operators with their own fuel farms, facilities, equipment and/or fuel trucks require a comprehensive fueling operations manual and a full quality control program. International aviation fuel companies can provide operators with current reference material and sample outlines, inspection/check forms and standards from which a company quality control program could be developed. Alternatively, an operator can adopt another company's quality control program, if the program is current and satisfactory, or could hire a specialist to help develop a program.

In addition to the employee designated by the operator to be primarily responsible for the fuel quality control program, a second employee should have outside training and thorough knowledge of the operator's fuel quality control program. If a backup has not been designated, employee turnover, vacations, sick leave and other personnel-related events can regularly leave an operator without the primary "brains" of the quality control program.

The officers of an operator's safety program — usually pilots — should be familiar with their company's fuel quality control requirements and should check periodically for compliance with these requirements.

Charter operators have at least a collateral responsibility, along with their fuel providers, to determine whether aircraft fuel is the right type and the proper quality, and to ensure that safe conditions prevail during fueling operations. This is especially true if the operator itself provides these services. Operators must take all reasonable care in assuring that the responsibilities of fuel providers — and/or the operators themselves — are without any doubt being met satisfactorily. Anything less is not acceptable.●

Bart J. Crotty is a consultant on airworthiness, flight operations, maintenance, aviation safety and security, and a writer based in Springfield, Virginia, U.S.

Notes

1. Two smaller databases also showed fuel contamination as the cause of a number of accidents. The Helicopter Safety Advisory Conference, in its *Gulf of Mexico Offshore Helicopter Operations and Safety Review, 2005*, said that five accidents (9 percent of the total) during the five previous years were caused by fuel quality problems. The Aircraft Owners and Pilots Association, in a safety advisory issued in 2006, said that in 2004, 18 accidents, including five fatal accidents, occurred as a result of fuel contamination.
2. Client confidentially precludes the discussion of details of these two recent accidents.
3. Grounding, also called "earthing," is the process of connecting an object that conducts electricity to the ground. Bonding is the process of connecting two or more conductive objects to each other.

InSight is a forum for expressing personal opinions about issues of importance to aviation safety and for stimulating constructive discussion, pro and con, about the expressed opinions. Send your comments to J.A. Donoghue, director of publications, Flight Safety Foundation, 601 Madison St., Suite 300, Alexandria VA 22314-1756 USA or donoghue@flightsafety.org.

Parts Inventory

Passengers were less likely to be killed or injured in accidents involving FARs Part 121 operations than in Part 135 on-demand accidents, an annual review of U.S. data shows.

BY RICK DARBY

Detailed studies of accident data must wait until all the accidents have been investigated and final reports issued, and 2002 is the most recent year for which an official annual review has been released in the United States. That year, U.S. Federal Aviation Regulations (FARs) Part 121 air carriers had the lowest accident rates among commercial operators, with 2.37 accidents per million flight hours.[1] Accidents involving Part 135 on-demand operations, in comparison, occurred at a rate of 20.6 per million flight hours, nearly nine times greater.[2] Part 135 scheduled operations resulted in 25.6 accidents per million flight hours.[3]

About 10 percent of passengers aboard Part 135 on-demand flights involved in an accident were killed. About 5 percent of passengers aboard Part 135 on-demand flights involved in an accident were seriously injured; in Part 121 accidents, about 0.4 percent. There were no fatalities in Part 121 operations or Part 135 scheduled operations. Part 135 on-demand operations produced 6.18 fatal accidents per million flight hours.

The review[4] was adopted by the U.S. National Transportation Safety Board in September 2006 and received at Flight Safety Foundation in early 2007.

In the 41 accidents in Part 121 operations (Table 1, page 50), 2,709 passengers were involved, of which 55, or 2 percent, sustained any type of injury. In those accidents, 213 crewmembers were involved, 23 of whom, or 11 percent, were injured. Nine cabin crewmembers received serious injuries, compared with three flight crewmembers.

Part 135 on-demand operations resulted in 72 accidents, with 18 of them, or one-fourth, involving fatalities. Among the 175 passengers involved in accidents, 17 were killed and nine were seriously injured (Table 1). For flight crews, the fatalities included 16 of 72 involved in accidents, or 22 percent.

Part 135 on-demand operations resulted in 72 accidents, with 18 of them, or one-fourth, involving fatalities.

Among on-demand Part 135 operations, the accident rate was higher for helicopters than for airplanes, at 28.4 accidents per million flight hours versus 20.2. The fatal accident rate was higher for airplanes, with 7.0 fatal accidents per million flights versus 5.0.

"Investigators describe the events that take place during an accident as a sequence of occurrences, each identified with a phase of flight," the report says. "The first occurrence associated with a phase of flight describes the initiating event for an accident flight and the starting point of the accident."

For Part 121 accidents, "on-surface collision with object" was the first occurrence in the largest number of accidents (Table 2, page 50), eight of 37 or 22 percent.[5] "In-flight encounter with weather"

Fatalities and Injuries, FARs Part 121 Operations and Part 135 On-Demand Operations, 2002	Fatal		Serious		Minor		None		Total	
	Part 121	Part 135	Part 121	Part 135	Part 121	Part 135	Part 121	Part 135	Part 121	Part 135
Flight crew	0	16	3	6	3	5	78	45	84	72
Cabin crew	0	0	9	0	8	0	102	0	119	0
Other crew	0	2	0	1	0	0	10	2	10	5
Passengers	0	17	11	9	44	10	2,654	139	2,709	175
Total aboard	**0**	**35**	**23**	**16**	**55**	**15**	**2,844**	**186**	**2,922**	**252**
On ground	0	0	1	0	1	1	0	0	2	1
Other aircraft	—	0	—	0	—	0	—	0	—	0
Total	**0**	**35**	**24**	**16**	**56**	**16**	**2,844**	**186**	**2,924**	**253**
Accidents	0	18	16	9	1	7	24	38	41	72

FARs = U.S. Federal Aviation Regulations

Source: U.S. National Transportation Safety Board

Table 1

First Occurrences in Accidents, FARs Part 121 Operations, 2002	Takeoff or Climb	Cruise or Descent	Approach or Landing	Standing	Taxiing	Total
On-surface collision with object	1			2	5	8
In-flight encounter with weather	1	4	2			7
Miscellaneous/other	1	1		2		4
Airframe/component/ system failure	1	1	1			3
Gear collapsed			2		1	3
In-flight collision with object	1	1	1			3
Dragged wing, rotor, pod, float or tail/skid			2			2
Abrupt maneuver		1				1
Collision between aircraft (not midair)					1	1
Fire				1		1
Hard landing			1			1
Loss of control — on ground/water			1			1
Near collision between aircraft			1			1
Propeller contact with person				1		1
Total accident airplanes	**5**	**8**	**11**	**6**	**7**	**37**

FARs = U.S. Federal Aviation Regulations

Source: U.S. National Transportation Safety Board

Table 2

was the second most frequently cited initiating event, cited in seven accidents or 19 percent. The report said that all in-flight encounters with weather during cruise or descent were turbulence, and all resulted in serious injuries. Turbulence was a factor in 19.5 percent of all Part 121 accidents and 50.0 percent of all serious injury accidents.

For Part 135 on-demand airplane operations, "loss of control in flight" — a category not found among first occurrences in Part 121 accidents — was the most common first occurrence, in six of the 41 accidents (Table 3). Although loss of control was the largest single category, it was equaled by the combination of "in-flight collision with object" and "in-flight collision with terrain or water." The same was true for Part 135 on-demand helicopter operations (Table 4).

"Although most of the injury-producing accidents in Part 121 operations occurred in flight and were typically associated with turbulence,

First Occurrences in Accidents, FARs Part 135 On-Demand Airplane Operations, 2002	Takeoff or Climb	Cruise or Descent	Approach or Landing	Maneuver	Taxiing or Standing	Total
Loss of control — in-flight		1	5			6
Overrun	1		3			4
Airframe, component, or system failure	1		2			3
In-flight collision with object		2	1			3
In-flight collision with terrain or water	1	1		1		3
In-flight encounter with weather	1	1	1			3
On-surface collision with terrain or water	1				2	3
Collision between aircraft (not midair)					2	2
Loss of control — surface	2					2
Loss of engine power (total) nonmechanical		1	1			2
Midair collision		1	1			2
On-surface collision with object					2	2
Gear collapsed			1			1
Loss of engine power			1			1
Loss of engine power (partial) nonmechanical	1					1
Main gear collapsed					1	1
Miscellaneous/other						1
Undershoot			1			1
Total	**8**	**7**	**17**	**1**	**7**	**41**

FARs = U.S. Federal Aviation Regulations

Source: U.S. National Transportation Safety Board

Table 3

First Occurrences in Accidents, FARs Part 135 On-Demand Helicopter Operations, 2002	Takeoff or Climb	Cruise or Descent	Approach or Landing	Maneuver or Hover	Standing	Total
Loss of control — in-flight	1	1	2			4
In-flight collision with object		1	1			2
In-flight collision with terrain or water			2			2
In-flight encounter with weather		2				2
Airframe, component, or system failure		1				1
Fire					1	1
Loss of control -on ground/water	1					1
Loss of engine power (total) mechanical		1				1
Rollover	1					1
Total	**3**	**6**	**5**	**0**	**1**	**15**

FARs = U.S. Federal Aviation Regulations

Source: U.S. National Transportation Safety Board

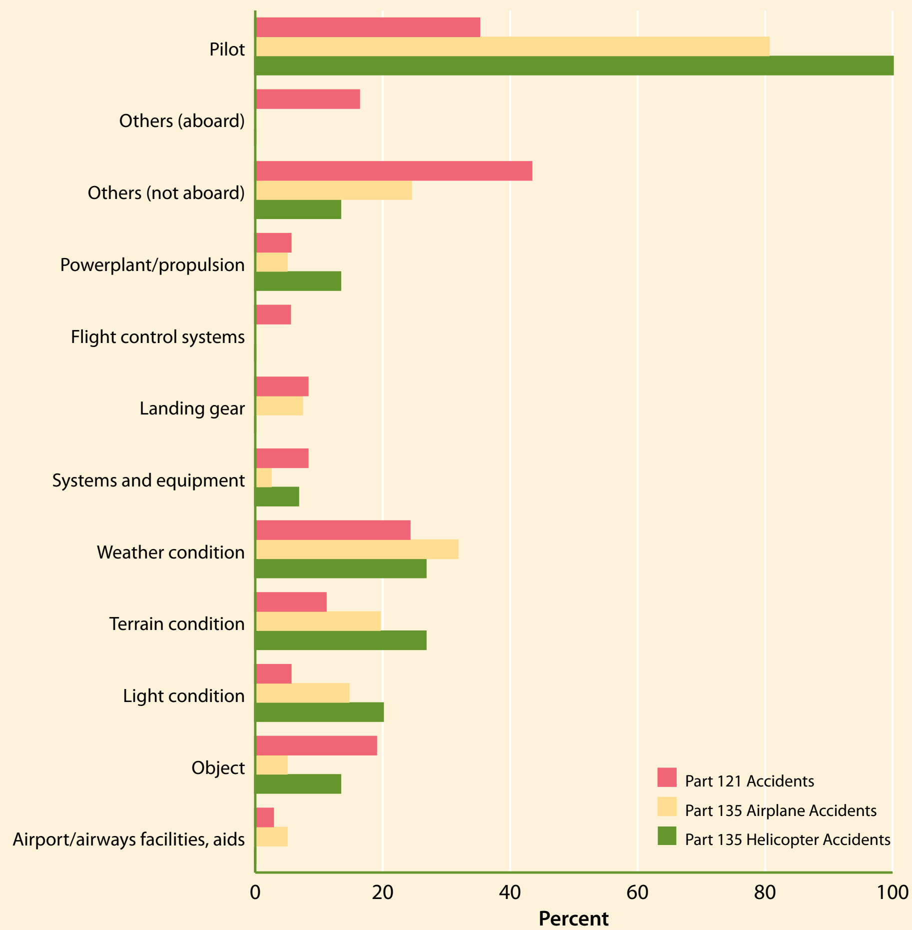
Table 4

turbulence was rarely cited as a cause or factor in on-demand Part 135 accidents," said the report.

More detail about Part 121 and Part 135 on-demand accident causes and factors is shown in Figure 1 (page 52). In Part 121 accidents, people who were not aboard the airplane — primarily ramp personnel, the report said — ranked highest as causes or factors in accidents. Weather, cited in about 24 percent of accidents, was the most frequent environmental cause.

Compared with Part 121 accidents, pilots ranked higher as causes or factors in Part 135

Causes and Factors, FARs Part 121 Accidents and FARs Part 135 Airplane and Helicopter On-Demand Accidents, 2002



FARs = U.S. Federal Aviation Regulations

Source: U.S. National Transportation Safety Board

Figure 1

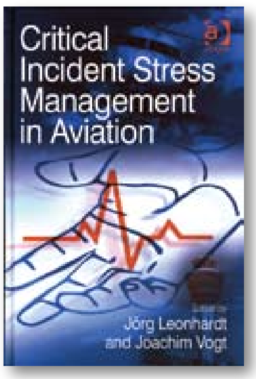
on-demand accidents, both for airplane accidents and helicopter accidents. Powerplant/propulsion and aircraft systems other than landing gear were factors in larger percentages of Part 135 helicopter accidents than airplane accidents. "Terrain condition," "light condition" and "object" were also determined to be factors in a larger proportion of helicopter accidents than airplane accidents. ●

Notes

1. U.S. Federal Aviation Regulations (FARs) Part 121, *Operating Requirements: Domestic, Flag, and Supplemental Operations*, applies to operators that fly large transport-category aircraft.
2. FARs Part 135, *Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft*, typically applies to commercial carriers flying smaller jet and turboprop aircraft. "On-demand" means that the flights are unscheduled or "air taxi" operations.
3. FARs Part 135 scheduled operations typically involve aircraft with single or twin turbine engines or piston engines on short routes.
4. U.S. National Transportation Safety Board. *Annual Review of Aircraft Accident Data: U.S. Air Carrier Operations, Calendar Year 2002.* NTSB/ARC-06/02. Adopted Sept. 14, 2006.
5. First occurrences could be determined for analysis in 37 of the 41 accidents involving Part 121 operations.

Stress Test

It isn't only airlines that need to be prepared to manage the stress of a critical incident.



BOOKS

Critical Incident Stress Management in Aviation

Leonhardt, Jörg; Vogt, Joachim (editors). Aldershot, England, and Burlington, Vermont, U.S.: Ashgate, 2006. 194 pp. Figures, tables, references, appendixes, index.

A serious aircraft accident is universally shocking, perhaps most of all to people who work in the aviation industry, says Jeffrey T. Mitchell, Ph.D., a professor of health services, in one chapter of this book. "They also feel responsibility and guilt because they design, manufacture, maintain, operate, communicate with, and control the aircraft that criss-cross the sky," he says. "The media, politicians, the public and, sometimes, even the airline's corporate leadership are quick to place blame on the employees of an airline and hold them accountable."

Distress quickly cascades through the industry after an aviation disaster. "Gate agents have a hard time facing the public," Mitchell says. "Pilots and flight attendants may not wish to fly [aboard] the same type of aircraft that crashed, especially if the type of aircraft has a history of several crashes. Ground and maintenance crews and air traffic controllers review their procedures to see if they may be at fault. Few within the industry feel at ease with their work in the months after a catastrophic incident."

But it isn't only the large-scale accidents widely reported in the media that can be emotionally jarring for aviation personnel, he notes. Passengers become ill or are injured. Occasionally one dies aboard the aircraft during an otherwise normal flight. Severe turbulence, threatening or violent passengers, upset passengers — all take a toll on flight attendants. Even pilots, despite their typical self-confidence and equanimity, can experience significant stress from "close calls," equipment failures, severe weather or hard landings.

"The aviation industry, at all levels, needs quality crisis support programs to assist its employees and keep them functioning at peak performance levels," says Mitchell. "That means peer and professional crisis responders must be properly trained and organized to respond quickly to an individual or group crisis and to provide the right support services at the right time and under the right circumstances."

The editors say that this volume was needed because most other information sources about critical incident stress management (CISM) relate to fire fighters and emergency rescue personnel. But crisis management in aviation also involves air traffic control, airports and airlines — each of which must coordinate its efforts with the others in many accidents and incidents.

Each of these "protagonist" organizations, as the editors call them, has its own "special organizational requirements, implementation and structure of CISM, rules and procedures, advantages, benefits and experiences." Representatives of each type of organization contributed chapters to the book, addressing CISM from their own perspectives.

For an air traffic controller, says Leonhardt, a psychologically critical incident need not be an accident or even a near-accident. A loss of required separation between aircraft, even if the standard allows enough margin for error that there is no serious danger, can result in a stress reaction. The controller's self-respect may suffer — after all, the essence of the profession is maintaining aircraft separation. In addition, controllers are selected partly because of their exceptional ability to visualize aircraft spatial relationships and project them into the future.

"The [controller's] *inner eye* is viewing a catastrophe, and the fantasy completes the inner picture," Leonhardt says. "In training and professional experience, the [controller] develops pattern recognition for potentially critical situations."

Counselors or others who would relieve the controller's stress may do more harm than good if they do not understand the profession's frame of mind and value system. Even psychologists, if they try to relieve the tension from the incident by pointing out that no harm occurred and none was likely, fail to understand that in the controller's "picture completing" imagination a "disaster" did happen. It is a longstanding axiom of psychology that people can react emotionally to mental cues as strongly as to real events.

A chapter by Walter Gaber and Annette Drozd about the CISM team at Frankfurt (Germany) Airport describes the planning and organization needed to cope with a crisis such as an accident at or near a large international airport. Generally, there will be many family members and friends of the victims who have come to the airport to drop off or greet passengers.

"This means that at least three times the number of people (900 to 1,200 persons per aircraft) will have intensive emotions in different constellations at any time of the day or night at the airport," the authors say. "These persons require the care of a continuously operating care team in order to keep [them] informed as best as possible. They must be isolated from the press and other persons at the airport in order to be provided with bad news or to be joined by their family members. Helpers having to give bad news must be trained for this. Furthermore, a sufficient number of helpers must be on hand."

In this era of globalization, victims and families are likely to represent many religions, and the crisis management group must have a comprehensive list of counselors they can call on. By the same token, an accident probably will affect people of different nationalities. "It is a big asset of an international airport to be able to utilize its workforce, which is also made up of various cultural backgrounds," Gaber and Drozd say. "Even if these colleagues are not already members of the care teams, their presence alone would be of major assistance in dealing with affected foreigners because by translating or helping with minor tasks, the grief and suffering of affected persons could be minimized."

REPORTS

Evaluation of the Human Voice for Indications of Workload Induced Stress in the Aviation Environment

Hagmueller, M.; Rank, E.; Kubin, G. EEC Note No. 18/06. December 2006. 87 pp. Figures, tables, annexes, references. Available via the Internet at <www.eurocontrol.int/eec/public/standard_page/2006_note_18.html>.

According to an established psychological principle called the Yerkes-Dodson law, cognitive arousal — alertness and readiness to respond — is related to performance. But it is not a one-to-one relationship. Up to a point, the greater the arousal, the better the performance; beyond that optimum point, however, further arousal results in decreasing performance.

"So, for an optimal safety of the human ATC [air traffic control] task, an operator ideally needs moderate workload," the report says. "Therefore, it is common ATC practice to modulate the size of a control sector during the day, depending on the traffic load. … The aim is to hold the workload for the controller continuously at a moderate level."

Currently, a supervisor determines subjectively the need for combining or splitting sectors, based on experience and administrative constraints. But the assessment of a "moderate" workload for a controller is difficult because the controller's stress level is affected by factors such as health and the environment.

"A real-time tool to evaluate objectively human stress indicators under a given workload, to keep the human at the optimal performance, could help to increase ATC safety," says the report.

Such a tool might be the human voice as it registers stress reactions through modification by respiration rate and blood pressure. This form of monitoring would have the advantage of requiring no sensors attached to the controller's body or intrusive video surveillance.

"The central part of this document is chapter 4, where we present a literature review of work on analysis and classification of speech under stress," the report says.

So far, research on voice and stress has used a very broad definition of stress, not necessarily related to workload, the report says. At this stage, analysis of voice to determine workload stress presents various confounding factors — for example, a controller might feel stressed about domestic problems rather than workload. The report notes, however, that "while the overall performance of speech-based classification is far from satisfactory, it is still not so different from the performance reported for non-speech-based methods."

Revisiting the 'Swiss Cheese' Model of Accidents

Reason, J.; Hollnagel, E.; Paries, J. Eurocontrol Experimental Centre. EEC Note No. 13/06. October 2006. 35 pp. Figures, annexes, references. Available via the Internet at <www.eurocontrol.int/eec/public/standard_page/2006_note_13.html>.

"In 1990, James Reason, then a professor with the University of Manchester, provided a crucial contribution to the concretization of this idea by proposing a 'model' of how accidents could be seen as the result of interrelations between real time 'unsafe acts' by front line operators and latent conditions," the report says. "This model turned out to be highly pedagogical [teachable], and a large number of safety analysts around the world quickly started to use it in different industries."

Typical interpretations of Reason's model describe multiple levels of defense, or barriers, between errors or failures and an accident. The barriers have been pictured as a series of slices of Swiss cheese, a metaphor that Reason did not coin. Weaknesses, including latent ones, that can contribute to an accident are signified by the holes in the slices, which must be aligned for a cause to penetrate the defenses and an accident to occur.

"While much of the accident investigation community swiftly adopted the Swiss cheese model (SCM), not least in the aviation domain, the enthusiastic use sometimes relied on interpretations of the model's semantics that went rather far beyond what was initially intended," the report says. "The aim of this report is therefore to discuss the relevance and limitations of using the SCM, particularly from an air traffic management accident investigation perspective."

Reason has revised the SCM, most recently in the Mark III version of 1997, which the report says includes "significant changes." One is an explanation of how the weaknesses in the layers of defense arise:

"Short-term breaches may be created by the errors and violations of front-line operators. Longer-lasting and more dangerous gaps are created by the decisions of designers, builders, procedure writers, top-level managers and maintainers. These are now called latent conditions rather than latent errors or latent failures. A condition is not a cause, but it is necessary for a causal factor to have an impact. Oxygen is a necessary condition for fire; but its cause is a source of ignition. The use of this term allows us to acknowledge that all top-level decisions seed pathogens into the system, and they need not be mistaken.

"Allocating resources between departments is rarely done by giving out equal shares; some departments get more than others for what are judged to be sensible reasons at the time. But those with smaller slices of the resource cake will often have poorer equipment, extra time pressure, under-manning and other error-provoking factors. The existence of latent conditions is a universal in all organizations, regardless of their accident record."

The report notes published criticisms of the SCM. Human factors researcher Sidney Dekker, for instance, said that "the Swiss cheese analogy is useful to think about the complexity of failure, and, conversely, about the effort it takes to make and keep a system safe. … But the analogy itself does not explain: where the holes are or what they consist of, why the holes are there in the first place, why the holes change over time, both in size and location, [and] how the holes get to line up to produce an accident."

Reason has speculated that "the pendulum may have swung too far in our present attempts to track down possible errors and accident contributions that are widely separated in both time and place from the events themselves."

WEB SITES

Aircraft Crashes Record Office (ACRO), <www.baaa-acro.com>

ACRO was founded in Geneva in 1990 with the goal "to record all information regarding commercial aircraft accidents worldwide since 1918 to today." According to the Web site, ACRO already has collected documentation and photos of more than 16,200 accidents.

The accident statistics section lists accidents from the database by several categories — country, airline, aircraft type, registration, fatality count and year. The accident news section lists recent accidents and provides basic information about the aircraft, passenger and crew data, and a brief news report.

Accident photos in color and black-and-white can also be accessed directly by the year an accident occurred. Not all years have accident photos. The oldest photo — a Caudron C.61 from the Czech Republic — dates from 1926 and shows the biplane with front-end damage, resting inverted.

The database is not all-inclusive and does not link to factual accident reports, but researchers may find this to be a convenient starting place with some attractive design features, such as airline logos. The Web site is in English and French.

U.S. Department of Transportation (DOT), Online Digital Special Collections Library, <dotlibrary.specialcollection.net>

The DOT has digitized several collections of archival library materials, including a large number of historic aviation documents, to preserve them and make them accessible to aviation enthusiasts.

Civil aviation materials are from U.S. regulatory and investigative agencies — the Federal Aviation Administration, the National Transportation Safety Board and their predecessors.

A visit to the history section of the FAA's Web site <www.faa.gov/about/history/brief_history> will help researchers understand the evolution of these groups and their respective documents.

Special collections include the following:

- Historic aviation accidents, 1934–1965;
- Civil aeronautic manuals;
- Civil Air Regulations administered by the Bureau of Air Commerce and the Civil Aeronautics Board;
- Civil Aeronautics Regulations administered by the CAA;
- Historic Federal Aviation Regulations, Part 121 and Part 135; and
- Superseded advisory circulars, dated 1957 and 1962–2000.

For many in the aviation field, the most useful will be the reports of historic accidents and incidents. Full-narrative accident reports, some with figures, appendixes and updates, have been scanned and/or reproduced. This collection supplements the NTSB aviation accident and incident database (1962–present) at the NTSB Web site <www.ntsb.gov/aviation/aviation.htm>.

As a result of today's technology, many materials in these special collections are available in two formats — scanned images of originals and versions reproduced as editable text. Documents can be read online, copied and printed at no charge. ●

— Rick Darby and Patricia Setze

Controller Averts Taxiway Takeoff

Warned, pilot rejects takeoff at 80 kt.

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

Commander Misidentified Taxiway Markings

Boeing 737-800. No damage. No injuries.

Nighttime visual meteorological conditions prevailed as the Pegasus Airlines flight crew prepared to depart from Oslo Airport in Gardermoen, Norway, for a scheduled flight to Antalya, Turkey, on Oct. 23, 2005. Traffic was light, and Runway 01L was being used for departures. A notice to airmen (NOTAM) indicated that a portion of the approach end of the runway and two stub taxiways, A1 and A2, were closed and that 3,200 m (10,499 ft) were available for takeoff after back-taxiing on Runway 01L from Taxiway A3.

However, the crew planned to take off from the intersection of A3, from which 2,696 m (8,846 ft) of runway were available, said the report by the Accident Investigation Board of Norway (AIBN). There are two parallel taxiways east of Runway 01L: Taxiway M is adjacent to the runway; Taxiway N is adjacent to the terminal. The crew was instructed to taxi south on Taxiway N to A3, which crosses Taxiway M and leads to Runway 01L. While proceeding south on Taxiway N, the crew was cleared for takeoff on Runway 01L from the A3 intersection.

The commander, the pilot flying, told investigators that as she made a right turn from Taxiway N onto A3, she turned on the landing lights and saw a dashed yellow line to her left, which she believed marked the closed part of the runway. The line actually was across Taxiway N and marked the intersection with A3.

"The commander has flown to many different airports in many countries and claims to be used to ground conditions not always being in accordance with ICAO [International Civil Aviation Organization] standards," the report said. "An airport operator marking a closed part of the runway in this way was considered absolutely possible by the commander."

She made a left turn to back-taxi on what she believed was the runway to position the aircraft at the dashed yellow line for takeoff. Observing the aircraft's movement, the air traffic controller said, "Confirm you are entering runway now; seems like you are turning onto Mike. Continue right turn and then left again to enter the runway." The first officer replied, "Turning right."

"When the right turn had been completed, and the nose of the aircraft pointed towards the north on Taxiway M, the commander pressed

The edges of the taxiway were not marked with blue lights, as recommended by ICAO.

the TO/GA [takeoff/go-around] button, and the aircraft accelerated," the report said. Taxiway M is significantly shorter than Runway 01L; 1,601 m (5,253 ft) of the taxiway remained from where the takeoff was begun.

The report noted that the edges of the taxiway were not marked with blue lights, as recommended by ICAO. However, Taxiway N had the recommended green centerline lights; white is recommended for runway centerline lights. "The type of lighting and the color of the lights were evidently not sufficient to make the commander doubt her own decision," the report said.

The controller heard the noise from the aircraft's engines increase substantially and told the crew, "Hold position. You are on Taxiway Mike." The commander said that indicated airspeed was almost 80 kt when she disengaged the autothrottles, closed the thrust levers and applied the wheel brakes.

After the aircraft was slowed, the controller told the crew to make a right turn on A4 to Taxiway N. The first officer replied, "Alpha 4."

"Instead of a right turn, the crew turned left towards Runway 01L," the report said. "[The 737] was the only aircraft in the immediate area, so the controller gave clearance to enter the runway via A4 and taxi southwards. This was performed, and the crew took off to the north after having received new clearance for takeoff."

The commander and first officer had not flown together before the incident occurred. Both pilots had received crew resource management (CRM) training by the company. AIBN said, however, that their CRM during the incident was inadequate.

Investigators were unable to obtain data on the number of passengers aboard the aircraft or its gross weight, and therefore could not calculate the aircraft's takeoff performance. Noting that air temperature was 0 degrees C (32 degrees F), the report said, "If the aircraft was not fully loaded, the crew would probably have been able to complete a takeoff [from Taxiway M], but it would not have been a safe operation. The risk of rolling off the end of the taxiway at almost takeoff speed was definitely present."

AIBN said that the incident might have been prevented if the crew had been instructed to taxi to the holding point on A3 or to line up and wait on the runway. The report cited a practice that has been adopted by controllers at Auckland (New Zealand) International Airport: "There, clearance for takeoff is not given before the air traffic controller can visually confirm that the aircraft is in a correct takeoff position on the runway. When visibility is poor, a person is positioned on the field to watch the aircraft, communicating a visual confirmation to the air traffic controller. This arrangement was established after repeated incidents where aircraft crew confused the runway and a parallel taxiway."

Brake Failure Causes Ground Accident

Airbus A320. Minor damage. No injuries.

Soon after the flight crew began to taxi the aircraft for departure from London Heathrow Airport the morning of April 4, 2006, a hydraulic connection in the braking system fractured, causing a leak in the Yellow hydraulic system. The departure was canceled, and the crew taxied the aircraft back to the terminal.

"After stopping at the allocated stand, the parking brake was selected 'ON,' but the brakes failed to apply, as the parking brake is operated by the Yellow hydraulic system," the U.K. Air Accidents Investigation Branch (AAIB) report said. "The aircraft then began to move forward under idle engine power. Attempts by the crew to stop, using the brake pedals, proved unsuccessful, as the other modes of braking are deactivated when the parking brake is selected 'ON.'"

The crew shut down the engines before the aircraft struck the unoccupied airbridge, causing damage to the aircraft's left engine inlet cowling and the airbridge's protective railings. None of the 116 occupants of the aircraft was injured.

Directional Control Lost in Crosswind

Bombardier CRJ200. Substantial damage. No injuries.

The Pinnacle Airlines airplane was climbing through Flight Level 200 (approximately 20,000 ft) after departing from La Guardia Airport, New York, the night of March 11, 2005, when a warning light indicated low pressure in the no. 1 hydraulic system. The flight crew conducted the quick reference handbook checklist, which advises, in part, that the outboard ground spoilers would not be available for landing and that the crew should land at the nearest suitable airport.

The crew elected to continue the flight to Milwaukee (MKE), the scheduled destination. "The captain reported that he decided to continue the flight to MKE after considering MKE's weather and runway length," said the report by the U.S. National Transportation Safety Board (NTSB).

A snow squall passed over the airport about 15 minutes before the airplane arrived. Reported weather conditions included winds from 290 degrees at 10 kt, gusting to 16 kt, 3/4 mi (1,200 m) visibility, light snow and broken ceilings at 500 ft and 2,000 ft. The instrument landing system (ILS) approach to Runway 01L was in use.

Air traffic control (ATC) did not provide, and the crew did not request, a braking-action report for Runway 01L. The report said that airport operations personnel had not conducted a friction measurement or issued a NOTAM on runway condition in more than 24 hours.

The airplane was crabbed 5 degrees left and banked 1 degree left when it touched down 2,400 ft (732 m) beyond the approach threshold of the 9,690-ft (2,955-m) snow-covered runway. The airplane veered left, ran off the left side of the runway about 4,200 ft (1,281 m) from the approach threshold and came to a stop on a taxiway intersection near the terminal.

"The captain reported that nothing appeared to be wrong with the airplane, so the decision was made to taxi to [the] gate … where the [nine] passengers were deplaned via the airstairs instead of the jet bridge," the report said. "An examination of the airplane revealed that the forward pressure bulkhead … was compromised. The flaps, the main landing gear doors, the nose landing gear and various skin panels also were damaged."

The report said that Runway 01L had not been closed, as required by the airport's snow and ice control plan, after a Raytheon Beechjet pilot reported braking action as nil about three hours before the accident. Between that report and the accident, 59 airplanes had been landed on the runway.

NTSB said that the probable causes of the accident were "the captain's failure to adequately compensate for the crosswind conditions and his failure to maintain directional control during landing." Among contributing factors listed by NTSB were "the captain's failure to land at the nearest suitable airport" and the failure of airport operations personnel to "conduct runway friction tests and to issue NOTAMs in accordance with existing regulations."

Low Flight Alarms Residents

Boeing 737-800. No damage. No injuries.

Weather was clear as the aircraft, with 134 people aboard, neared the destination — Cork (Ireland) Airport — the afternoon of June 4, 2006. The flight crew had briefed for the ILS approach to Runway 17 but requested and received clearance from ATC for a visual approach.

The aircraft arrived on final approach too high and too close to the runway to land, and the first officer suggested a standard go-around. Instead, the commander told the first officer to request clearance to conduct a 360-degree right turn, said the Irish Air Accident Investigation Unit (AAIU) report. ATC approved the request.

The aircraft was in landing configuration when the commander began the turn about 1,050 ft above ground level (AGL). From the left seat, the commander's "awareness of the position of his aircraft relative to the ground in a steep right-hand turn was considerably less than that of the [first officer], who had a direct view of the ground," the report said. The first officer repeatedly warned that the aircraft was descending but was disregarded by the commander. During the turn, the aircraft descended to 425 ft AGL over a populated area and "alarmed many of its residents, both because of its unexpectedly low height above the ground and the engine noise levels," the report said.

The first officer repeatedly warned that the aircraft was descending but was disregarded by the commander.

The first officer said that he heard two terrain awareness and warning system (TAWS) "TOO LOW, GLIDESLOPE" warnings, which were silenced by the commander. He also saw four red lights on the precision approach path indicator (PAPI). "Visual contact with the ground and PAPIs (four reds) showed them to be too low and flat on the approach, so a climb was initiated to a height from which a safe landing was effected," the report said.

AAIU classified the event as a serious incident that was caused by the commander's nonadherence to standard operating procedures (SOPs) and nonconformance with established CRM principles.

TURBOPROPS

Ice on Wing Triggers Stall on Takeoff

Cessna 208B Caravan. Destroyed. One minor injury.

The pilot had flown the cargo aircraft from Sweden to the Helsinki–Vantaa (Finland) Airport early on the morning of Jan. 31, 2005, and the aircraft was parked outside in snow and freezing temperatures. When the pilot returned to the airport that evening, he used a brush to remove a substantial amount of snow and ice that had accumulated on the aircraft. "He did not, however, manage to brush all of the impurities off of the surfaces of the aircraft," said the report by the Accident Investigation Board of Finland (AIB).

Aircraft deicing was available from two ground-service providers at the airport, but the pilot did not have the Caravan deiced. "A contributing factor to the neglect of the deicing may have been a sense of hurry that the pilot had developed as he was trying to make it to his primary destination on time," the report said.

The aircraft operator, Nord-Flyg, usually assigns two pilots to cargo flights in the Caravan, but the copilot who was scheduled for the flight had become ill. "The company could not find a replacement … therefore, contrary to company practice, the flight was flown with a one-person crew," the report said.

After cargo was loaded for the return flight to Sweden, the pilot took off from Runway 22L with flaps extended 10 degrees. When he retracted the flaps between 800 ft to 1,000 ft AGL, the right wing stalled, and the aircraft turned right and descended. The pilot lowered the nose to decrease angle-of-attack, but the aircraft remained stalled. He was able to level the wings before the aircraft struck a snow-covered mound of sand off the right side of the runway.

Examination of the wreckage revealed 0.5- to 1.5-cm (0.2- to 0.6-in) accumulations of snow, frozen slush and ice on the upper surfaces of the wings, fuselage and horizontal stabilizers. "These kinds of impurities are detrimental to airfoil aerodynamics and may reduce the coefficient of lift of the wing as much as 20–30 percent," the report said.

AIB said, "The primary cause of the accident was that the pilot executed a takeoff with an aircraft whose aerodynamic properties were fundamentally degraded due to the accumulated ice and snow on the upper surface of the wing. During the initial climb and immediately after flap retraction, airflow separated from the surface of the wing, and the pilot did not manage to regain control of the aircraft. The pilot did not recognize the stall and did not act in the manner required to recover from one, or it might be that he had not received sufficient training for such situations."

The report said that the pilot did not extend the flaps or increase power during his attempt to recover from the stall. "[Flap extension] might have returned the separated airflow back to the surface of the wing," the report said. "Approximately 30 percent more propeller power could have been gained by exceeding the engine manufacturer's limitations for normal operations."

Skydiver Struck by Horizontal Stabilizer

Beech 99. Substantial damage. One serious injury.

During a skydiving flight near Lodi, California, U.S., on Aug. 22, 2006, "a skydiver jumped up and out of the airplane instead of dropping out of the exit and keeping a low trajectory," the NTSB report said. "He then impacted the horizontal stabilizer and fell away from the leading edge. The skydiver's automatic deployment system activated and opened the parachute." The pilot and 12 other skydivers were not injured.

The injured skydiver had made about 200 jumps, most of which were from the accident airplane. He had exited the airplane the same way the day before the accident and was told by other skydivers that he had barely missed the horizontal stabilizer. "In addition, he was instructed to stay low and not to jump up just prior to exiting the airplane" during the accident flight, the report said.

"According to statements from the operator and three other skydivers, the skydiver jumped up when he exited the airplane, exposing himself to the propeller blast, which drove him aft to the horizontal stabilizer," the report said.

Elevator Partially Detaches on Takeoff

Aerospatiale/Aeritalia ATR 42. Minor damage. No injuries.

While preparing to depart from Bergen (Norway) Airport the afternoon of Jan. 31, 2005, the Danish Air Transport flight crew conducted a flight-control check. Following company SOPs, the commander checked the rudder while the first officer checked the elevator and ailerons. The first officer told the commander that the elevator required more force than normal and that he thought the "stiffness" was due to the wind. The commander accepted the first officer's explanation and did not check the elevator himself.

"Correct elevator function is a condition for safe flight, and, in the light of hindsight, it is easy to see that the commander should have been more careful and investigated whether he could register any anomaly with the elevator," the AIBN report said.

The airplane accelerated normally during takeoff, but the commander had to apply excess elevator-control force for rotation. "At first, he thought that the elevator trim was incorrect," the report said. "However, immediately after liftoff, it became clear that the elevator was not working as it should. Full elevator deflection was necessary to maintain normal pitch [attitude]. For a period, the first officer assisted the commander physically with the controls, and both have explained that it was extremely demanding to maintain control of the aircraft."

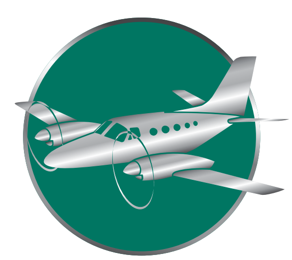
The crew declared an emergency and returned to the airport. "The landing was accomplished without further incident seven minutes after takeoff," the report said. None of the 25 occupants was injured.

Examination of the aircraft revealed that the outboard end of the right elevator was hanging 30 cm (12 in) below the horizontal stabilizer and remained attached to the aircraft only by the inboard hinge. "A bolt was missing from both the center and outer hinges," the report said. "Both of the bolts and one of the nuts that normally should connect the hinge assemblies together were found. One of the bolts was found on the runway, the other inside the elevator."

AIBN concluded that inadequate torque had been applied to the self-locking nuts on the hinge bolts during reinstallation of the elevator after the aircraft was repainted in 1999; the nuts had progressively loosened and eventually detached from the bolts on the center and outboard hinges.

"Investigation indicates that the bolt belonging to the outer hinge assembly fell out during the takeoff in question, while the bolt in the center hinge assembly had fallen out at an earlier point in time, without being discovered," the report said, noting that a double inspection had been performed after reinstallation of the elevator and that maintenance and various inspections had subsequently been conducted.

PISTON AIRPLANES



'Extremely Slippery When Wet'

Beech 58 Baron. Substantial damage. No injuries.

Winds were from 40 degrees at 11 kt, gusting to 29 kt, when the pilot attempted to land the airplane on Runway 12 at Lee Airport in Annapolis, Maryland, U.S., on Oct. 6, 2006. A witness said that heavy rain was falling and that he observed the airplane hydroplane after touchdown, the NTSB report said.

The pilot said that the airplane touched down with 2,000 ft (610 m) of the 2,500-ft (763-m) runway remaining. He was unable to stop the airplane on the wet, asphalt runway. The Baron overran the runway and struck a pole. The two occupants were not injured.

The report said that the U.S. Federal Aviation Administration *Airport/Facility Directory* notes that Runway 12 is "extremely slippery when wet."

Oil Contamination Causes Engine Failure

Piper PA-23-250 Aztec. Substantial damage. No injuries.

The left engine failed while the airplane was in cruise flight at 2,000 ft after departing from Land's End (England) Airfield on July 4, 2006. "The pilot feathered the propeller and carried out the engine failure checks," the AAIB report said. "He secured the engine and decided to divert to St. Mawgan."

The hydraulic pump that supplies pressure to operate the landing gear and flaps is on the left engine's accessory drive and therefore was inoperative. "Consequently, the pilot performed an orbit on final approach in order to manually lower the landing gear," the report said. "He then carried out a successful flapless landing without further damage or injury."

Initial examination of the engine revealed that the no. 4 connecting rod had been forced through the crankcase but had been retained within the cowling. During a teardown inspection of the engine, "pieces comprising the complete connecting rod assembly were found, but not the no. 4 crankshaft bearing shell," the report said. All the crankshaft bearings showed wear caused by metallic particles in the engine oil. A large amount of metallic debris consistent with crankshaft bearing shell material was found in the oil. The AAIB concluded that failure of the no. 4 connecting rod was caused by the break-up of the no. 4 bearing.

Both engines had been operated about 130 hours following an overhaul in 2002. "The most recent maintenance was a 50-hour check carried out on 23 January 2003, 30 hours prior to the engine failure," the report said. "At that time, a note in the left engine logbook stated, 'Very small amount of alloy particles found in oil filter, considered fit to continue and to be reinspected at next 50-hour inspection.'" Investigators were unable to determine the source of the initial oil contamination.

Flat Light Foils Water Landing

De Havilland DHC-3 Otter. Substantial damage. One serious injury, three minor injuries.

The float-equipped airplane departed from Juneau, Alaska, U.S., for a charter flight to Berner's Bay, about 60 nm (111 km) north-northwest of Juneau, the afternoon of July 31, 2006. The pilot said that weather conditions at the bay included a 2,500-ft overcast and 5 sm (8 km) visibility in rain. He also said that flat lighting conditions existed and that the rain had turned the glassy water a milky color in the cove where he intended to land.

"A witness who watched the accident from the ground said there were fog and low clouds in the area, and that surface visibility was about 1 mi [1,600 m]," the NTSB report said.

The pilot told investigators that he was conducting a descending right turn and was looking for a dock on the shoreline that would provide a landing reference when the airplane struck the water.

"[A passenger] indicated the fuselage filled with water from the front, and passengers had to scramble over cargo piled at the aft doorway to escape," the report said. The passenger, who was seriously injured in the accident, said he believed that his leg and hand were broken when struck by unrestrained cargo. Two passengers received minor injuries; the pilot and two other passengers escaped injury.

HELICOPTERS

Rotor Blades Strike Fuel Bowser

Agusta A109C. Substantial damage. No injuries.

As the helicopter approached a private landing site in High Legh, Cheshire, England, the evening of June 21, 2006, the pilot saw another helicopter parked near the mobile fuel bowser. "He wanted to land as close as possible to the bowser, to facilitate refueling, and as far away as practicable from the other helicopter," the AAIB report said.

After landing the helicopter and letting the engines spool down for two minutes, the pilot shut down the engines. As main rotor speed decreased below 50 percent rpm, the rotor blades began to droop and struck the side of the bowser. "The pilot immediately applied the rotor brake, but the blades continued to strike the bowser," the report said. "One blade then became lodged in the bowser; this caused the rotors to stop suddenly. As a result, the main rotor blades were extensively damaged, one main rotor damper sheared off the rotor head, and both engines required an inspection. The fuel bowser suffered only minor damage."

Power Line Inspection Gets 'Boxed-In'

Bell 206B JetRanger. Substantial damage.
One serious injury, three minor injuries.

The helicopter was being operated on a power-line-inspection flight near St. Albans, New South Wales, Australia, on April 4, 2006. Aboard were the pilot, two power-supply company inspectors and a photographer. The inspection flight is conducted annually in accordance with the company's bush fire risk management plan, said the Australian Transport Safety Bureau report.

The pilot said that he normally maintained an airspeed of 25–30 kt and flew the helicopter 5–10 m (16–33 ft) left of the power lines and 3–5 ft above the highest line to give the inspectors an optimum view of the lines.

During the accident flight, the pilot saw a previously unnoticed wire rubbing against the left side of the helicopter. "The single-strand wire was unused and had previously supported a telephone cable, but was not marked on the relevant telephone company's network charts," the report said. "The telephone company had not removed that support wire after the telephone cable had been taken down, nor was there a statutory requirement for the company to have done so."

The pilot told investigators that the helicopter became "boxed-in" by the wire and the power lines. "In response, he attempted to clear the single-strand wire," the report said. "However, the tail rotor came into contact with the wire, and the helicopter began rotating. … The pilot climbed the helicopter clear of both sets of wires before attempting to land the helicopter in an upright position in an adjacent paddock. However, on contact with the ground, the helicopter rolled onto its right side, resulting in severe damage to the helicopter's skid landing gear, main and tail rotors, and cabin structure."

One inspector received serious head injuries; the other inspector, the pilot and the photographer received minor injuries. "The pilot was the only occupant wearing a helmet, and he reported that the helmet was damaged during the accident sequence," the report said.

Engine Fails During Surveillance Flight

Eurocopter France AS350-B2. Substantial damage. No injuries.

A loss of engine power occurred as the helicopter was being flown about 600 ft over a residential area during a law-enforcement aerial surveillance flight in Hayward, California, U.S., the night of March 17, 2001.

"The pilot entered an autorotation and attempted to make an emergency landing on a lawn located within the dimly lit residential area," the NTSB report said. "The helicopter struck a small-gauge residential power-supply line that was stretched across the emergency glide path." The helicopter landed hard on the lawn, and the main rotor hub assembly, tail boom and fuselage were substantially damaged. The three occupants escaped injury.

The report said that a bevel gear in the engine accessory gearbox had fractured due to high-cycle fatigue, resulting in failure of the fuel pump and fuel control unit. ●

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Feb. 2, 2007	Dartmouth, Massachusetts, U.S.	Socata TBM 700	destroyed	3 fatal
The ceiling was overcast at 200 ft and visibility was 1 mi (1,600 m) when the airplane struck terrain during a missed instrument landing system (ILS) approach to Runway 05 at New Bedford Regional Airport at 1940 local time. A notice to airmen advised that the approach lights were out of service.				
Feb. 6, 2007	Belgrade, Montana, U.S.	Beech Super King Air 200	destroyed	3 fatal
The air ambulance crashed 100 ft below a mountain peak during a visual approach to Gallatin Field at 2104.				
Feb. 6, 2007	East Bay Cay, North Caicos	Beech Super King Air B200C	destroyed	1 fatal, 7 NA
The airplane struck terrain during approach. The pilot was killed; seven passengers received unspecified injuries.				
Feb. 8, 2007	Alliance, Nebraska, U.S.	Cessna 208B Caravan	substantial	1 serious
The ceiling was overcast at 200 ft and visibility was 1 mi when the cargo airplane struck a building, a telephone pole and terrain during a nonprecision approach at 0225. Ice was found on the deicing boots and unprotected surfaces of the airplane.				
Feb. 9, 2007	Great Bend, Kansas, U.S.	Beech H18	destroyed	1 fatal
The ceiling was overcast at 500 ft and visibility was 2 mi (3,200 m) when the cargo airplane crashed out of control during an ILS approach at 0850.				
Feb. 9, 2007	Rocksprings, Texas, U.S.	Cessna 414	destroyed	2 fatal
The ceiling was overcast at 300 ft and visibility was 3/4 mi (1,200 m) when the airplane struck terrain during an instrument approach at 1715.				
Feb. 10, 2007	Gresse-en-Verco, France	Piper PA-34-200T Seneca	destroyed	3 fatal
Daytime visual meteorological conditions (VMC) prevailed when the airplane struck terrain under unknown circumstances.				
Feb. 12, 2007	Gulf of Mexico	Eurocopter France EC120B	substantial	2 fatal
Daytime VMC prevailed when the helicopter struck a boom on an offshore platform during approach to the platform's helipad.				
Feb. 12, 2007	Rieschweiler, Germany	Piper PA-31T Cheyenne	destroyed	1 fatal
The airplane crashed in a field soon after departing from Zweibrucken in VMC at 1020.				
Feb. 13, 2007	Moscow, Russia	Canadair Regional Jet	destroyed	3 NA
Visibility was 1,000 m (5/8 mi) in snow showers when the airplane crashed on takeoff for a maintenance flight to Berlin.				
Feb. 16, 2007	Natal, Brazil	Piper PA-34-200T Seneca	destroyed	1 fatal
The airplane crashed into the Atlantic Ocean about 50 nm (93 km) from Natal after departing from Natal in VMC for a flight to Dakar, Senegal.				
Feb. 16, 2007	Council Bluffs, Iowa, U.S.	Cessna 340A	destroyed	4 fatal
The airplane struck trees and terrain 3 nm (6 km) from the airport during approach in nighttime instrument meteorological conditions.				
Feb. 18, 2007	Cleveland, Ohio, U.S.	Embraer ERJ-140	substantial	74 none
The airplane overran the runway while landing in a heavy snowfall.				
Feb. 20, 2007	Phenix City, Alabama, U.S.	Piper PA-31-350 Chieftain	substantial	1 serious
The airplane crashed in a ravine near a road during a forced landing following loss of power from both engines.				
Feb. 21, 2007	Surabaya, Indonesia	Boeing 737	destroyed	148 none
The fuselage buckled and broke near the wings during a hard landing at Juanda Airport. The airplane then overran the runway, collapsing the landing gear.				
Feb. 24, 2007	Dallas, Texas, U.S.	Embraer EMB-145LR	minor	26 none
Winds were from 250 degrees at 26 kt, gusting to 36 kt, when the airplane ran off the right side of Runway 31R while landing.				
Feb. 25, 2007	New York, New York, U.S.	Canadair CRJ200	NA	NA none
The flight crew heard a loud noise soon after departing from Norfolk, Virginia. Examination of the airplane after arrival at La Guardia Airport revealed an engine cowling missing and unspecified damage to the horizontal stabilizer.				

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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Flight Safety Foundation

International Air Transport Association

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