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THE JOURNAL OF FLIGHT SAFETY FOUNDATION

DECEMBER 2011–JANUARY 2012

Great Expectations

I spent a couple days in a seminar in Dubai discussing the future of training in our industry — a session dominated, like most recent meetings, by discussions of "the Air France 447 problem." Of course, people have been talking about the challenge of automation dependency and its impact on training for years, but that crash of an Airbus A330 over the South Atlantic two years ago has moved people to act.

I was amazed to hear the response already in place at some Middle East airlines. Emirates, for example, has added a two-day manual flying session to its training syllabus, and substantially revised its policies on the use of automation. Those changes represent a big shift in training philosophy and a big commitment of cash. Other airlines in the region are going down the same path.

I applaud the renewed emphasis on manual flying skills. Studies show that some crews lack confidence in their ability to fly the aircraft. When the airplane starts to head the wrong way, crews often go "heads-down" to troubleshoot the automation instead of punching it off and pointing the aircraft in the right direction.

Only good things can come from a healthy dose of manual flying, but it seems that a lot more has to be done to bring our training in line with the new realities of the job. We still train as if flying the airplane is the primary job. But when recent accidents are examined, it seems like today's vital skill is the ability to recognize early when something isn't right. When a crew figures out what is going wrong, it doesn't usually take much in the way of refined skills to fix it. The life-or-death moment seems to be in the detection of the problem, not the recovery.

This brings us to the subject of monitoring versus watching. My dog watches television, but I don't think I can say he is monitoring the programming. To monitor something, a person has to have expectations of what should be happening, and compare what he or she is seeing against those expectations. I have a feeling that "expectation" may be an insufficiently developed part of the puzzle.

Years of relying on automated systems dulls our sense of expectation. When numbers are always calculated by dispatch, we lose a sense of a normal range for takeoff weights, which allows us to punch in a takeoff weight that is 100 tons off. If we have not manually calculated top-of-descent data for a decade, it is difficult to notice that something is wrong in the automation and we should be starting down. If we have always flown with autothrottles, it is more difficult to know when the engines are not spooling back up on approach as they should on capturing the glide slope. If we never have to manually establish cruise power settings, it is more difficult to understand what is going on when a sensor breaks in the middle of the night.

As we revise our training programs over the next few years, I believe this point will have to be central. Somehow we have to find a way to continuously reinforce in pilots' minds a sense of what is normal — establishing the correct expectation — so they will be able to notice quickly when things are not right. Right now, our procedures erode that capability. It is time to reverse that.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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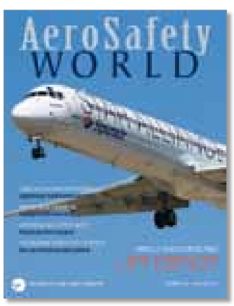

About the Cover
Failure to configure for takeoff caused the loss of this aircraft and death or injury of all aboard.
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If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about aviation safety, we will be glad to consider it. Send it to Director of Publications J.A. Donoghue, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA or donoghue@flightsafety.org.

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ESSENTIAL Skills

Training is a topic for endless discussion in the aviation community, and for good reason. Accidents often point out gaps in training curriculums that allow hazards to grow with fatal consequences. Then, in a seemingly endless cycle of repetition, the act of closing those gaps develops new inadequacies as priorities are shifted to accommodate the existing training footprint.

Some aviation dangers, however, can never be directly addressed by training. These can only be overcome by the application of a vague set of skills commonly referred to as experience and "airmanship."

So it was for the enhanced crew of Qantas 32, the Airbus A380 flight out of Singapore on Nov. 4, 2010 (see story, page 32). Their trial, triggered by the uncontained failure of the no. 2 turbofan's intermediate pressure compressor disk, presented them with an avalanche of failures never envisioned by certification standards, and therefore, an untrainable event.

Capt. Richard de Crespigny commanded that flight, assisted by an experienced crew of two pilots, standard for that long-haul flight, plus a check captain and a check captain in training.

Confronted with a barrage of checklists and warning alarms, the crew divided up assignments and worked to understand, contain and ultimately control the situation to achieve a happy ending that really was outside the realm of experience, or reasonable expectation. "By any measure, QF32 was a success because of teamwork," de Crespigny said, extending his praise to all involved, including cabin crew, air traffic control, airport crash fire rescue personnel and even passengers.

Discussing what his experience taught him about safety theory, de Crespigny initially said, "The Swiss cheese model is now outdated and, I would say, totally dead." On reflection, he qualified that statement: "In black swan events, it has no application. The model is a fairly flat and constrained model." It is based on the idea that, in the worst case, "a tiny failure will result in a few threats coming through," he said.

"It is not designed for something like our event, a flood of problems, a flood of warnings," a flood made somewhat more likely because "aircraft have become much more complicated. The Swiss cheese model does not apply when the cheese is overwhelmed and the water flows over the reservoir. It needs to be scaled to survive black swan events, and [human factors expert James] Reason admits it was not designed to be scalable."

What does survive seemingly unsurvivable situations is not the result of simple rote repetition of scripted training routines but "stress-proofing practice. [You] have got to be bullet-proof, not gun-shy. Teamwork, CRM [crew resource management], experience with a level command gradient, now we truly get to a safer régime," de Crespigny said.

Sadly, having resources in the cockpit and in other key safety positions capable of responding to such outrageous situations is a luxury not commonly available. Even in QF32 it was just a happy coincidence that gathered that team in that cockpit at that time. However, as the aviation industry continues to expand rapidly, we must be vigilant to not overlook the essential benefits of experience and airmanship. The system is designed to minimize the need for such extreme skills, but when needed, they are irreplaceable.

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

Serving Aviation Safety Interests for More Than 60 Years

Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 1,075 individuals and member organizations in 130 countries.

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JAN. 23–25 ➤ Fourth Middle East Conference. Civil Air Navigation Services Organisation. Cairo. Anouk Achterhuis, <anouk.achterhuis@canso.org>, <www.canso.org/middleeastconference2012>, +31 (0)23 568 5390.

JAN. 23–25 ➤ Initial SMS Auditor Course. Continuous Safety. Zurich, Switzerland. <sms@mycs.it>, <www.mycs.it>, +41 (0)81 826 51 52.

JAN. 23–27 ➤ Safety Management Principles. The MITRE Corp. McLean, Virginia, U.S. Mary Beth Wigger, <mbwigger@mitre.org>, <mai.mitrecaasd.org/sms_course/sms_principles.cfm>, +1 703.983.5617.

JAN. 23–27 ➤ Organizational Change Workshop. Southern California Safety Institute. San Pedro, California, U.S. <registrar@scsi-inc.com>, <www.scsi-inc.com/OCW.php>, 800.545.3766; +1 310.517.8844, ext. 104.

JAN. 23–FEB. 1 ➤ SMS Theory and Application Plus SMS Development Guidebook. The MITRE Corp. McLean, Virginia, U.S. Mary Beth Wigger, <mbwigger@mitre.org>, <mai.mitrecaasd.org/sms_course/sms_application.cfm>, +1 703.983.5617.

JAN. 26–28 ➤ Initial Bow Tie Risk Assessment. Continuous Safety. Zurich, Switzerland. <sms@mycs.it>, <www.mycs.it>, +41 (0)81 826 51 52.

JAN. 29–31 ➤ Safety Management System/Quality Assurance Genesis Symposium. DTI Training Consortium. Orlando, Florida, U.S. <www.dtiatlanta.com/Symposium.html>, +1 866.870.5490.

JAN. 31 ➤ Second Annual Aviation Safety Management Summit. EtQ. Tempe, Arizona, U.S. Angela Lodico, <alodico@etq.com>, <www.etq.com/smssummit>.

FEB. 1–3 ➤ Cabin Safety Inspector Course. CAA International. London Gatwick. <training@caainternational.com>, www.caainternational.com, +44 (0)1293 768821.

FEB. 1–3 ➤ Airport Wildlife Workshop. Embry-Riddle Aeronautical University. Orlando, Florida, U.S. <bit.ly/rAArZ8>.

FEB. 5–8 ➤ Airport Rescue and Fire Fighting Chiefs Leadership School. ARFF Working Group and American Association of Airport Executives. St. Petersburg, Florida, U.S. <events.aaae.org/sites/120204/index.cfm>.

FEB. 6 ➤ Implementing a Just Culture. Baines Simmons. Fairoaks Airport, Surrey, England. <training@bainessimmons.com>, <bit.ly/roXTXr>, +44 (0)1276 859 519.

FEB. 6–7 ➤ Business Aviation Safety Conference. Aviation Screening. Munich, Germany. Christian Beckert, <info@basc.eu>, <www.basc.eu>, +49 7158 913 44 20.

FEB. 7–9 ➤ Military Aircraft Accident Investigation Conference. The Boeing Co. and International Society of Air Safety Investigators. Phoenix. <www.militaryasi.webs.com>.

FEB. 8–10 ➤ Human Factors in Aviation Maintenance. Southern California Safety Institute. San Pedro, California, U.S. <registrar@scsi-inc.com>, <www.scsi-inc.com/HFAM.php>, 800.545.3766; +1 310.517.8844, ext. 104.

FEB. 13–15 ➤ Advanced SMS Assessment. Continuous Safety. Geneva. <sms@mycs.it>, <www.mycs.it>, +41 (0)81 826 51 52.

FEB. 13–24 ➤ Aircraft Accident Investigation. Southern California Safety Institute. San Pedro, California, U.S. <registrar@scsi-inc.com>, <www.scsi-inc.com/AAI.php>, 800.545.3766; +1 310.517.8844, ext. 104.

FEB. 15–16 ➤ IATA Training and Qualification Initiative Conference. International Air Transport Association and Royal Aeronautical Society. London. <itqi@iata.org>, <bit.ly/sbVn6b>.

FEB. 16–18 ➤ Advanced Bow Tie Risk Assessment. Continuous Safety. Geneva. <sms@mycs.it>, <www.mycs.it>, +41 (0)81 826 51 52.

FEB. 27–MARCH 2 ➤ Human Factors for Accident Investigators. Southern California Safety Institute. San Pedro, California, U.S. <registrar@scsi-inc.com>, <www.scsi-inc.com/HFAI.php>, 800.545.3766; +1 310.517.8844, ext. 104.

FEB. 28 ➤ European Fatigue Risk Management Symposium. Flight Safety Foundation. Dublin, Ireland. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/EASS>, +1 703.739.6700, ext. 101.

FEB. 28–29 Air Charter Safety Symposium. Air Charter Safety Foundation. Ashburn (near Dulles Airport), Virginia, U.S. <www.acsf.aero/symposium>, 888.723.3135.

FEB. 29–MARCH 1 ➤ European Aviation Safety Seminar. Flight Safety Foundation, European Regions Airline Association and Eurocontrol. Dublin, Ireland. Namratha Apparao, <Apparao@flightsafety.org>, <flightsafety.org/aviation-safety-seminars/european-aviation-safety-seminar>, +1 703.739.6700, ext. 101.

MARCH 5–9 ➤ Helicopter Accident Investigation. Southern California Safety Institute. San Pedro, California, U.S. <registrar@scsi-inc.com>, <www.scsi-inc.com/HAI.php>, 800.545.3766; +1 310.517.8844, ext. 104.

MARCH 8–9 ➤ Global ATM Operations Conference. Civil Air Navigation Services Organisation. Amsterdam. Anouk Achterhuis, <events@canso.org>, <www.canso.org/events/globalatmoperationsconference2012>, +31 (0) 23 568 5390.

MARCH 19–23 ➤ Aircraft Maintenance Investigation. Southern California Safety Institute. San Pedro, California, U.S. <registrar@scsi-inc.com>, <www.scsi-inc.com/AMI.php>, 800.545.3766; +1 310.517.8844, ext. 104.

APRIL 3–6 ➤ AEA International Convention and Trade Show. Aircraft Electronics Association. Washington. <www.aea.net/convention/DC2012>, +1 816.347.8400.

APRIL 16–17 ➤ PDP Course: Emergency Response Planning Workshop. National Business Aviation Association. San Antonio, Texas, U.S. <info@nbaa.org>, <www.nbaa.org/events/pdp/emergency/20120416>, +1 202. 783.9000.

APRIL 18–19 ➤ Corporate Aviation Safety Seminar. Flight Safety Foundation and the U.S. National Business Aviation Association. San Antonio, Texas, U.S. Namratha Apparao, <Apparao@flightsafety.org>, <flightsafety.org/aviation-safety-seminars/corporate-aviation-safety-seminar>, +1 703.739.6700, ext. 101.

APRIL 25 ➤ AViCON: Aviation Disaster Conference. RTI Forensics. New York. <www.rtiforensics.com/news-events/avicon>, +1 410.571.0712; +44 207 481 2150.

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If you have a safety-related conference, seminar or meeting, we'll list it. Get the information to us early. Send listings to Rick Darby at Flight Safety Foundation, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 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

New CAST Charter

The U.S. Commercial Aviation Safety Team (CAST) has a new charter and leadership with two "aggressive goals," says Ken Hylander, one of the new industry co-chairmen and senior vice president, corporate safety, security and compliance, Delta Air Lines. "We're looking at [achieving] another 50 percent reduction in commercial aviation fatality risk — basically between the 2010 numbers and [those in] 2025," Hylander said. The other goal is to "expand CAST influence on international fatality risk." He said the government-industry partnership also will follow through on 75 existing CAST safety enhancements.

Paul Morell, new industry co-chair of the U.S. Federal Aviation Administration (FAA) Aviation Safety Information Analysis and Sharing (ASIAS) Executive Board, said analysts now can study 92 percent of commercial operations in the National Airspace System.

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Morell is a captain and vice president, safety and regulatory compliance, US Airways. Hylander and Morell replace Don Gunther, retiring Dec. 31 as vice president, safety, Continental Airlines.

A directed study under way, focusing on pilot deviations and other issues reported during "RNAV [area navigation] off the ground" instrument departures, exemplifies ASIAS influence on FAA decisions, said Peggy Gilligan, FAA associate administrator for aviation safety and government co-chair of CAST and ASIAS (*ASW*, 11/11, p. 32).

ASIAS is analyzing data from airports with these standard instrument departures, which require selection of flight management system (FMS) navigation immediately after takeoff, to determine "if there may be a procedure-design issue, a training issue or [an FMS] issue [and] what the solution sets would be," she said, noting that the departures have been stopped at a couple of airports.

Morell said the ASIAS network is expanding from 46 to 64 databases. From June 2010 to December 2011, ASIAS participation grew from 12 to 20 flight operational quality assurance (FOQA) programs and 7 million to 8.1 million FOQA flights; 30 to 37 aviation safety action programs (ASAPs) and 71,000 to 106,000 ASAP reports; and 12,000 to 29,000 reports in the FAA's air traffic safety action program.

— Wayne Rosenkrans

Warnings on Single European Sky

Many European Union member states are in danger of missing 2012 "critical targets" for development and implementation of the Single European Sky — the ongoing effort to harmonize air traffic management (ATM) throughout Europe, the European Commission says.

"There is a genuine risk that we will lag behind and find ourselves unable to satisfy the rising demands of air travel, which is set to nearly double by 2030," said Siim Kallas, European Commission vice president responsible for transport. "2012 is a make-or-break year for the Single European Sky, and there is a lot at stake."

Kallas cited the findings presented in reports that assessed the progress of the 27 member states in establishing ATM performance targets and "functional airspace blocks" — blocks of airspace designed to eliminate the current fragmentation of European airspace. Only five member states were considered "on track" to meet cost and capacity goals with their ATM performance targets; only one was rated as being on track to meet goals on functional airspace blocks.

The European Commission's criticisms were echoed by four airline associations — the Association of European Airlines, the European Low Fares Airline Association, the European Regions Airline Association and the International Air Carrier Association.

The member states must "stop procrastinating on the Single European Sky project and start finally delivering on their obligations," the associations said.

However, the Civil Air Navigation Services Organisation (CANSO) extended its criticism to include not only the member states but also the European Commission.

Members of a CANSO committee that includes all leading air navigation service providers (ANSPs) "are calling on the European Commission and member

© Zmeel Photography/iStockphoto

states to play their part in order that ANSPs can move ahead with the modernization of the European ATM system," CANSO said.

Committee Chairman Massimo Garbini added, "We are fully committed to deliver the changes necessary to further improve ATM performance, but currently we are still waiting for the commission to set a timeframe which is then to be endorsed by the member states relating to a number of crucial decisions."

High-Tech Audits

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Gael Ltd., a developer of safety, quality and risk management systems, has developed a program using an Apple iPad-based system and its own Q-Pulse compliance management to create a mobile offline audit capability that the company says makes the audit process more effective and efficient.

Gael, working with the General Civil Aviation Authority of the United Arab Emirates (UAE), uses iPads "to regulate the safety performance of almost 800 operators and 600 registered aircraft operating in UAE airspace," the company said.

An Anniversary


ПОТЕРИ

Russian aviation safety specialists Valery Shelkovnikov and Sergey Melnichenko are celebrating the fifth year of publication of their monthly magazine, *Indicator of International Flight Safety*.

Shelkovnikov, former president of the Moscow-based Flight Safety Foundation International, and Melnichenko operate Aviation Safety: Consultancy and Analysis in Moscow. Issues of the magazine are available on their organization's website at <aviasafety.ru>.

"The *Indicator of International Flight Safety* has filled a critical void in Russian aviation safety," said Flight Safety Foundation President and CEO William R. Voss. "It has taken some of our best information and made it available to thousands of aviators in Eastern Europe. Through their hard work, they are proving that the language gap does not have to result in a safety gap."

New Rules for UAS

The Australian Civil Aviation Safety Authority (CASA) is reviewing rules governing operations of unmanned aircraft systems (UAS) in preparation for the development of new guidance material.

CASA plans to issue six advisory circulars discussing topics that include UAS training and licensing, operations, manufacturing and initial airworthiness, maintenance and continuing airworthiness, and safety management.

After the advisory circulars have been developed, CASA will review regulations dealing with UAS and look into "the long-term integration of unmanned aircraft operations into normal aviation operations in all classes of airspace."

The current UAS rules were drawn up 10 years ago, when there were few civilian UAS operations.

"At the time, there was little … operational experience to draw on from around the world," CASA said. "This meant the rules do not contain great detail in areas such as pilot qualifications, risk management and airworthiness. … With a rapid increase in activity in this sector, there is a risk that unsafe decisions could be made without comprehensive guidance material being available."

U.S. National Oceanic and Atmospheric Administration

Engine Shutdowns

The U.S. Federal Aviation Administration (FAA) has proposed a regulatory change to require the removal from service of the engine electronic control unit (ECU) on General Electric CF6-80C2B turbofan engines.

The FAA's notice of proposed rulemaking (NPRM) follows reports of in-flight engine flameouts that the FAA believes have been caused by exposure to ice crystals. A 2007 airworthiness directive (AD), which called for installation of new software for the ECU, has failed to correct the problem, the FAA said, noting that it has received additional reports of flameouts involving engines with the updated ECU software.

In the NPRM, published in November in the *Federal Register*, the FAA said the existing AD should be superseded by a new AD to require the affected ECUs to be removed from service. "These ECUs, if not corrected, could result in flameout or uncommanded [in-flight shutdown] of one or more engines, leading to an emergency or forced landing of the airplane," the FAA said.

The agency accepted comments on the proposal through Jan. 13.

Tail Wind Training

Patrick Cardinal/Wikimedia

The U.S. National Transportation Safety Board (NTSB), citing a Dec. 22, 2009, accident in which an American Airlines Boeing 737-800 ran off the departure end of a runway after landing in Kingston, Jamaica, is calling for a review of pilot training in tail wind landings.

Accident investigators said that the 8,911-ft (2,718 m) landing runway was wet when the accident airplane touched down about 4,000 ft (1,220 m) beyond the threshold with a 14-kt tail wind; the airplane ran off the departure end and continued through a fence, across a road and onto a Caribbean Sea beach. Eighty-five people in the airplane were injured, and the airplane was substantially damaged. The Jamaican Civil Aviation Authority has not issued its final report on the accident.

The NTSB, which participated in the accident investigation, said that the flight crew told investigators that, although they had conducted landings in tail winds, they had not received training on how to land in tail wind conditions. Several line pilots said that the first time they landed a company aircraft in a tail wind was during line operations.

The NTSB said it "believes pilots should be knowledgeable about the effects of a tail wind on the landing performance of their aircraft and should be trained on specific procedures and techniques associated with conducting tail wind landings, with the aim of reducing the risk of a runway overrun."

In a safety recommendation letter to the U.S. Federal Aviation Administration (FAA), the NTSB noted several runway overrun studies conducted in recent years by Flight Safety Foundation and other organizations that have found that overrun risks increase when landings are conducted on contaminated runways in tail winds.

The NTSB cited the Foundation's 2009 publication, *Reducing the Risk of Runway Excursions*, noting that it "provides prevention strategies for flight operations departments to implement as a means of addressing risk factors associated with runway overruns, including ensuring flight crews understand 'that landing with a tail wind on a contaminated runway is not recommended.'"

The NTSB's recommendations called on the FAA to "require principal operations inspectors to review flight crew training programs and manuals to ensure training in tail wind landings is provided during initial and recurrent simulator training."

The training should, "to the extent possible, [be] conducted at the maximum tail wind component certified for the aircraft" and should emphasize "the importance of landing within the touchdown zone, being prepared to execute a go-around, with either pilot calling for it if at any point landing within the touchdown zone becomes unfeasible, and the related benefits of using maximum flap extension in tail wind conditions," the NTSB said.

All-EU Licensing

The European Commission (EC) has published a regulation to harmonize qualifications and medical requirements for pilots throughout the European Union (EU).

The changes, based on International Civil Aviation Organization safety standards, will take effect in April 2012 and will "enable pilots holding a license issued in one member state to fly throughout the European Union without needing to fulfill any additional technical or medical requirements," the EC said.

Siim Kallas, EC vice president responsible for transport, added, "These new rules will simplify the lives of thousands of pilots across the EU while ensuring high levels of safety."

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The regulation also harmonizes and strengthens existing rules concerning the medical fitness of cabin crewmembers, the EC said.

The EC said that it plans to issue new, EU-wide requirements for aviation authorities, pilot training organizations, aeromedical centers and simulators.

In Other News …

The European Commission is planning a series of steps to boost capacity and reduce delays at **European airports**. … Christian Schleifer of Austria, a commissioner of the International Civil Aviation Organization's **Air Navigation Commission** since 2009, has been named to a one-year term as president of the commission. The commission is responsible for developing international aviation standards and recommended practices. … The U.S. Federal Aviation Administration has announced its overhaul of **flight, duty and rest scheduling rules** for commercial passenger airline pilots. A detailed report will be published in the February issue of *AeroSafety World*.

Compiled and edited by Linda Werfelman.

© Chris Sorensen Photography

NTSB concern about confusion surrounding oversight of public aircraft operations prompts guidance and standardization.

Not Quite Clear

BY WAYNE ROSENKRANS

Persistent confusion about nuances of complying with the U.S. law[1] that separates public aircraft operations from civil aircraft operations should be reduced during 2012, say officials from the U.S. Federal Aviation Administration (FAA), other government agencies and commercial aircraft operators.

The U.S. National Transportation Safety Board (NTSB), however, remains concerned about the pace of improvements and gaps in the safety oversight of contractors by government agencies under the law, which exempts public aircraft operations from compliance with most U.S. Federal Aviation Regulations (FARs) and safety oversight by the FAA.

During the NTSB public aircraft forum in Washington on Nov. 30 and Dec. 1, 2011, the board questioned diverse stakeholders about oversight of public aircraft and encouraged them to adopt best practices in safety from commercial air transport and their peers. NTSB Chairman Deborah A.P. Hersman said, "From 2000 through the first eight months of 2011, the NTSB has investigated about 350 accidents involving public aircraft operations [that resulted] in 135 deaths. During that time, we have issued more than 90 [related safety] recommendations. … In May 2011, a private company operating a modified Boeing 707 contracted with the U.S. Navy to perform air refueling, lost an engine and crashed on takeoff from [Naval Base Ventura County] Point Mugu, California. This accident is still being investigated, but the initial investigation reveals significant uncertainty regarding whether the operation was public or civil." That is important because this status can affect safety oversight and related systems and risks, she said.

For example, NTSB determined that the 2008 fatal crash of a contractor's helicopter near Weaverville, California, while transporting firefighters for the U.S. Forest Service likely was caused in part by "insufficient oversight by the U.S. Forest Service and the FAA," Hersman said (*ASW,* 2/11. p. 30). "We do not want to come to any more accidents and have finger-pointing [by entities saying,] 'It's not my responsibility.'"

The law allows public aircraft operations by the federal government, state governments, the District of Columbia, territories and their possessions and political subdivisions, and the armed forces of the United States, said Karen Petronis, senior attorney for regulations in the FAA Office of Chief Counsel. Within government and industry, however, many have not understood that public aircraft operation is a statutory, flight-by-flight status that must be declared by the overseeing government entity.

"The FAA does not grant permission to operate as a public aircraft," she said. "The FAA does not have regulations on status, and it cannot write regulations on status." Nor does a contractor obtain this status merely by having a contract with a government agency. Moreover, the law does not confer this status "when an aircraft is used for commercial purposes or is used to carry an individual other than a crewmember or a qualified non-crewmember[2]," she said. "The law also does not tell operators what they get [to do] when they qualify for public aircraft operations." The basic factors in declaring the status are operational details of the mission and the roles of people aboard the aircraft.

Industry Pushback

Several NTSB members called public aircraft operations an "orphan" of the aviation industry, with no entity having custody of sufficient safety data to evaluate the sector's risk exposure, accident/incident rates and other indicators. A number of forum panelists disagreed with this characterization and the relative severity of issues raised by the NTSB.

Matt Zuccaro, president of Helicopter Association International and cochair of the International Helicopter Safety Team, said that imminent improvements include a data initiative to accurately count the hours these helicopters are flying; concentration on inadvertent penetration of instrument meteorological conditions (IMC) and controlled flight into terrain at night; pilot proficiency and currency for operation under instrument flight rules (IFR); and "dedicated IFR helicopter infrastructure with low-level routing, point-in-space approaches and a seamless transition from visual flight rules to IFR."

He said that a new mission-specific accreditation program — as an overlay to International Standard–Business Aircraft Operations (IS-BAO) registration through the International Business Aviation Council (IBAC) — is scheduled for introduction in January 2012. To resolve confusing issues of operational control of government-contracted aircraft, auditor qualifications to evaluate 55 different standard helicopter missions, and inconsistencies in FAA surveillance, Zuccaro also called for the formation of a public aircraft/mission working group.

"The majority of the missions being flown by both government aircraft and private owner-operator contractors are … being done now, safely, by the tens of thousands," he said. He urged the FAA, other government agencies and contractors to participate in the proposed working group to focus on roughly 10 to 15 problematic missions, and explore the idea of

U.S. National Oceanic and Atmospheric Administration

The hoist rescue (page 11) by the Los Angeles County Sheriff's Department requires public aircraft operation status. International business aviation standards increasingly influence how U.S. federal agencies (above) perform safety oversight.

the FAA assuming safety oversight of just this subset of public aircraft operations.

The FAA, however, rejects the idea of overseeing any public aircraft operations. "In public aircraft operations, the sponsoring and contracting government agency is responsible for the assurance of safety of that operator," said John Allen, director of the FAA Flight Standards Service. "We are not trained, staffed or budgeted to have the expertise to exercise appropriate oversight, but the agency that has that mission [also has the safety specialists] who would know what they are looking for and how to ensure the safety of at least that [public aircraft] operation [for] the government agency."

Bob Galloway, director of aviation policy, General Services Administration, said, "To date [in 2011], we have had three mishaps in the federal aviation community. For our last complete calendar year of flight hours and mishaps, our mishap rate for the non-DoD [non-Department of Defense] federal aviation community was 1.65 per 100,000 flight hours … roughly akin to the Part 135 on-demand mishap rate for the same year of 1.63."

Civil regulations are unable to address the unique operating characteristics of natural resource missions, added Keith Raley, chief of the Aviation Safety and Programs Evaluation Division in the Aviation Directorate of the Department of Interior (DOI). "Regardless of any status as a public aircraft operation, DOI contractors must operate 'in accordance with' their FAA-approved [Part 135] ops specs [operations specifications] and all portions of Part 91 [general operating and flight rules]. We ask them to do everything they reasonably can within Part 135 [ops specs during public aircraft operations] but they are not operating under the Part 135 requirements. … If they do not do this, [they face] a contractual action, not an FAA enforcement action." DOI contractors need public aircraft operation status only when they otherwise could not comply with their FAA Part 135 certificate or ops specs while conducting short-haul, that is, a person being extracted by a rope underneath a helicopter; rappel, a person descending from the helicopter by rope; or the aerial delivery of fire retardant in close proximity to populated areas, Raley said.

Gaming the System

On March 23, 2011, the FAA announced a new policy directive on public aircraft operations, and later conducted industry briefings and began training FAA inspectors. Accompanied by a pending advisory circular (AC) containing a decision flow chart, the policy directs that declarations of public aircraft operation status be issued by sponsoring agencies to contractors, and that contractors furnish them to the local FAA inspector. The database of declarations, accessible to all FAA inspectors, will eliminate situations in which aircraft operators falsely or inadvertently refuse an FAA inspection or surveillance by claiming to be a public aircraft operation outside FAA jurisdiction, the FAA's Petronis said. The policy will take about two years to implement after the AC is published.

The policy basically says "until and unless we have notice, we will consider [the operator's aircraft] a civil aircraft and maintain full oversight [and operators will] have to comply with all the [FARs]," she said. The FAA then will be better able "to take enforcement action against people who are pretending to [conduct] public aircraft operations when they are really not," she added.

One significant safety-oversight advance has been government agencies obtaining IS-BAO registration, said Donald Spruston, director general of IBAC. Panelists said that the Federal Bureau of Investigation in September 2010 was the first non-DoD agency to obtain IS-BAO registration, followed by FAA Flight Operations and the National Aeronautics and Space Administration. The National Oceanic and Atmospheric Administration is scheduled to undergo an IS-BAO survey in February 2012, and the Forest Service plans to undergo the survey in 2013.

Panelists speaking for several state and local agencies also touted exemplary safety records in public aircraft operations. The Air Support Division of the Houston Police Department has 40 years of service without a serious injury or death in helicopter operations, said James Waltmon, a lieutenant and pilot in the division. Nevertheless, the department is pursuing certification by the four-year-old Airborne Law Enforcement Accreditation Commission, and would be only the second police agency in the nation to begin the process.

In another example, the Los Angeles County Fire Department has had no helicopter emergency medical services accidents in 41 years of operations, said Tom Short, senior pilot for the department, which implemented a safety management system in 2011.

Notes

1. The law is 49 United States Code 40102 (a)(41)(A)-(E), which defines public aircraft operations.
2. The law says that a qualified non-crewmember is "a person aboard an aircraft … who is required to perform or is associated with the performance of a government function."

This aircraft struck terrain while departing with the flaps and slats retracted.

© Gábor Kovács-Dódi

Misconfigured MD-82 stalled on takeoff.

Lift Deficit

BY MARK LACAGNINA

A series of mistakes and omissions by the flight crew and an inoperative takeoff warning system were among the factors that led to the loss of control of a Spanair McDonnell Douglas MD-82 during departure from Madrid-Barajas Airport the afternoon of Aug. 20, 2008, said the final report by Spain's Civil Aviation Accident and Incident Investigation Commission (CIAIAC).

The crew had rejected a previous takeoff because of an excessively high ram air temperature (RAT) indication and had taxied the aircraft back to the ramp to have the problem fixed. Taxiing out again after an hour's delay, the pilots skipped over critical checklist items and neglected to extend the flaps and slats, an error that was not flagged by the takeoff warning system (TOWS). The crew did not identify — and actually aggravated — the stall that occurred shortly after the aircraft became airborne. Of the 172 people aboard, 154 were killed and 18 were seriously injured when the MD-82 struck the ground.

Uneventful Arrival

The crew had flown the aircraft to Madrid from Barcelona, arriving shortly after 1000 local time. "The flight was uneventful, and no abnormalities were reported in the aircraft technical logbook," the report said. The second leg, to Gran Canaria in the Canary Islands, was scheduled to depart from Madrid at 1300 as Spanair Flight 5022.

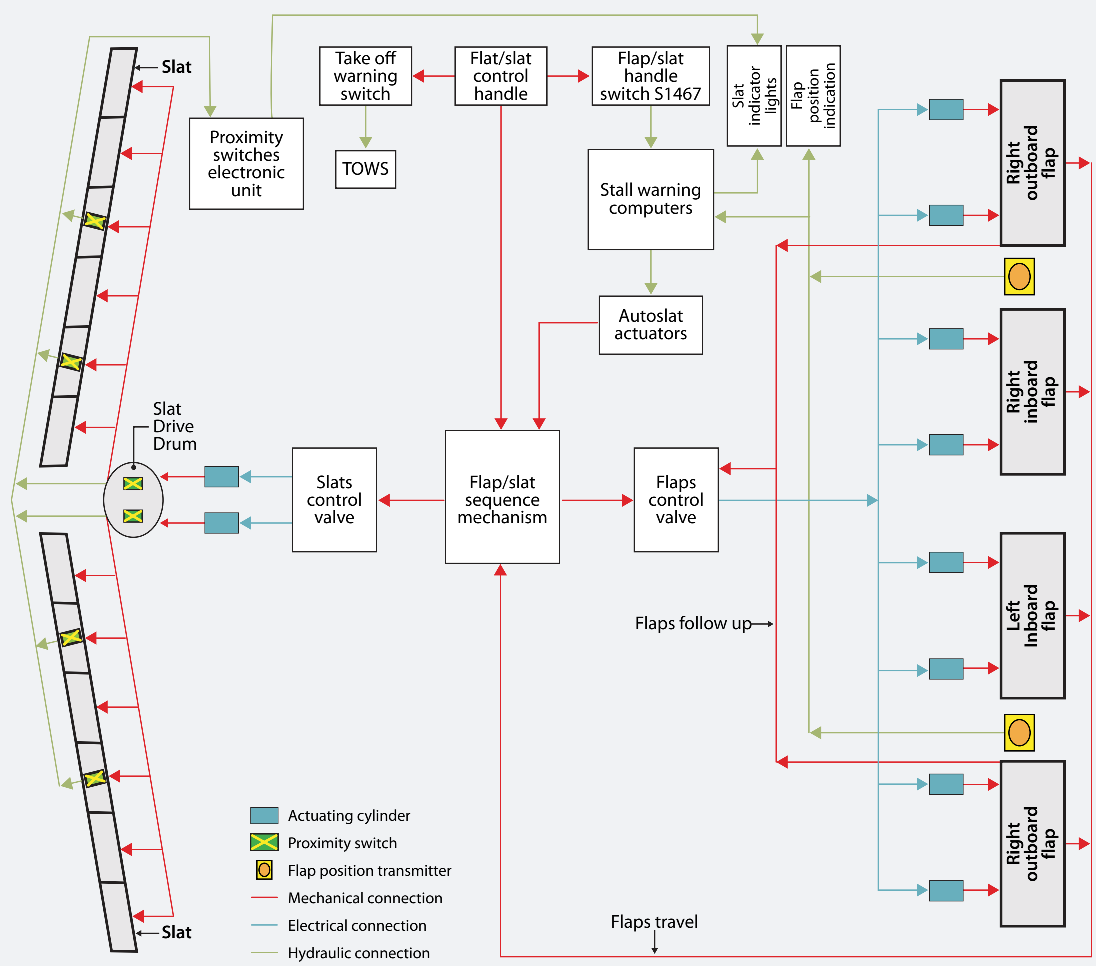
The captain, 39, had 8,476 flight hours, including 5,776 hours in type. He had served as a CASA 212 flight instructor and test captain in the Spanish air force before joining Spanair in 1999. "The reports of his tests, simulator sessions and line training indicate he was an above-average pilot," the report said. "Crewmembers who knew the captain described him as being disciplined, precise and meticulous in his job, someone who adhered to procedures rigorously."

The first officer, 31, had 1,276 flight hours, including 1,054 hours in type, and was hired by Spanair in 2007. "Pilots who had flown with him described him as a serious and disciplined pilot who was polite and made an effort to collaborate," the report said. "They specifically noted how much he loved to fly and how happy he was to have the chance to do so."

The MD-82 was manufactured in 1993 and had accumulated 31,963 flight hours and 28,133 cycles. The aircraft has two trailing-edge flaps and six leading-edge slats on each wing (Figure 1). "All the sections are mechanically linked so that the extension and retraction movements are synchronized," the report said. "The flaps and slats are operated jointly on the flight deck with a single flap/slat control lever, situated on the front right of the cockpit's central pedestal."

Markings on each side of the control lever slot show various flap positions from 0 degrees, or fully retracted, to 40 degrees, or fully extended. Flap positions from 0 to 24 degrees

MD-82 Flap/Slat System



TOWS = takeoff warning system

Source: Spanish Civil Aviation Accident and Incident Investigation Commission

Figure 1

© Jeroen Hribar/AirTeam Images

The control lever on the right side of the center pedestal is in the position at which the flaps and slats are fully retracted.

are marked for takeoff; positions from 24 to 40 degrees are marked for landing.

'Slight Problem'

The crew began taxiing from the stand at 1310. The aircraft was lined up on Runway 36L and had just received clearance for takeoff when the crew told the airport traffic controller, "Look, we have a slight problem. We have to exit the runway again." The controller asked if they wanted to return to the ramp, and the crew replied that they were communicating with company technical specialists and would advise of their intentions as soon as possible.

The "slight problem" was the high RAT indication. The external probe for the RAT system is not supposed to be heated, for anti-icing, while the aircraft is on the ground. However, the crew observed the indication increase precipitously, due to the lack of sufficient cooling airflow, as they taxied the aircraft to the runway. Recorded flight data showed that the RAT indication was 104 degrees C (219 degrees F) when the aircraft was lined up on the runway.

The crew received authorization to park on a taxiway while they studied the problem. "The captain established contact via cell phone with the operator's maintenance control center (MCC), located at its headquarters in Palma de Mallorca, to request guidance and information regarding the problem," the report said.

MCC personnel told investigators that they instructed the captain to reset the "Z-29" circuit breaker, which guards the electrical circuit that heats the RAT probe. When the captain replied that he already had reset that circuit breaker, the MCC referred him to the company's on-site maintenance facility for further assistance.

The crew then radioed the airport traffic controller and Spanair's maintenance shift supervisor and ground assistance agent that they were returning to the ramp because of "an overheating RAT probe." The controller cleared the crew to park at a remote stand.

The ground assistance agent advised that a replacement aircraft was available at the airport, "but the crew decided to wait until maintenance reported on the scope of the malfunction," the report said.

Two maintenance technicians met the aircraft at the stand and confirmed that the RAT probe heating circuit was energized. The technicians and the pilots discussed the use of dry ice to cool the probe, a remedy that eventually was rejected.

One of the technicians then consulted the minimum equipment list (MEL) and found that the aircraft could be dispatched with the RAT probe heating system inoperative if icing conditions were not forecast for the flight. After receiving confirmation from the maintenance shift supervisor, "the maintenance technician finally proposed to the captain that the aircraft be dispatched with breaker Z-29 pulled so as to disconnect the electrical supply to the RAT probe heater," the report said. "The captain agreed."

According to provisions of the MEL, the circuit breaker was pulled, the RAT display was labeled "INOPERATIVE," the RAT probe heating circuit was checked to verify that it was de-energized, and the proper entries were made in the technical logbook and on a release-for-service document.

Interrupted Checklist

The temperature in the passenger cabin increased while the aircraft was parked with the engines shut down. There was no external electrical power available at the stand, and, with an ambient temperature of 30 degrees C (86 degrees F), the aircraft's auxiliary power unit apparently provided insufficient power for the air conditioning system. The purser advised the captain several times that the cabin was hot.

Passenger discomfort and the schedule disruption likely caused the captain to feel frustrated and rushed, the report said, noting that these factors, plus the first officer's distraction about whether the autothrottle could be used for takeoff with the RAT probe heat inoperative, contributed to a breakdown in crew coordination.

After restarting the engines at 1407, the pilots began the "After Start" checklist. However, upon reaching the final item, a check of the flap and slat settings, the captain interrupted the checklist by asking the first officer to request clearance to begin taxiing.

The crew apparently did not return to the checklist and "thus missed its first opportunity to discover that the aircraft's configuration was not correct for takeoff," the report said. While waiting for taxi clearance, the pilots attended to other tasks, such as calculating an engine pressure ratio (EPR) setting of 1.95 for takeoff and discussing whether to use the autothrottle or set thrust manually.

At 1414, the captain asked the ground traffic controller for an estimate of the expected delay in receiving taxi clearance. "They were told there was no delay and [were] given instructions to taxi to the Runway 36L holding point," the report said.

Cockpit voice recorder (CVR) data showed that the pilots and a Spanair flight attendant occupying the cockpit jump seat engaged in nonpertinent conversations while the aircraft was being taxied to the runway. This constituted another distraction for the flight crew, the report said.

The crew missed several more opportunities to find that the aircraft was not configured properly for takeoff, the report said. The "Taxi" checklist, for example, requires a check that the automatic reserve thrust system is armed, an action that is inhibited if the slats are not extended. "The CVR revealed that while doing this item, the captain told the first officer that they would attempt a takeoff with autothrottle and that if it did not work, they would do it in manual," the report said, noting that the crew did not observe, or did not recognize the significance of, the absence of the indication that the reserve thrust system was not armed.

Moreover, *expectation bias* likely played a role when the first officer called out a flap setting of 11 degrees while conducting both the takeoff briefing and the final check before takeoff. "There is a natural tendency for the brain to 'see' what it is used to seeing (look without seeing)," the report said. "In this case, the first officer, accustomed to doing the final checks almost automatically, was highly vulnerable to this type of error, which was possibly exacerbated by the restlessness he displayed throughout the flight preparations involving the availability of autothrottle during takeoff. … The captain, for his part, should have been monitoring to ensure that the answers being read aloud by the first officer corresponded to the actual state of the controls."

'Engine Failure?'

The crew began the takeoff from Runway 36L at 1423, with the first officer apparently the pilot flying. The CVR recorded callouts of "sixty," "one hundred," " V one" (at 154 kt), "power check" and "rotate" (at 157 kt). The MD-82 lifted off after using 1,950 m (6,398 ft) of the 4,349-m (14,269-ft) runway. Four seconds later, the stick shaker activated, the stall-warning horn sounded and a synthetic-voice "stall" warning was generated.

"The first officer said 'engine failure' in a questioning voice," the report said. "A second later, at 1424:15, the captain asked in a very loud voice how to turn off the warning voice." Digital flight data recorder (DFDR) data showed that airspeed was 168 kt and that the aircraft was 25 ft above the runway with a nose-up pitch attitude of 15.5 degrees and a right bank angle of 4.4 degrees.

The bank angle increased to 20 degrees as the first officer retarded the throttles, resulting in a momentary decrease in EPR from 1.95 to 1.65 in both engines. "The throttles were immediately moved to their maximum thrust positions, resulting in EPR values of around 2.20 [the maximum for takeoff]," the report said. "These values remained constant until the end of the [DFDR] recording."

The stick-shaker and aural stall warnings continued, and "bank angle" warnings were generated by the enhanced ground-proximity warning system as the right bank reached 32 degrees. Pitch attitude was 18.3 degrees when the aircraft reached its highest height above the ground, 40 ft, at 1424:19. The MD-82 descended, slowly at first, and drifted right until striking the ground between Runway 36L and Runway 36R.

"The first part of the aircraft to impact the ground was the tail section, followed almost immediately by the right wing tip and the right engine fairings," the report said. The aircraft then traveled down a slope and over a road, and struck an embankment, where a fuel-fed fire erupted.

Post-accident performance calculations and simulations revealed that, even with the flaps and slats retracted and the power reduced to 1.65 EPR, "the aircraft could potentially have flown if the pitch angle had not been so high and the bank angle had been controlled," the report said.

'The aircraft could potentially have flown if the pitch angle had not been so high and the bank angle had been controlled.'

Defective Relay?

No TOWS warnings had been generated during the takeoff roll. The system is designed to generate warnings, when the throttles are advanced for takeoff, if the parking brake is not released or if the flaps, slats, spoilers or horizontal stabilizer are not configured properly. For example, if the TOWS detects that the slats are retracted, it sounds a warning horn and generates a verbal warning, "Slats."

Although TOWS is a go/no-go item for flight, and McDonnell Douglas recommended that it be checked before each flight, Spanair required an operational check of the system only before the first flight of the day. Thus, the pilots likely checked the system before taking off from Barcelona but not before the takeoff attempt at Madrid, the report said.

Investigators were unable to determine conclusively why the TOWS did not sound an alarm. De-energizing the RAT probe heat circuit would not have affected the system. However, the report discussed the possibility that faulty contacts in the "R2-5" relay, an electromechanical component of the aircraft's ground-sensing system, might have affected both the TOWS and the RAT. Among the relay's functions are to disable the RAT probe heating system and enable the operation of the TOWS when the aircraft is on the ground.

Boeing, which merged with McDonnell Douglas in 1997, told the CIAIAC that it was aware of 13 cases from 2000 to 2008 in which TOWS failures discovered during preflight checks were solved by replacement of the R2-5 relay. During the same period, 71 RAT probe overheats and four combined TOWS failures and RAT probe overheats were solved by replacing the relay. "In some of these cases, the relay was found 'stuck' in the 'air' position," the report said.

DFDR data showed that the RAT probe on the accident aircraft had overheated on the ground five times in the two days preceding the accident. "These events involved three different crews," the report said. Three events were not noticed, and two were not reported until after the flights were completed. "Different maintenance practices were used to deal with the two reported cases," the report said. "The maintenance tasks did not succeed in solving the problem."

Furthermore, the maintenance performed just before the accident flight focused on complying with MEL provisions enabling the aircraft to depart rather than fixing the RAT problem, the report said.

Among the many recommendations made by the CIAIAC during the accident investigation were requirements that the source of a malfunction be identified before using an MEL and that specific instructions be provided for troubleshooting malfunctions of the RAT probe heating system.

The commission also recommended that flight crews of MD-82s and similar aircraft be required to conduct an operational check of the TOWS before every flight.

This article is based on the English translation of CIAIAC report A-032/2008, "Accident Involving a McDonnell Douglas DC-9-82 (MD-82) Aircraft, Registration EC-HFP, Operated by Spanair, at Madrid-Barajas Airport on 20 August 2008," July 26, 2011.

Financial SMS

Excel worksheets help airline safety officers to predict return-on-investment while proposing risk mitigations.

BY WAYNE ROSENKRANS

Airline leaders who hold corporate purse strings appreciate safe flight operations as much as anyone. Yet, paradoxically, an already-high level of safety these days could make them balk if their director of safety proposes improvements yielding vague financial returns. So safety specialists increasingly are challenged to make a business case — not just a safety case — complete with convincing return-on-investment (ROI) calculations and time factors, according to John Cox, a retired airline captain and chief executive officer of Safety Operating Systems, and Triant Flouris, professor and dean of academic affairs, Hellenic American University.

In a presentation to Flight Safety Foundation's 64th annual International Air Safety Seminar (IASS) in Singapore in November, Cox and Flouris recommended that safety management systems (SMSs) incorporate sophisticated financial analysis, beginning with tools such as a Microsoft Excel worksheet that they developed to assess safety interventions in ways that acknowledge the perspective of chief financial officers (CFOs). Senior management tends to respect safety officers' expert opinions if properly validated, they added.

Cox said the goal has been to "give safety officers the ability to speak the language of the financial boardroom in a way that accomplishes their safety goal … a tool that is easy to use and brings in that language … and numbers that CFOs recognize."

Their concerns prompted hypothetical questions as they explored the issue. As air travel becomes safer, does it become so safe that further improvements lack sufficient value financially to be implemented? In other words, can senior management justify the cost of additional programs to lower an already low accident rate?

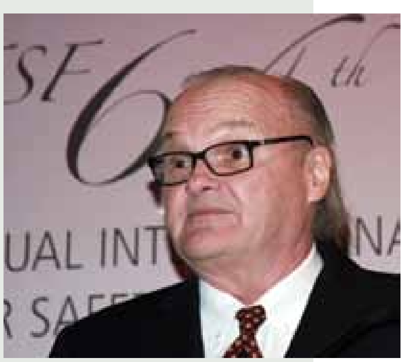
"We have seen already a paradigm shift for safety programs, in their design and inclination toward proactivity [such as] SMSs," Flouris said. "Conventional wisdom says that what safety officers do is a cost center … we need to start thinking of safety not in terms of cost and revenue centers [but as] a value-producing center."

Value-chain management today has become a business management method highly relevant to airline safety, one that shows the value of each input in an airline's production equation. "Traditional costing methods have not provided true organizational costs [of safety]," Flouris said. "We have to start looking at our airlines as integrated organizations, not as silos. … In most cases, we have not had accounting for multi-dimensional departmental costs." Even the cost of rebooking passengers, for example, must be factored into the safety officer's business case.

Their proprietary worksheet[1] is based on a financial methodology called time-driven activity-based costing (TABC) and also reflects the presenters' research on typical costs of all activities — that is, anything that generates cost — relevant to the financial effects of airline safety initiatives. Essentially, any activity in the airline that "touches safety" should be part of the accounting at the organizational level under TABC.

Cox said the worksheet, with separate data tabs for each aircraft type in airline fleets, is customizable by safety officers who likely are not financial analysts. The worksheet is "fairly extensive," he said, and captures details such as aircraft maintenance costs, fuel burn, flight crew and cabin crew labor, gate agent labor, airline-level operating expense, average passenger load factor, average ticket price, average landing fees, rescue-aircraft leasing fee, catering cost, cost of aircraft out of service, aircraft repositioning, hotels, meal vouchers, emergency-slide repacking, gross profit, and operating profit. The worksheet incorporates a cost database of variables defined and attributed to government and private-sector sources. Safety professionals can use or update the suggested amounts in prototyping their business case, including the ROI.

Cox, Flouris and Johnson



If the chief financial officer accepts the TABC premise, the worksheet gives senior management a reasonably accurate prediction of the corporate-level bottom line, they said. "For our [worksheet demonstration of a hypothetical] diversion … we account not only for variable costs but an appropriately prorated portion of the fixed costs generated," Flouris said.

This demonstration showed overall financial consequences of the diversion of a Boeing 757, with 251 seats and a 92 percent load factor on a planned four-hour flight from Los Angeles to Atlanta. The flight was diverted to Oklahoma City after 2.5 hours because of smoke odor, and the crew conducted an evacuation. The scenario included a rescue airplane that retrieved passengers and ferrying of the 757 to Atlanta for maintenance.

"We ended up with an event that would cost about $131,000," Cox said. "To generate that amount at the bottom line, it would take $7 million of revenue — that amounts to [more than] 20,000 revenue passengers assuming a $337 average ticket price. Now you have your chief financial officer's attention. … Even without four slides being repacked, under the same conditions, it is still a $67,000 event. … An average U.S. airline with about 100 to 110 airplanes averages about 13 diversions a year … so their average annual cost of diversions is about $880,000 using these assumptions."

A director of safety with a well-documented proposal for reducing those costs by 75 percent by spending $1 million on a new safety initiative could demonstrate a payback in 16 months and net savings of $3.6 million over the [subsequent] five years, according to the worksheet's ROI calculations. "So the safety officer brings about $800,000 a year to the bottom line … 10 diversions did not occur … and 1,500 passengers did not have to go through a diversion scenario," he added.

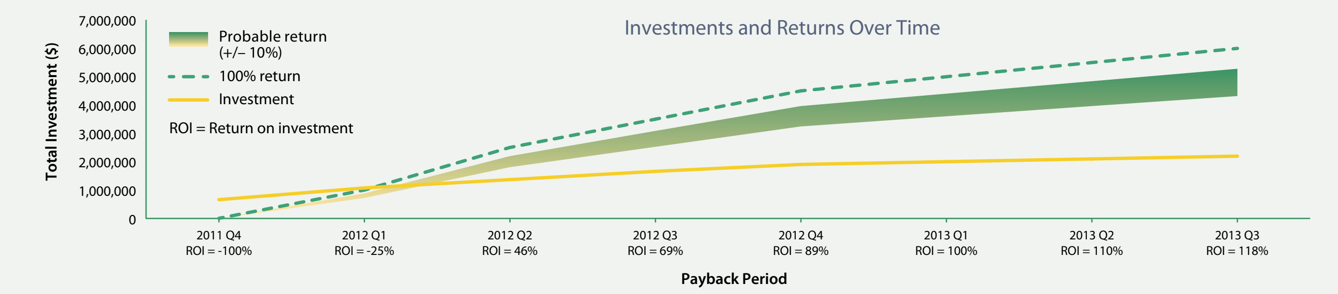
IASS attendees suggested that future versions of their worksheet integrate easily with SMS architectures, insurance data, safety event reporting systems, training costs, value-based management rules and data from failure-prediction systems — such as vibration monitors attached to aircraft cooling fans (*ASW,* 3/11, p. 46) to prevent smoke-fire-fumes diversions.

FAA's New ROI Simulator

In a separate presentation, William B. Johnson, the U.S. Federal Aviation Administration (FAA) chief scientific and technical adviser for human factors in maintenance, announced a new worksheet and Microsoft PowerPoint course[2] designed to help any aviation safety manager communicate with financial specialists. "Our Return-on-Investment[3] Calculator for Human Factor Interventions has a lot of built-in directions, [including estimated] probability of the ROIs, and helps users do a prediction of whether or not a project is going to work," Johnson said. The worksheet also plots summary charts

Photos: J.A. Donoghue

Example of U.S. Federal Aviation Administration Worksheet Graph



Note: The dashed green line shows maximum returns possible when there is a 100% probability that a proposed aviation safety intervention will succeed.

Source: U.S. Federal Aviation Administration

Figure 1

showing "who does what, when and for how much money," when the organization would recoup its investment, how payback would occur incrementally and the quarterly ROI changes in relation to the scheduled expenditures, he said.

FAA documentation says the worksheet primarily has been designed to help users "make strategic decisions regarding human factor interventions" in aviation safety. The software's navigation panel of five color-coded labels guides users through the step-by-step sequence to calculate multiple ROIs, and a built-in user guide defines terms and provides brief explanations regarding the ROI calculator.

The term *returns* in the FAA worksheet refers to quantifiable indicators expected — for example, expected change in cost and/or frequency of specific safety events and the number to be eliminated. Changes may include labor productivity gains, cost savings, time savings, reduced rework or avoidance of aircraft damage. Each return must be assigned either to the safety results section or the financial results section.

Worksheet steps include estimating and scheduling investments, estimating and scheduling returns, estimating the probability of success, generating a project summary, and generating a project analysis. Investments include all costs associated with developing and implementing the human factors intervention (the project), such as labor costs (employee roles, hourly salaries and labor time) and non-labor costs (such as annual number of flights/flight hours, facilities improvement, new technology and materials).

The investment schedule specifies a start year and quarter, and shows percentages of the total investment allocated over six quarters. This facilitates discussion of the intervention's life-cycle from the financial accounting perspective. Each return assigned to be a financial indicator has metrics enabling before-and-after comparisons. The return schedule functions as preparation for project tracking, and shows duration of benefits by quarters, allocation of payback by quarter and ROIs within and beyond six quarters if needed.

Users answer a short built-in survey to gauge the project's probability of success. In this way, the formulas account for risks of failure due to the project leader's level of expertise, team members' experience in similar projects, quality of planning and success/failure in relevant prior projects. The survey also enables users to quantify effects of having a project sponsor who brings budget authority, agreement on deliverables, a relevant business case and careful tracking of milestones.

Within the project summary, a project benefit summary automatically generates plus/minus 10 percent variations in investments, best-case and worst-case scenarios, and how desired ROIs become "discounted" (that is, diminished) by any probabilities of success rated at less than 100 percent. The project summary also lists safety returns metrics and their probabilities.

For easy visualization, a final project analysis comprises five graphs: investments and returns over time (Figure 1), investment profile, financial return profile, probability of success, and total safety events over time.

Notes

1. For worksheet details, send an email to Cox <j.cox@safeopsys.com>.
2. These products can be downloaded at <https://hfskyway.faa.gov/Fatigue/Documents/Final%20ROI%20Calculator_2003_20111028.xls> and formulas can be unlocked for customization, if desired, with the included password.
3. The FAA worksheet contains the following formula: ROI = estimated return (benefits) times probability of success (a percentage) minus investment (cost), all divided by investment (cost). The higher the ROI, the more money the airline makes from the investment.

Most accident investigators lack the tools and training to analyze language-related factors in aviation accidents.

Language Gap

First of Two Parts

© dvarg/iStockphoto

BY ELIZABETH MATHEWS

Did language proficiency and language use play a contributory role in the 2006 collision of an Embraer Legacy 600 and a Boeing 737-800 over the Amazon rain forest? A linguistic analysis of the evidence provided in the accident investigation reports suggests that a number of subtle — but significant — language factors helped create an atmosphere in which a series of communication failures were allowed to develop.

However, most accident investigations — and this one was no exception — do not adequately examine language factors because accident investigators typically do not have the background training required to perceive any but the most blatant language errors.

The Brazilian Aeronautical Accident Investigation and Prevention Center (CENIPA) led the investigation of the Sept. 29, 2006, collision of the Legacy — just purchased by ExcelAire Services, a U.S. charter and aircraft management company — and the Gol Transportes Aéreos Boeing 737. The accident killed all 154 people in the 737; the seven people in the damaged, but still controllable, Legacy were uninjured (*ASW*, 2/09, p. 11).

CENIPA, in its final report on the accident, said the loss of situational awareness by the

Legacy pilots and by the air traffic controllers was among factors leading to the midair collision. The U.S. National Transportation Safety Board (NTSB) questioned some of the report's findings and published its own summary and comments about the accident.[1]

The CENIPA report is particularly lengthy and detailed, not unexpected for an investigation of an accident that had required an extraordinarily intricate chain of unlikely events to link up so precisely that a breach in the multilayered safety wall opened.

On the other hand, interrupting that chain of events may have been as simple as an air traffic controller saying to the Legacy pilots, "N600XL, check your transponder."

Unanswered Questions

Accidents are almost never the result of one single error. The CENIPA report and the NTSB responses detail a complex host of factors that led the American, English-speaking pilots ferrying the new Legacy business jet from São Paulo, Brazil, to Fort Lauderdale, Florida, U.S., by way of Manaus to fly a northwest heading at 37,000 ft — on a collision course with the 737 — on a route on which northbound aircraft normally fly at 36,000 or 38,000 ft. One significant factor was air traffic control's (ATC's) loss of the transponder replies from the Legacy, approximately 54 minutes before the collision. The cause of the loss of the transmissions is unclear, but the investigation teams, after rigorously testing multiple theories, finally concluded that the pilots had most likely inadvertently shut off their transponder. Additionally, CENIPA found that distractions on the flight deck interfered with the crew's duties to monitor their instruments and maintain an awareness of ATC communications.

One question left unanswered concerns the controllers' response to the transponder failure. CENIPA noted that ATC "did not perform the procedures prescribed to contact the aircraft when the transponder signal transmission was interrupted, a contact which was mandatory for the maintenance of the aircraft under RVSM [reduced vertical separation minimum] vertical separation parameters."

What is not clear is why air traffic controllers who noticed the loss of the transponder transmissions did not notify the pilots. In its summary response to the CENIPA report, the NTSB said that the "basic investigative question centers on how the primary mission of ATC to separate aircraft was unsuccessful," finding that ATC did not take adequate action to correct a known lost communication situation with the Legacy, and that inadequate communication between ATC and the flight crew was a contributory factor in the accident. The NTSB also said that the causes behind this failure were not "sufficiently supported [in the CENIPA report] with analysis or reflected in the conclusions or cause of the accident."

Inadequate communication between ATC and the pilots of a Legacy 600 was found to be a contributing factor in the midair collision that sent a 737 into the Brazilian rain forest.

AP photo/Brazilian Air Force

This review intends to take up where the CENIPA report left off and to move in a direction suggested by the NTSB: to provide a more careful linguistic analysis of the evidence for "inadequate communication between ATC and the [Embraer] flight crew" that was determined to have been a contributory factor.

Language Factors

A hallmark of aviation accident investigations is that they are generally meticulous and thorough. Trained and experienced specialists methodically gather information and evidence according to published protocols. The information is analyzed by technical specialists, and the team draws conclusions about the likely causes of the accident, based on the best interpretation of the evidence gathered.

There was no failure in CENIPA's willingness to look at all issues, including possible language factors, in this accident, and the agency said, "It is important to analyze the attempts to communicate made by both sides."

CENIPA reported the communication failures involving the controllers and the pilots of the business jet and their linguistic challenges. Nonetheless, a systematic linguistic review of all the information available in the report uncovers a disparity between how language proficiency as a possible factor in this accident was investigated, compared with the deliberate, more intensive, and expert investigation of other human and operational factors. For example, a number of hypotheses to explain the loss of the transponder signal were systematically tested, with the procedures and results detailed in more than eight pages of the report. In contrast, language proficiency and communication as a possible contributory factor does not appear to have been formally, systematically or expertly addressed.

As a result, it remains unclear how language interacted with other factors to — as the report said — "generate a scenario favorable to the collision" over the Amazon.

A linguistic review of the evidence provided in the accident reports suggests that language use was a more significant factor in the chain of events leading to this accident than the accident investigation teams were able to uncover. Just as the purpose of aviation accident investigations is not to assign blame, neither is the purpose of this review to criticize the accident investigation or the reports.

Language use as a contributory factor has been inadequately investigated in this — and most — accidents, precisely because language is complex, because the impact of language factors often can be subtle, and because accident investigators typically have neither the tools nor the training to systematically probe, uncover, and analyze possible language-related factors in aviation accidents and incidents. As a result, safety gaps involving language are inadequately addressed.

Review of Reports

One of the challenges to identifying and analyzing possible language factors in accidents is that references to language are not standardized and are often included under the too-broad category of "communications," whereas communications can include a host of issues unrelated to language use, such as poor radio reception.

In the CENIPA report, there are approximately 28 references to language, language proficiency or communications.

Two of the more than 60 safety recommendations in the CENIPA report correspond to language proficiency:

- The Airspace Control Department shall ensure that all "controllers have the required level of English language proficiency, as well as provide the means for that purpose"; and,
- The Department of Teaching shall "establish a minimum level of proficiency relative to the English language."

The CENIPA report said that "communications between the control units and the [Legacy] crew presented failures," which were grouped as follows: configuration of the controller's console; standard phraseology, as specified by the International Civil Aviation Organization (ICAO); English language phraseology; operational procedures; and organizational problems.

At the time of the accident, the report says, the most recent English test of the air traffic controllers at the Airspace Control Detachment of São José dos Campos was reported to have been administered in 2003, with five controllers earning "non-satisfactory" results, one scoring "satisfactory within minima," and three self-reporting difficulties in the English language. The information regarding controller English language proficiency is unclear and non-standardized.

No information on English proficiency was reported for the Sector 5 controller who transferred control of the Legacy to Sector 7 at what CENIPA and NTSB agreed was an exceptionally early point, a fact highlighted as a latent failure in the events leading to the accident.

The report included little information on the language proficiency of the pilots. However, the document noted that GOL requires a high level of English proficiency as part of its pilot selection process and that the first officer on the business jet reported "difficulties with the ATC use of the English language."

The report documented that both the controllers and the business jet pilots failed to communicate key information appropriately.

A miscommunication between the pilots and the controller at São José ground control is identified as the "first failure in communication between the pilots and air traffic control." The report added, "An insufficient training of the standard phraseology and the English language was clearly observed in the communications between São José ground and [the Legacy]. This insufficient training was also noticed in other phases of the flight."

The communication gap involving the São José ground controller centered on the delivery of the clearance information. The CENIPA report said, "Another problem … relates to the English language phraseology. On two different occasions, the [Legacy] crew tried to learn the altitude to be maintained at the OREN SID [the OREN standard instrument departure], but the pilot did not get a correct answer from the ATC unit."

The report also cited an earlier apparent problem in communication, when the ground controller at São José "said that later on, when reading the transcription of the communications with [the Legacy], he noticed that the pilot did not understand 'Pocos de Caldas' [a city in southwestern Brazil]. Nevertheless, the pilot accepted the instruction."

The CENIPA report said that the crew dynamics of the Legacy pilots were a significant factor in the accident, and that of special significance was the crew's "lack of concern with the air traffic control communications." The crew flew for 57 minutes without establishing or receiving any ATC communications, the report said.

CENIPA found that "the lack of situational awareness also contributed to the crew's not realizing that they had a communication problem with the ATC," the report said. "Although they were maintaining the last flight level authorized by the [Brasilia Area Control Center], they spent almost an hour flying at a nonstandard flight level for the heading being flown, and did not ask for any confirmation from the ATC."

Regarding ATC communication to the Legacy, CENIPA and the NTSB agreed that a number of critically important communications should have occurred but did not:

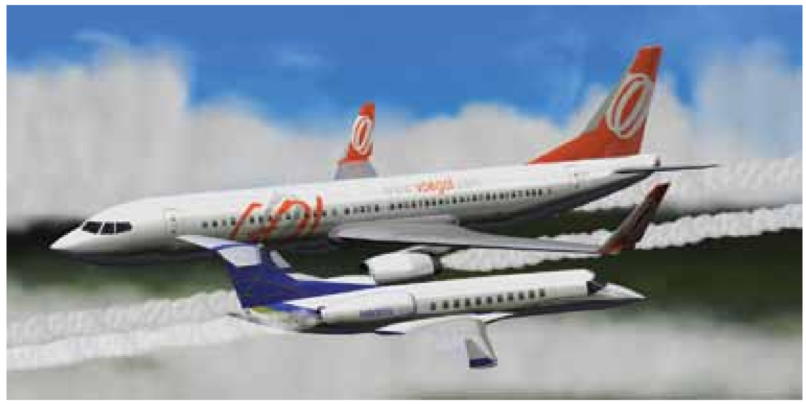


Photo Illustration/Wikimedia

- ATC did not issue a level change instruction when the airplane crossed the Brasilia VHF omnidirectional radio (VOR);
- ATC did not notify the Legacy's pilots of the lost transponder signal;
- ATC did not provide the separation required in response to loss of transponder in RVSM situations; and;
- ATC did not take adequate action to correct a known lost communication situation with the Legacy.

Language factors likely were at play when the Legacy crew was not informed about the loss of their transponder signal and remained at an improper altitude for almost an hour before colliding with the 737.

A related factor, determined to be a latent failure, was that the Sector 5 controller handed off the Legacy crew to the next sector at an unusually early point, well before the aircraft crossed the Brasilia VOR — the point at which the level change was scheduled to occur — and 60 nm (111 km) before the sector boundary.

In addition to the communication and language factors identified by CENIPA, an analysis of the cockpit voice recorder data uncovered other linguistic anomalies not highlighted in the report.

For example, a routine exchange with the Sector 5 controller revealed brief but compelling evidence of probable English language insufficiency. Although the message was brief and consisted entirely of routine phraseology (so that it should be very familiar to the controller), the controller stammered and repeated himself, compounding the challenge to understanding English spoken with an accent not easily understood by the Legacy pilots.

In response, although the Legacy first officer replied, "Roger, radar contact," the area cockpit voice recording registered the pilot's expression of frustration: "I've no idea what the hell he said."

An additional communication difficulty occurred at São José, when a Legacy pilot failed to use standard ICAO phraseology to communicate the number of persons on board the flight. "Souls on board," he said, instead of the ICAO-required "persons on board." Although this was a minor and inconsequential exchange, it nonetheless revealed a lack of awareness of the ICAO requirement to use standard ICAO phraseology and of the threats inherent in cross-cultural communications.

Language as a Human Factor

After summarizing the accident investigation teams' findings regarding language proficiency, it was possible to analyze the information that was available to them. Although these references to language proficiency, language use and communication problems were included in the CENIPA report, the information is not gathered, presented or analyzed systematically. In essence, CENIPA uncovered evidence of linguistic factors that were at play but did not establish the relationship between language proficiency and use, and the key communication failures that contributed to the chain of events.

The ease with which we normally use our first language belies the complexity of the cognitive, neurological, social, behavioral and physical processes and phenomena that interact to allow humans to produce and process language. A superficial review of communications fails to uncover the subtle cues that shed light on why the communications between the Legacy and ATC failed so significantly. All the communications bear analysis at multiple levels of linguistic inquiry: at the level of phonology (or sound), lexis (word choice), syntax (structure), semantics (meaning), pragmatics (interplay of context and meaning) and more.

A more detailed linguistic analysis suggests that inadequate language proficiency, a low level of awareness of the threats inherent in cross-cultural communications and inadequate communication strategies were the weak foundation upon which the series of unsuccessful communication events were able to develop. A complete linguistic analysis is too lengthy for this article; however, a partial analysis will point to the conclusions drawn here.

It is useful to start by looking at language factors in the context outlined by Sexton and Helmreich in their discussion of language in the cockpit: "The aviation industry has embraced the notion of assessing pilot ability to manage threats and errors in order to achieve safe and efficient flight, and *problem solving communications are the verbal manifestations of threat and error management*" (italics added). Threat and error management requires not only pilot-to-pilot coordination and communication but also problem-solving communications between pilots and controllers.[2]

The evidence shows that both the Legacy pilots and the controllers contributed to the communication failures that occurred at numerous points along the business jet's route. In fact, ICAO language standards are applicable to both speakers of English as a first language and speakers of English as a second, or foreign, language. Both groups share equally the ICAO requirement — outlined in ICAO's standards and recommended practices (SARPs), Annex 1 *Personnel Licensing* — to not only demonstrate English proficiency at the ICAO Operational Level 4 but also to:

- "Use appropriate communicative strategies to exchange messages and to recognize and resolve misunderstandings";
- "[Deal] adequately with apparent misunderstandings (by checking, confirming, or clarifying information)";
- Communicate effectively;
- Communicate with accuracy and clarity;
- "Use a dialect or accent which is intelligible to the aeronautical community"; and,
- Be able to manage "a situational complication or unexpected turn of events."

Conclusions

The linguistic evidence reveals that the communication failures stem from an interplay of a number of factors.

To start, the Legacy pilots demonstrated a lack of awareness of the applicability of ICAO language requirements for native English speakers, a lack of awareness of the threats inherent in cross-cultural and cross-linguistic communications. Additionally, they appear to have responded to several instances of difficult or failed communications with controllers with a degree of inhibition not uncommon to native English speakers when encountering workplace communication breakdowns with non-native English speakers. They failed to "deal adequately with apparent misunderstandings (by checking, confirming or clarifying information)."

The evidence also suggests that the enroute controllers at Sectors 5 and 7 had inadequate English language proficiency and may have experienced a resulting degree of "communication apprehension," a factor that could explain the otherwise nearly inexplicable failure of a series of three controllers to communicate critical and required information regarding required flight levels and the loss of transponder replies — communication failures that directly contributed to the collision. This possible explanation for the failure of three controllers to communicate critical information would have been a valid investigative question in this accident.

The accident investigators were hampered by a number of factors in their ability to document or confirm the English language proficiency of controllers involved in the accident; among these factors were the unavailability of standardized English language testing and limited access to the controllers for interview after the accident.

The legal prosecution of one of the controllers and, in particular, his defense against the legal charges — that "he does not speak English and was obliged to coordinate a flight involving foreign pilots"[3] — provides external support for the hypothesis that inadequate English language proficiency underlay this controller's failure to comply with required communication procedures.

In summary, there is evidence that factors related to language proficiency, language use and language awareness may have been the weak foundation upon which the series of assumptions, errors and dropped responsibilities leading to the accident were allowed to develop.

The linguistic analysis of the information uncovered by CENIPA and the NTSB does not change the report's fundamental conclusions. Whether one holds that the primary error involved pilots who failed to maintain proper vigilance and to notice that they were flying a nonstandard altitude for the direction they were flying, or controllers who failed to maintain proper separation between aircraft under their control, it is clear that both sides had an opportunity to interrupt the causal chain. Doing so would have required problem-solving communication in plain English.

The possibility that communication apprehension based on self-awareness of inadequate English proficiency was the underlying cause of the controllers' failure to communicate essential information is an inadequately investigated factor that lies at the heart of this accident investigation. If insufficient English language proficiency and inadequate language awareness were holes in the last barrier to the accident, then only by accurately perceiving the full extent of underlying causes of the communication failures can we adequately implement safety improvements.

Only by accurately perceiving the full extent of underlying causes of the communication failures can we adequately implement safety improvement.

Elizabeth Mathews, a specialist in applied linguistics who led the international group that developed ICAO's English language proficiency requirements, is the managing member of Elizabeth Mathews and Associates, which develops and implements training programs in aviation English for airlines and air navigation services.

Notes

1. Except where otherwise noted, all information and data in this review come from the Final Report A-OOX/CENIPA/2008 of Brazil's CENIPA and the NTSB summary and comments, DCA06RA076A.
2. Sexton, B.J.; Helmreich, R.L. "Using Language in the Cockpit: Relationships With Workload and Performance." In R. Dietrich (editor), *Communication in High Risk Environments*. Berlin: Humboldt Universitat zu Berlin. 2003 57–73.
3. Lehman, Stan. Associated Press. "Brazil Air Controller Convicted Over 2006 Crash." Oct. 27, 2010.

No Longer Best

BY WAYNE ROSENKRANS

Proposals call for reworking familiar systems that fall short in mitigating aviation risks.

Commercial air transport expansion in the Asia Pacific Region without compromising safety depends largely on exchanging routine operational data and best practices, and adopting integrated systems, say a number of airline, manufacturing and government specialists. In November, they told Flight Safety Foundation's 64th annual International Air Safety Seminar (IASS) in Singapore, however, that further risk reduction worldwide also requires addressing threats that have been a low priority or only recently have received serious attention.

"The biggest, all-encompassing challenge is rising air travel demand," said Lui Tuck Yew, minister of transport and second minister for foreign affairs of Singapore. "Based on projections by Airbus, outside of the traditional cores of North America, Western Europe and Japan, air traffic in emerging markets will account for an overwhelming 70 percent of global volumes by 2030. … With more crowded airspace, aerodromes and increasingly complex future operations, the challenge of upholding — let alone advancing — safety levels is a daunting one. ... This is where the greatest strains on infrastructure, on resources and on expertise will need to be addressed."

Singapore, which in 2009 implemented safety management systems (SMSs) among operators and in 2011 implemented a state safety program, is among states committed to accelerating the regional and global adoption of "more focused safety governance," he said.

Today's highest safety level ever coincides with tough economic choices and requires conscious resistance to any relaxation of safety efforts, Lui said, adding, "About 0.6 major accidents per million flights [globally] is not bad, but

J.A. Donoghue

… cold comfort to the close to 800 people who died in accidents last year [and] their surviving loved ones. … The many close calls and 'could have beens' clearly leave no room for complacency [see "Letting Go of Precursors," p. 30]."

Circular Logic

Circling approaches have been an underestimated risk, said Tzvetomir Blajev, coordinator, safety improvement, Eurocontrol. Essentially, they are anachronistic given today's highly automated, turbine-powered aircraft operating with precise navigation capabilities. As chairman of the FSF European Advisory Committee (EAC), Blajev said that committee research has explored the changes in risk level, technical inconsistencies and operational concerns expressed by 110 respondents to a recent international survey.

"The majority, if not all, of the respondents considered the risk associated with a circling approach to be much higher than for other types of approaches," he said. "I was quite astonished to see that … there appears to be widespread confusion about the meaning of terms." The EAC also has found faulty/disconnected expectations among procedure designers, regulators and pilots.

For example, visual maneuvering areas have been explained to pilots but are not well depicted. "The pilot [typically] must have other pieces of knowledge of how the aircraft must be maneuvered on the prescribed track for the protection to be maintained," Blajev said. Ironically, visual reference points and tracks with turning points defined by navigation systems exist at some airports, and more circling approaches could be flown using automation, offering "a very powerful mitigation," he added (Figure 1).

Other concerns include inadequate international guidance for air traffic control (ATC); differences in vectors from ATC for visually identifying the airport environment or visually following the preceding aircraft; and ATC requiring the same reported ceiling and visibility as for a visual approach. "There was no common understanding of when the crew can commence descent to touchdown from the minimum descent altitude/height," Blajev said.

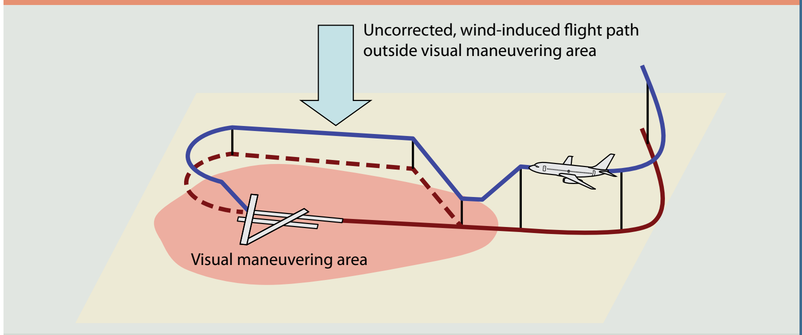
The likelihood that pilots will not be able to see the entire circling area, and could become disoriented, also was deemed a significant risk. "The long-term solution is replacement by performance-based navigation approaches," he said. Some IASS attendees suggested that the EAC also consider the effects of routine aircraft operation with minimum fuel and poor flight crew compliance with standard operating procedures (SOPs).

Visible TCAS RAs

Another legacy problem — potentially unsafe interactions among traffic-alert and collision avoidance systems (TCAS), short-term conflict alert systems (STCA) and air traffic controllers — is controversial for stimulating technological solutions at the ATC facility level, said Nick McFarlane, managing director, Helios Technologies. The driving reason is that surveillance technology bought recently by air navigation service providers (ANSPs) that have Mode-S radar has selectable, built-in capability to display downlinked TCAS resolution advisories (RAs).

"Many RAs are not reported [because] pilots don't make the report to a controller," he said, citing a European study in which only 45 percent of RAs were reported in a correct and timely manner. "The aircrew should always follow the RA. … If the controller is not aware that the RA is under way, he may provide an instruction that is contrary to the RA if he doesn't have

Blown Into Harm's Way During a Circling Approach



Note: Standards assume pilots will fly at minimum descent altitude or minimum descent height only with visual references, not timing, to compensate for wind direction and velocity, and to safely maintain terrain and obstacle clearance.

Source: Tzvetomir Blajev, Eurocontrol

Figure 1

Letting Go of Precursors

All-too-familiar scenarios during flight simulator training underutilize opportunities for pilots to exercise skills in solving complex, unexpected problems, says Ed Pooley, a retired airline captain and principal of the Air Safety Consultancy. Many loss of control–in flight (LOC-I) accidents and some runway excursions of the past 10 years arguably did not even have recognizable precursors, he said during IASS 2011 in Singapore.

The implication is that pilots may not find it "possible to experience a particular type of challenge often enough — or at all — in the simulator to be familiar with its specifics," Pooley said. "Modern reliability means … the informed response to the unexpected counts."

Pyramid and iceberg diagrams in aviation safety education have helped to explain some, but not all, relationships of causal elements preceding unacceptable outcomes, which he defined as major aircraft accidents and situations in which a major accident was narrowly avoided. Some types — especially LOC-I — can be resistant to an oversimplified, precursor-dependent analysis, he said.

One difficulty in de-emphasizing precursors is that they seem obvious even in some LOC-I situations, he noted. These comprise issues like mismanaged response to a single system abnormality, non-awareness of actual autopilot or autothrottle status, activation of the stall protection system, unintended penetration of severe weather, inappropriate aircraft configuration, fuel mismanagement and/or a significant bird strike.

Fairly recent runway excursions, however, have revealed causal "paths," or sets of circumstances, too numerous or complicated to lead directly to the unacceptable outcome. "They can have as much to do with the degree to which a safety culture and a just culture prevail generally within an operation," Pooley said, citing as examples the 2010 overrun of a Boeing 737 at Mangalore, India, and another 737 runway overrun at Yogyakarta, Indonesia, in 2007.

Ample cases of other connections also exist between unacceptable outcomes and precursors such as a minor runway excursion, deep landing, excessive airspeed or height over the landing threshold, high-speed rejected takeoff, significant delay in anti-skid unit activation or initial wheel spin-up, deviation from a straight line during takeoff or landing when above normal taxi speed, abnormally slow acceleration during takeoff, tail scrape at rotation, a change from reduced thrust to takeoff/go-around thrust after initial setting of reduced thrust, and/or an abnormal pattern of thrust reverser deployment, he said.

In five of six recent cases cited, "a fatal accident was avoided because of the optimum response of the pilots involved," Pooley noted, encouraging airlines and pilots to be open to the introduction in flight simulators of "first-time, out-of-the-blue scenarios that require more than just … correct application of the quick reference handbook." Such a change would have to shift away from only handling a prescribed sequence of engine malfunctions, for example, "to focus more on the … response to unanticipated, typically 'once-in-a-career' challenges," he said. Direct observations or routinely automated analysis of flight simulator data then could generate pilot response–based methods for predicting, tracking and trending the collective performance of pilots, Pooley said.

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a pilot report. Safety margins will be severely degraded if pilots follow ATC clearances that are contrary to the RA."

Downlinking TCAS RAs to ATC displays involves risks not yet addressed by international standards. Proponents say the practice increases situational awareness. Regulators in the United States, the United Kingdom, Australia and other countries reject the practice.

"The desired behavior … is that an STCA alert will go off about 30 seconds before the TCAS RA goes off in the cockpit," McFarlane said. "That should give the controller a chance to intervene and take action before the geometry becomes so bad that the RA occurs. Unfortunately, in certain geometries, the STCA alerts can be [too late]."

TCAS RA downlinks were implemented in Japan in 2003 in the wake of a 2001 near-midair collision, and a series of European studies since the mid-1990s also expanded knowledge of the safety and feasibility of downlinks. "In parallel, [six] European ATC centers have implemented RA downlink," McFarlane said. The latest initiative, Projects 4.8.3 and 15.4.3 of the Single European Sky Air Traffic Management Research program, recently developed an operational concept. "An RA displayed on the controller's position [would be] equivalent to having a pilot report," McFarlane said. "Until the [TCAS] 'clear of conflict,' this means that the controller shall not attempt to modify the aircraft flight path and ceases to be responsible for the separation of the affected aircraft."

Opponents fear an "inevitable human response" to intervene improperly if a controller believes a pilot is not correctly following the RA. "There are concerns among ANSPs about how controllers should respond if they receive an RA displayed on their screen but they have [no] pilot report to go with it." Other issues include the form of presentation to ATC, including the TCAS sense, and the signal latency and legal responsibility.

Safe Functional Checks

Functional check flights were the focus of another effort to mitigate a chronic safety problem. IASS panelists and attendees discussed outcomes from the FSF Functional Check Flight Symposium, held in February in Vancouver, Canada (*ASW,* 3/11, p. 14). This type of flight "had been something that the industry had quietly forgotten about or pushed into the background for too long," said Harry Nelson, experimental test pilot, Airbus, and moderator. "The airlines [in February] made a very strong demand of the manufacturers for more assistance … examples and advice on check schedules." A follow-on FSF working group continues to issue guidance (see "Golden Rules").

The operational mindset must be to assume that failure is likely to occur at any point during the flight until the aircraft testing has proven otherwise, panelists agreed. "Decide and brief breakoff points," Nelson said. "Do not ad lib … which I call 'snag chasing.'"

Everyone involved must internalize the potential risks and spare no effort to mitigate them, said Rod Skaar, assistant chief pilot, production, The Boeing Co. "A functional check flight is an active validation. … We [must] know what answer to every test is expected [and] the acceptable parameters for success," he said. Such flights differ in critical respects from first flights, demonstration flights, acceptance flights, end-of-lease flights and ferry flights.

In selecting team members for these flights, airlines seriously err if they view all captains and first officers as equally qualified, said panelist Craig Hoskins, director of safety at JetBlue Airways, adding, "This [selection] is not manufacturer-specific, it is mission-specific."

"The team approach is fundamental to safety," said Al Wongkee, flight operations manager, Bombardier, suggesting flight crew augmentation by at least two airframe/avionics specialists. "You have to be prepared for what can go wrong. … There is a lot more involved than just the skill or training or currency of two pilots."

The FSF Functional Check Flight Working Group met in July to determine the role and tasking of manufacturers, and will be validating proposals to be forwarded to a separate European Aviation Safety Agency (EASA) maintenance check flight working group, said Claude Lelaie, special adviser to the Airbus president and CEO, and chairman of the European group.

The EASA meetings began in June to draft regulatory language prompted by the November 2008 crash of an A320 near Perpignan, France, and by other requests from European accident investigation bodies, Lelaie said. "By the end of 2011, we should have almost completed all the work, and maybe in the middle of 2012, we will have a full document," he said.

The preliminary work envisions a regulation applicable to both airplanes and helicopters using the term "maintenance check flights" and defines "complex" aircraft check flights as involving at least two pilots operating a jet or turboprop aircraft with seating for more than 19 passengers and maximum takeoff weight of more than 5.7 tonnes (12,500 lb), according to Lelaie.

A matrix sets out pilot qualifications and any special training required in relation to straightforward, post-maintenance checks of normal functions using line operations SOPs; high-risk tests of a safety-critical system or involving a non-standard flight maneuver with specially developed SOPs; complex vs. non-complex aircraft, etc.

Golden Rules

Participants in the FSF Functional Check Flight Symposium in February 2011 agreed that the following principles, designed for a flight team comprising a flight crew typically augmented by airframe and avionics specialists, mitigate well-known risks:

- Get the mission priorities right (first safety, then test accuracy, then efficiency).
- Decide and brief team members on "break off" points for discontinuing the sequence of steps in each test.
- If test results do not match the team's expectations, stop the check.
- Take extra care any time the planned sequence of steps is disrupted.
- Identify in advance which check points will involve relatively high risk, including a low-currency flight crew, and practice related procedures in a flight simulator before conducting the functional check flight.
- Do not introduce unplanned tests during flight, and do not be tempted to explore aircraft certification test points.
- Always be failure-minded by assuming and preparing for functional failures as the norm.

A Black Swan Event

Singapore — First came the matter of determining how much of the Airbus A380 was still functioning. Then the issue was maintaining control of the crippled aircraft flying on the edge of a stall during approach with marginal aileron control effectiveness. Finally there was the problem of sitting over a rapidly spreading pool of jet fuel in an aircraft with white-hot brakes and an engine that refused to shut down.

The uncontained engine failure on a Qantas A380 on Nov. 4, 2010, did not precipitate a catastrophic accident, and 469 people returned safely to the ground at Singapore, said the Qantas Flight 32 captain, Richard de Crespigny, because five experienced pilots in the cockpit — three in the regular crew and two check captains — worked as a unified team with cool heads and a singleness of purpose.

In his keynote speech opening Flight Safety Foundation's 64th International Air Safety Seminar in Singapore in November 2011, and in an extensive interview with *AeroSafety World*, de Crespigny detailed the accident. What follows are just a few of the significant details of this incredibly complicated situation.

The triggering failure that launched the drama was the uncontained failure, while climbing through 7,000 ft, of the airplane's no. 2 Rolls-Royce Trent 972 three-spool turbofan, perceived in the cockpit as "two bangs, not terribly loud," de Crespigny said. The aircraft damage caused by the heavy, high-speed engine parts leaving the nacelle created what he called "a black swan event, unforeseen, with massive consequences.

"What did we know? We knew that engine no. 2 had failed, there was a hole in the wing, fuel was leaking from the wing and we had unending checklists. What we didn't know is that no. 2 had had a failure of the intermediate pressure turbine, engine no. 1 had also been damaged, we had 100 impacts on the leading edge, 200 impacts on the fuselage, impacts up to the tail and seven penetrations of the wing, going right through the wing and up through the top. We had lost 750 wires…. We lost 70 systems, spoilers, brakes, flight controls. … Every system in the aircraft was affected.

Saving a crippled A380.

BY J.A. DONOGHUE

"Flight controls were also severely damaged. It wasn't just the slats; we [lost] a lot of our ailerons … lost 65 percent of our roll control," de Crespigny said. The situation was made worse, he said, because, with fuel flowing out of the left wing, the aircraft was laterally unbalanced.

"We were getting pretty close to a [cockpit work] overload situation," working through the checklists, canceling the alarms. "It was hard to work out a list of what had failed. It was getting [to be] too much to follow. So we inverted our logic. Like Apollo 13, instead of worrying about what failed, I said, 'Let's look at what's working.' If all we could do is build ourselves a Cessna aircraft out of the rubble that remained, we would be happy."

Wanting to be well prepared and drop as much fuel as possible before making what would still be an overweight landing, de Crespigny entered a holding pattern. "We had seven fuel leaks coming out of multiple parts of the wing. At 50 tonnes overweight, and no [working] fuel-jettisoning system, this was our jettisoning system."

Fortunate to have the longest runway in Southeast Asia available to them, the crew still had slim margins. Taking into account the known problems — including no slats and no drooping ailerons on final — the crew computed that the aircraft could be stopped 100 m (328 ft) before the runway end.

"We briefed the approach, and then — one of the more emotional events of the crisis — we did … three control checks. We proved the aircraft safe for landing in a landing configuration. We did a rehearsal for the landing with the gear down," using gravity to drop the gear, he said, "flaps out and at approach speed, and the aircraft proved out."

Knowing that the fly-by-wire stick would mask the aileron movement needed to maintain attitude, de Crespigny "went to the control page to look at the percentage of effort of the flight controls we had remaining. We had normal flight controls except for the ailerons, and there we'd lost 65 percent of our roll control, lost both outer ailerons, lost one of the mids, and we were left with … one mid and the high-speed ailerons, small and inboard.

"But we also had imbalances" due to fuel issues, he said. "I was very concerned about controllability. So we did the control check, and as I rolled the aircraft up to about 10 degrees of bank, we looked at the flight controls [ECAM page] and it looked like we were using like 60 to 70 percent of the remaining ailerons just to do a very gentle turn.

"I could easily reach maximum deflection of the ailerons, and when you reach that point, the spoilers come up next. You keep getting roll control by dumping more lift, increasing your stall speed. I was really worried, [knowing I had] to be so careful to not get the spoilers coming up. I had to keep the heading and yaw as accurate as possible, so I decided to use the automatic pilot for the approach — its accelerometers sense small changes and put in tiny corrections earlier than I will."

Manual thrust control can allow for unbalanced thrust, which would induce destabilizing yaw. "We had a long approach, so to get stable thrust I exactly matched [engines] one and four and locked them down, and used engine three to adjust the approach speed, using that [engine] because it is inboard and produces less yaw. So I had accurate heading control, controls were not used very much, and with only one engine used to fine tune the speed, [we maintained] minus 2 kt to plus 3 kt for the whole approach."

Another pilot in the cockpit warned, "'Richard, you can't be fast.' During approach, our air speed margin was very small. Put in 3 kt, we run off the end of the runway."

As it turned out, he couldn't be slow, either. "I slowed down 1 kt and we got a speed warning," he said. "That was unexpected, absolutely. We clearly didn't have a 17 to 18 percent stall margin. We had two speed warnings" during the approach, and "in the flare, we got a stall warning."

"We landed 40 tonnes overweight, a relatively good landing. When we stopped, the brakes said 900 degrees C (1,650 degrees F), but it takes five minutes for heat to get to the sensor, so 900 degrees on stopping meant that those brakes were going to go well beyond 2,000 degrees C."

However, on landing "fuel sloshed to the front" and began gushing out of the holes in the wing leading edge. "The auto-ignition point of kerosene is 220 degrees C, so we were concerned." Happily, the Singapore crash rescue crew's response was superb, de Crespigny said. "Firemen came in and put foam down over the fuel, over the brakes, and the temps started going down."

Finally, though, the engine no. 1 refused to shut down, further delaying evacuation. But with the threat of fire mitigated, the aircraft was evacuated before the engine was killed with massive amounts of fire-fighting foam.

To see the video of extended interviews with Capt. Richard de Crespigny and Michael von Reth, chief of cabin service on QF32, go to <www. flightsafety.org>.

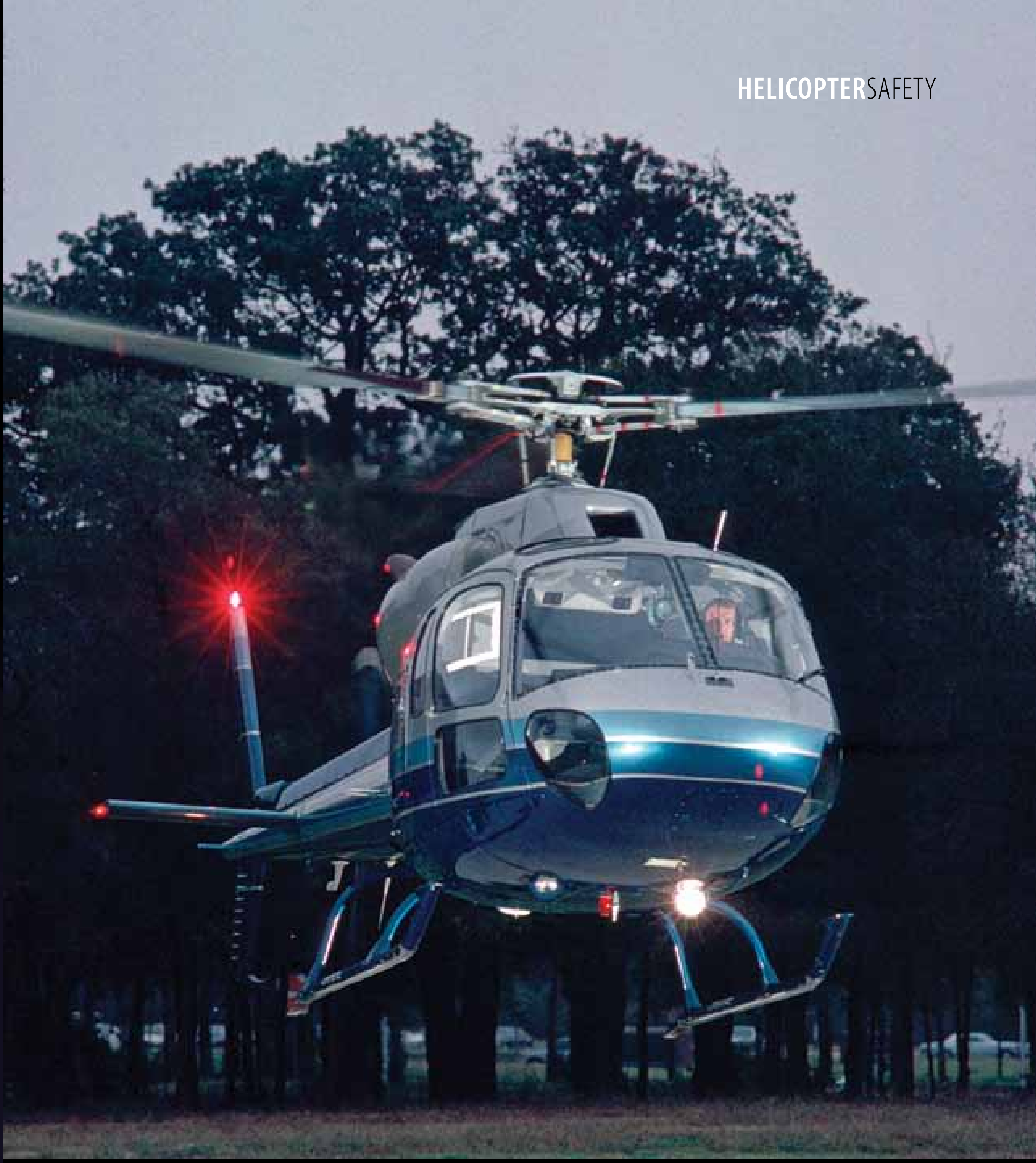
FirstPerson is a forum for sharing personal experiences that have yielded lessons about aviation safety. We welcome your contributions. Send them to J.A. Donoghue, director of publications, Flight Safety Foundation, 601 Madison St., Suite 300, Alexandria VA 22314-1756 USA or donoghue@flightsafety.org.

BY CLARENCE E. RASH

Downward Trends

Data show a decline in U.S. helicopter accidents in 2001–2010, with an accident rate of 5.7 per 100,000 flight hours.

Photo: © BP



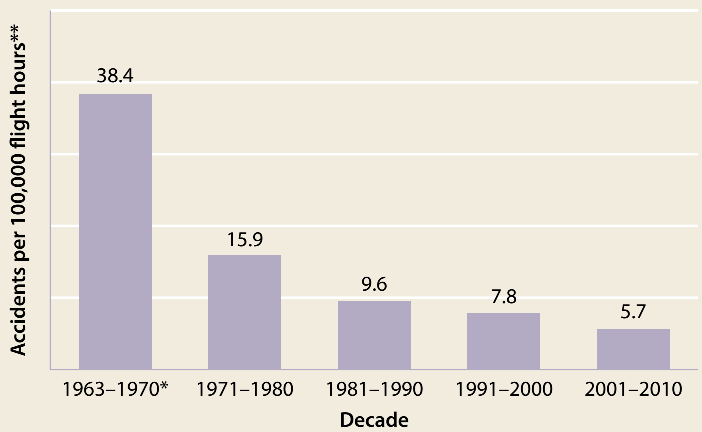
Photos: © Chris Sorensen Photography

While the advantages of helicopters have encouraged their use, they also have contributed to hazards. The ability to operate low to the ground and in confined areas increases the probability of loss of control caused by dynamic rollover; collision with wires, trees and other objects; and loss of situational awareness resulting from brownout (blowing dust) or whiteout (blowing snow). Frequent takeoffs and landings at unprepared landing sites present an additional, substantial hazard.

Historically, helicopter accident rates in the United States have been as high as 38.4 accidents per 100,000 flight hours — for the period from 1963 through 1970. In the most recent decade (2001–2010), accident rates stabilized and declined to 5.7 per 100,000 flight hours — down from 7.8 per 100,000 flight hours recorded in 1991–2000 — due in large part to improvements in pilot training, maintenance and overall helicopter design (Figure 1, p.36).[1]

At the start of the decade, in 2001, the world's civil aviation helicopter fleet was estimated at 27,000, with 46 percent of those in North America.[2] By 2010, the estimate had increased to 36,000 helicopters worldwide, with 50 percent in North America. The next largest concentration of helicopters is in the European

Accident Rates Involving U.S.-Registered Helicopters, 1963–2010



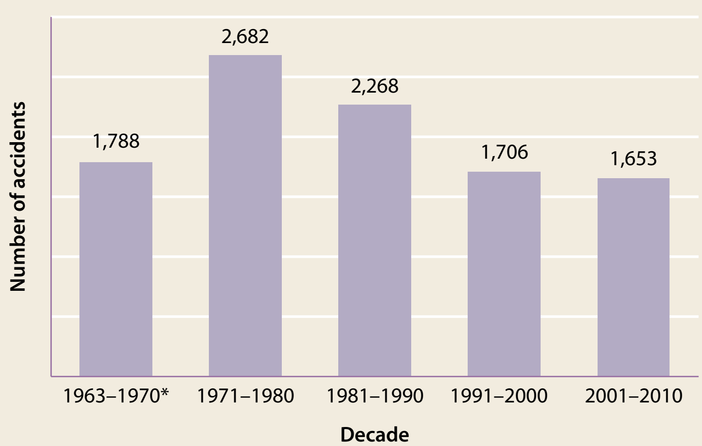
*The first helicopter accidents in the U.S. National Transportation Safety Board database occurred in 1963.

** Estimated flight hours

Source: Clarence E. Rash

Figure 1

Accidents Involving U.S.-Registered Helicopters, 1963–2010



*The first helicopter accidents in the U.S. National Transportation Safety Board database occurred in 1963.

Source: Clarence E. Rash

Figure 2

Union, which has an estimated 17 percent of the world's total.[3,4]

The Past

From 1963 — the date of the first helicopter accident recorded in the U.S. National Transportation Safety Board (NTSB) database — through 2010, there were 10,097 accidents involving helicopters registered in the United States (Figure 2).[5] Of these, 1,653 accidents occurred from 2001 through 2010. The number represents an approximate 38 percent decrease from the historic high of 2,682 accidents, recorded for 1971–1980, and a 3 percent decrease from 1991–2000.

The total number of accidents in any period is influenced by the number of aircraft in operation and the total number of flight hours, both of which have increased significantly over the decades. Estimated total flight hours (Figure 3) have increased from 4.65 million for 1963–1970 (an annual average of 581,538) to 28.93 million for 2001–2010 (an annual average of 2.89 million).

Ups and Downs

For 2001–2010, NTSB data show an increasing trend in both accident frequency (Figure 4) and accident rate (Figure 5, p. 38) in the first three years (2001–2003), followed by a decrease and stabilization trend over the latter half of the decade.

Of the 1,653 accidents recorded during the decade, 265 (16 percent) were fatal accidents, resulting in a total of 520 fatalities. The average number of accidents each year during the decade was 165.3, and the average annual accident rate was 6.1 per 100,000 flight hours.[6]

The worst year in the decade for both the number of accidents — 203 — and the accident rate — 9.5 per 100,000 flight hours — was 2003. The deadliest year was 2008, with 76 fatalities, including seven that resulted from the midair collision of two Bell 407s, both on emergency medical services flights, in Flagstaff, Arizona (*ASW*, 7/09, p. 21).[7]

Accident Analyses

An individual accident can be categorized by a number of parameters, including the aircraft model, engine type, phase of flight, and lighting and meteorological conditions at the time of the accident, as well as causal factors. Analyses based on one or more of these parameters can help identify trends in the accident data.

For 2001–2010, an accident analysis by engine type shows an approximately equal frequency of accidents involving reciprocating (48.2 percent) and turbine shaft (50.9 percent) engine aircraft.

In general, about a third of all helicopters in operation today are reciprocating models, and the remaining two-thirds are single- or twin-engine turbine models.[8] This implies that aircraft with reciprocating engines are involved in a disproportionately higher percentage of accidents (48.2 percent). One explanation may be the average older age of reciprocating-engine aircraft; another consideration is the turbine engine's greater available power, which allows easier recovery from precarious flight situations.

Eighty-nine percent of accidents for the decade occurred in daytime conditions. Eight percent occurred at night, and 3 percent occurred in dawn and dusk lighting conditions. This was a consistent annual trend (Figure 6, p. 38).

Phase of Flight

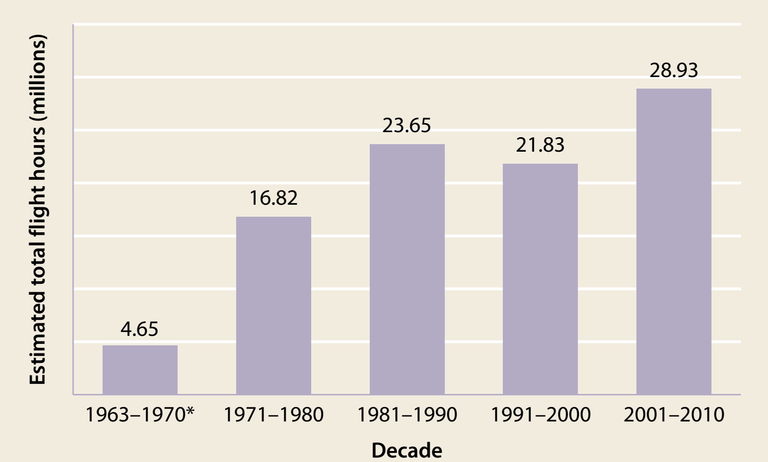
The NTSB database also categorizes accidents by phase of flight (Table 1, p. 39).

With the exception of years when a significant number of accidents did not have phase of flight identified, maneuvering was the most common phase, and 30 percent of accidents occurred then. Landing was the second most common phase of flight for an accident, with 16 percent. Thirteen percent occurred during cruise, and 12 percent occurred during takeoff.

In the latter part of the decade, while maneuvering still was the most common phase of flight for an accident to occur, the number of accidents in the cruise phase decreased dramatically. Caution must be exercised in interpreting these data, however, because on average, a third of all accidents in these later years were not identified as to phase of flight.

Overall, in an annual average of 13 percent of the accidents, the phase of flight was not recorded and could not be determined.

Estimated Total Flight Hours for U.S.-Registered Helicopters, 1963–2010

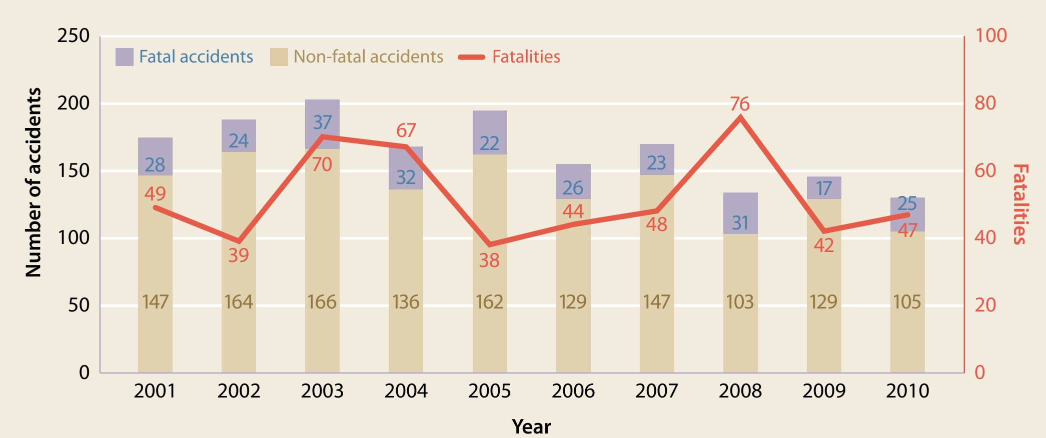


*The first helicopter accidents in the U.S. National Transportation Safety Board database occurred in 1963.

Source: Clarence E. Rash

Figure 3

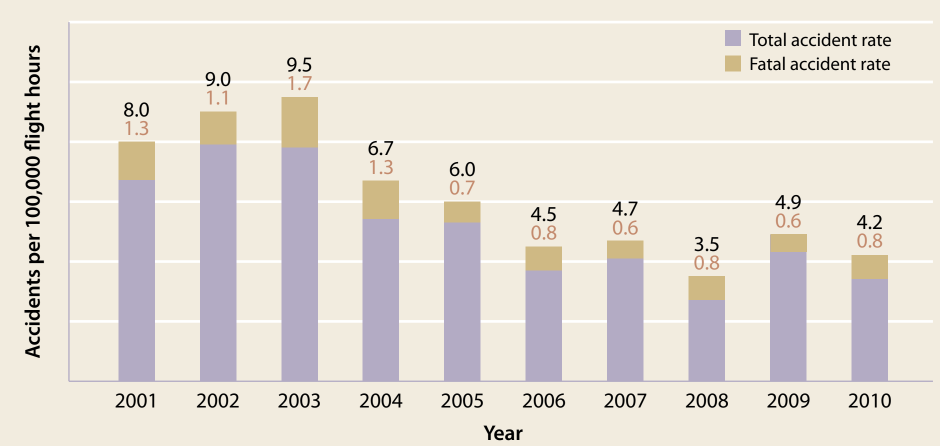
Accidents and Fatalities Involving U.S.-Registered Helicopters, 2001–2010



Source: Clarence E. Rash

Figure 4

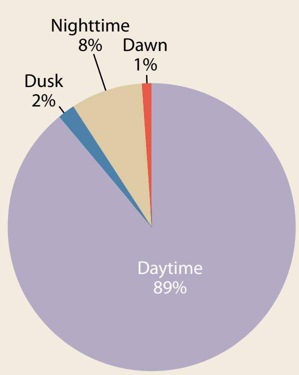
Accident Rates for U.S.-Registered Helicopters, 2001–2010



Source: Clarence E. Rash

Figure 5

U.S.-Registered Helicopter Accidents by Lighting Condition, 2001–2010



Source: Clarence E. Rash

Figure 6

Causal Factors

Perhaps the most important analysis that can be performed on the NTSB accident data involves causal factors, as the results of this analysis can play the greatest role in preventing future accidents.

Although the NTSB database does not categorize accidents by causal factor, it provides a narrative stating the conclusions of the accident investigation. Causal factor analyses, such as presented here, assign a first event causal factor to various categories using an acceptable category scheme. Such schemes may vary but generally conform to the following: pilot error; material failure, in which a component of the aircraft fails or does not function as intended; maintenance error; manufacturer fault; environmental factor, including weather or a bird strike; other factors such as an error by air traffic control, ground crewmembers or passengers; and undetermined factors.

Pilot error was the leading causal factor for every year (Table 2), with NTSB narratives consistently opening with phrases such as "The pilot's failure to … " or "The pilot's inadequate … ." The second most common accident causal factor was a material factor, followed by maintenance error.

For the decade as a whole, annual averages showed that pilot error was the first event causal failure in 69 percent of all accidents; material factor in 11 percent; and maintenance error in 4 percent. The NTSB database did not list a determined causal factor for 11 percent of the decade's accidents.

Although there is no such thing as a typical accident, the analyses of helicopter accidents for 2001–2010 identified the most common accident as one involving a reciprocating engine aircraft, and occurring during a maneuvering phase of flight, under daytime lighting conditions and as a result of pilot error.

Clarence E. Rash is a research physicist with 35 years experience in military aviation research and development and the author of more than 200 papers on aviation display, human factors and protection topics. His latest book is Helmet-Mounted Displays: Sensation, Perception and Cognition Issues, *U.S. Army Aeromedical Research Laboratory, 2009.*

Notes

1. Fox, R.G. *The History of Helicopter Safety*. Presented at the International Helicopter Safety Symposium, Montreal, Sept. 26–29, 2005.
2. Helicopter History Site, <helis.com>, retrieved 12 July 2011.
3. *Helicopter Fact Sheet*, Vertical Flight Society, <vstol.org/helifact.html>, retrieved 12 July 2011.

U.S.-Registered Helicopter Accidents by Phase of Flight, 2001–2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Annual Average
Approach	8%	8%	7%	5%	9%	5%	8%	4%	6%	4%	6%
Climb	2%	4%	0%	0%	1%	2%	2%	1%	0%	2%	1%
Cruise	18%	22%	20%	18%	12%	21%	14%	2%	1%	2%	13%
Descent	3%	2%	2%	3%	4%	1%	1%	2%	1%	1%	2%
Go-around	1%	0%	0%	0%	0%	1%	0%	0%	1%	0%	0.3%
Landing	15%	16%	16%	19%	18%	19%	19%	10%	17%	13%	16%
Maneuvering	35%	28%	34%	38%	38%	35%	18%	19%	29%	27%	30%
Standing	5%	4%	2%	4%	2%	4%	5%	2%	7%	3%	4%
Takeoff	9%	15%	13%	12%	13%	10%	15%	9%	10%	10%	12%
Taxi	1%	1%	3%	1%	2%	1%	2%	1%	3%	1%	2%
Other	1%	1%	0%	0%	0%	1%	0%	0%	0%	1%	0.4%
Unknown	1%	0%	1%	0%	2%	1%	18%	49%	25%	37%	13%

Note: Some columns do not total 100 percent because of rounding.

Source: Clarence E. Rash

Table 1

U.S.-Registered Helicopter Accidents by Causal Factor, 2001–2010

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Annual Average
Pilot error	67%	70%	69%	68%	74%	66%	71%	75%	71%	58%	69%
Material failure	14%	12%	15%	8%	10%	13%	12%	13%	8%	5%	11%
Maintenance error	2%	6%	3%	5%	2%	6%	4%	1%	4%	4%	4%
Manufacturer fault	2%	1%	0%	0%	1%	3%	0%	3%	1%	0%	1%
Environment	0%	1%	2%	1%	2%	1%	2%	1%	1%	2%	1%
Other	5%	2%	2%	5%	3%	3%	5%	1%	3%	2%	3%
Undetermined	11%	8%	8%	13%	8%	8%	6%	5%	12%	29%	11%

Note: Some columns do not total 100 percent because of rounding.

Source: Clarence E. Rash

Table 2

4. Aircraft Owners and Pilots Association Air Safety Institute. *The 2010 Joseph T. Nall Report of Accident Trends and Factors*. <www.aopa.org/asf/publications/nall.html>.

5. Harris, F.D.; Kasper, E.F.; Iseler, L.E. *U.S. Civil Rotorcraft Accidents, 1963 Through 1997*, NASA/TM-2000-209597. December 2000.

6. The average annual accident rate of 6.1 per 100,000 flight hours is not the same as the decade average of 5.7 per 100,000 flight hours, shown in Figure 1, because of slight differences in methods of calculation.

7. The NTSB — in accident report DEN08MA116A — said that pilots of the two 407s failed to see and avoid each other's helicopter as both were approaching the Flagstaff, Arizona, Medical Center helipad in daytime visual meteorological conditions on June 29, 2008. Everyone aboard both helicopters was killed, and both aircraft were destroyed.

8. General Aviation Manufacturers Association. *General Aviation Statistical Databook and Industry Outlook, 2010*. <libraryonline.erau.edu/online-full-text/books-online/GamaDatabookOutlook.pdf>.

Disorientation After Dark

The flight path of the Bell 206L-1 was characteristic of a pilot's spatial disorientation and loss of control, the NTSB says.

BY LINDA WERFELMAN

The pilot's spatial disorientation after an inadvertent entry into dark night instrument meteorological conditions was responsible for the loss of control and in-flight break-up of a Bell 206L-1 LongRanger on an emergency medical services (EMS) positioning flight in Walnut Grove, Arkansas, U.S., the U.S. National Transportation Safety Board (NTSB) says.

The pilot, flight nurse and flight paramedic were killed in the crash at 0355 local time on Aug. 31, 2010. The main rotor and tail boom separated from the helicopter, operated by Air Evac EMS, before it struck the ground in an area of "forested and rolling terrain" at an elevation of about 585 ft above mean sea level (MSL), 3.5 nm (6.5 km) south of the intended landing site.

According to radar, global positioning system (GPS) receiver data and a witness, the helicopter had reversed course "multiple times" immediately before the crash, the NTSB said in its final report on the accident. "The flight path … was consistent with spatial disorientation and subsequent loss of control."

Flight preparations had begun after the Van Buren County emergency dispatcher contacted the Air Evac Communications Center in West Plains, Missouri, at 0316 to request "that a flight be placed on standby to transport a patient from Crabtree, Arkansas." The dispatcher added that she was not certain the helicopter would be able to make the flight because of "some crappy weather" in Van Buren County.

After the communications center operator contacted the flight crew, however, the crew said the weather was "good" for the flight. At 0335, the helicopter departed from Vilonia, Arkansas, and at 0339, the crew contacted the Air Evac Communications Center, estimating the flight — to be conducted at an altitude of 1,200 ft above ground level (AGL) — would take 27 minutes. They also said that the "risk assessment score" for the flight was 15 points — which meant that risks were low enough that the pilot could accept the flight without consultation with the company's operational control center.

Radar data showed that the helicopter was flown primarily at altitudes between 2,000 and 2,600 ft MSL over rolling terrain, with the last radar information indicating an altitude of 2,700 ft.

The last flight data recorded by the helicopter's GPS showed that the helicopter was at 1,760 ft. The last minute of data on the GPS also showed that the helicopter had turned to the left and then to the right, followed by "a reversal to the left, a reversal back to the right and then a final reversal to the left," the report said.

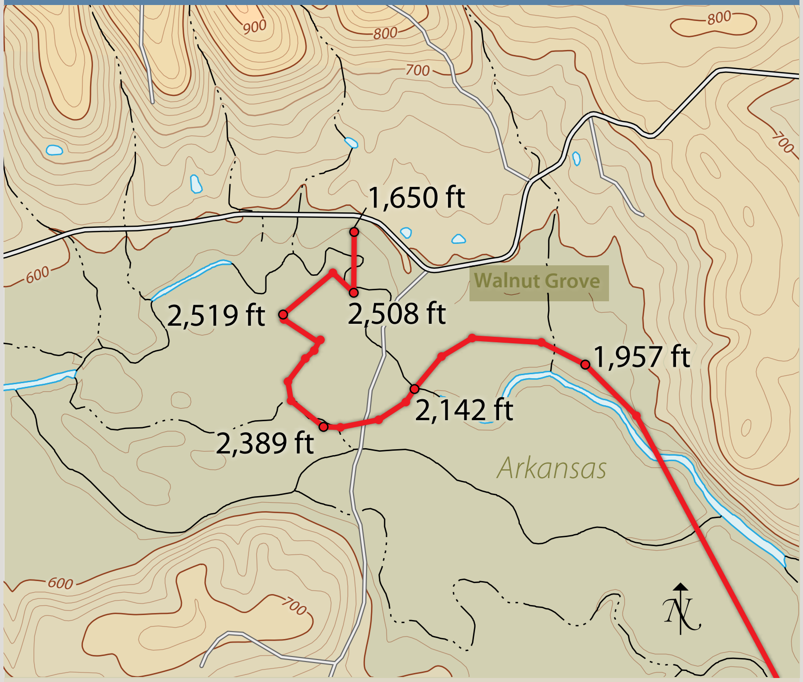
A flight-tracking program used by Air Evac's operational control center, which recorded flight data every 60 seconds, showed the helicopter at 1,800 ft and 4.4 mi (7 km) southeast of the intended destination about one minute before the crash.

Former Military Pilot

The 35-year-old pilot was the pilot supervisor at the company's base in Vilonia, Arkansas, and had a commercial pilot certificate with a helicopter rating and instrument helicopter

The helicopter had reversed course 'multiple times' immediately before the crash, the NTSB said.

Final Seconds of Accident Flight



Source: U.S. National Transportation Safety Board

Figure 1

> Witnesses … described the weather as hazy or foggy, with an overcast, and said the sky was very dark and the moon was not visible.

rating and an airplane single-engine land rating; he also had an airline transport pilot certificate with an airplane multiengine land rating.

A former military pilot, he had accumulated at least 3,312 flight hours in rotorcraft, including 489 hours in Bell 206Ls, 622 hours at night and 311 hours in actual or simulated instrument conditions, and more than 200 hours using night vision goggles (NVGs). In the 90 days preceding the accident, he had 35 flight hours, including 12 hours at night.

Company records showed that he had accepted 11 night flights in the previous three months and had used NVGs on five of them. Investigators could not determine whether the pilot was using NVGs on the accident flight.

The pilot completed a competency/proficiency check on Sept. 1, 2009, with a satisfactory rating in all areas that were tested. He completed an NVG flight proficiency check ride, including simulation of inadvertent flight into instrument meteorological conditions (IMC) on Dec. 11, 2009. Both proficiency flights were in Bell 206Ls.

The Air Evac safety director said there had been no safety issues involving the accident pilot.

The accident occurred on the pilot's fourth night of a night-shift rotation — from 1900 to 0900 local time — that was to have lasted seven days. Three days before the accident, he had recorded 2.5 hours of flight time, including 0.2 hours during the day, 0.6 hours at night and 1.7 hours using NVGs.

The accident helicopter was manufactured in 1978 and had total airframe time of 24,690 hours. It was maintained under an approved aircraft inspection program, and maintenance records showed that a 150-hour engine inspection had been completed Aug. 29, 2010.

A post-accident examination of the airframe, engine and related systems showed no pre-impact anomalies.

The helicopter was equipped for flight into IMC but was not certified for instrument flight rules (IFR) flight; Air Evac's policy was not to operate in IMC. In addition to the GPS, it had a radar altimeter and a night vision imaging system. It did not have a helicopter terrain awareness and warning system, and the system was not required; the GPS, however, provided visual and aural terrain awareness warnings.

The GPS was damaged beyond repair in the crash, but flight data related to the accident flight were extracted from a memory device for use in the investigation.

Accident investigators also examined recordings of communications between the Van Buren emergency personnel and the accident helicopter, but there was only one clear transmission from the helicopter in which a male voice called the base operator. In the background, investigators also could hear — but could not identify — a short tone that increased in pitch. The other communications on the recording were between the base operator and personnel who were members of the ground unit transporting the patient.

97 Bases, 400 Pilots

Air Evac was granted an operating certificate from the Federal Aviation Administration (FAA) in 1986 for on-demand EMS flights. At the time of the accident, the company operated at 97 bases in 14 states and employed 400 pilots. It was audited and accredited by the Commission on Accreditation of Medical Transport Systems and several air medical associations in the two years before the accident; all audit results were satisfactory, the report said.

All new pilots were required to have a minimum of 2,000 flight hours, including 500 hours of turbine time, as well as experience with night flight and instrument flight.

The company's operational control center in West Plains, Missouri, was staffed by several dispatchers, who took calls and provided flight following. Although they were not FAA-certified flight dispatchers, they were trained in emergency response.

The control center also was staffed with operational controllers, who were responsible for helping pilots with weather, publications and emergency information. They also had the authority to decline a flight request or to terminate a flight, if required by safety concerns.

Warnings of IMC

Satellite images showed low clouds throughout the region, as well as clouds directly above the accident site. Doppler radar did not show precipitation in the area, but mist had been reported in the hours before the accident.

Witnesses near the accident site described the weather as hazy or foggy, with an overcast, and said the sky was very dark and the moon was not visible, although the U.S. Naval Observatory said that, above the clouds, "60 percent of the moon's visible disk [was] illuminated."

At Clinton Municipal Airport, 6 nm (11 km) northeast of the accident site, the routine aviation weather report issued at 0355 reported visibility of 10 mi (16 km), few clouds at 1,600 ft, broken clouds at 4,900 ft and an overcast at 6,000 ft. Three hours earlier, visibility had been as low as 4 mi (6 km) in mist, and a National Weather Service AIRMET (airman's meteorological information) warned of IMC, with low ceilings and poor visibility. A weather service area forecast called for marginal visual meteorological conditions throughout Arkansas.

The NTSB said accident investigators had found no record that the pilot had obtained a weather briefing from either an FAA flight service station or the Direct User Access Terminal System. Air Evac said its pilots were encouraged to obtain information from a flight service station or another approved source and that its bases were equipped with computer terminals to enable frequent weather checks. In addition, all helicopters had satellite radio weather information.

"It could not be determined which resources were used by the pilot prior to the flight," the NTSB report said, adding that the pilot had not discussed weather with the dispatcher before or during the flight.

The burned wreckage was found in a forested area, and the wreckage distribution pattern was consistent with the in-flight separation of the main rotor and the tail boom, the accident report said. The main rotor assembly was found 715 ft (218 m) northwest of the main wreckage at an elevation of 611 ft MSL, and the tail boom was 190 ft (58 m) southwest of the main wreckage at 578 ft (176 m).

Risk Assessment

Air Evac required its pilots to use a risk assessment worksheet before all air medical flights and air medical repositioning flights.

The first portion of the risk assessment system was the "short form," which required pilots to answer questions in 17 areas, including pilot experience with the company, with the make and model of helicopter to be flown and with the weather and terrain likely to be encountered during the flight. The pilots tallied the points associated with each of their answers, and if the total was less than 35, "pilots were advised that the flight [was] at their discretion," the report said.

"If the total of the short form was 35 or greater, the pilot was required to complete the long form and consult with the operational control center."

The long form presented questions in 31 areas, and pilots responded and added up the resulting scores. Again, a score of 35 or less indicated a low-risk flight, "with the conduct of the flight being pilot's choice," the report said. Scores up to 60 indicated a low to moderate risk, "advising the pilot to exercise caution." Scores of 61 to 99 were considered moderate to high risk, and the pilot was urged to exercise extreme caution.

"A score of 100 and above was high risk, and the flight was not permitted," the report said.

Pilot Training

When the accident occurred, Air Evac provided its pilots with annual ground training in areas including situational awareness, human factors, patient interaction and awareness, critical incident task saturation, workload management, risk assessment, loss of tail rotor effectiveness and weather. Additional training included night operations, NVG operations and recovery from inadvertent entry into IMC.

Pilots had simulator training twice a year, including unusual attitudes and recovery from inadvertent entry into IMC, simulated whiteouts (blowing snow) and brownouts (blowing dirt or sand), emergency procedures and various types of instrument approaches.

NVG training also was provided, including various maneuvers and emergency procedures, system failures and flight into different types of lighting conditions. IMC was simulated.

After the accident, Air Evac "took several steps to increase safety within their operations," the report said. "Air Evac placed additional focus and emphasis on [inadvertent entry into] IMC training during night operations, in addition to [inadvertent entry into] IMC procedures at night while using the night vision goggles."

This article is based on NTSB accident report CEN10FA509 and related information from the accident docket.

MONITORING SAFETY

ICAO annual report measures progress in bolstering aviation safety.

BY LINDA WERFELMAN

The number of accidents involving scheduled commercial flights increased in 2010 to 121, up from 113 in 2009, the International Civil Aviation Organization (ICAO) says in a report analyzing global aviation safety performance.[1]

ICAO's *State of Global Aviation Safety* is expected to become an annual report on global progress toward improved safety. The report is available on ICAO's website at <icao.int/Safety/Documents/ICAO_State-of-Global-Safety_web_FINAL.pdf>.

"While safety information is readily available from a number of sources, this innovative report presents a compelling and holistic plan for ICAO and the industry to consistently improve aviation safety, our number one priority," said ICAO Secretary General Raymond Benjamin.

ICAO data showed a 4.5 percent increase in scheduled traffic from 2009 to 2010, with a record 30.5 million departures. That number is expected to climb to more than 52 million by 2030.

The worldwide accident rate in 2010 was 4.0 per million departures, marginally above the 3.9 per million recorded in 2009, ICAO said.

Fatalities in 2010 totaled 707, compared with 670 in 2009. The 2010 figure was the highest since 2006, when 806 people were killed in this type of airplane crashes.

The report assessed accident rates separately for each of the United Nations' six regions of the world and found the lowest accident rate — 3.1 per million departures — in the Asian region. Nevertheless, nine of Asia's 24 accidents, 38 percent, were fatal — the highest percentage of any of the regions (Table 1).

Both Europe and North America had 3.3 accidents per million departures. No fatal accidents were recorded in North America in 2010, but there were 35 non-fatal crashes. Twenty-four accidents, including two fatal accidents, were recorded in Europe.

Latin America and the Caribbean, which has about 10 percent of the world's total scheduled commercial traffic and 13 percent of the accidents, recorded an accident rate of 5.4 per million departures — above the world

© Chris Sorensen Photography

average — with 31 percent of those accidents resulting in fatalities.

The highest of the regional accident rates — 16.8 per million departures — was in Africa, where there were 17 crashes in 2010, three of them fatal.

"While Africa has the highest regional accident rate, it also accounts for the lowest percentage of global traffic volume — 3 percent of scheduled commercial traffic," the report said. African accidents accounted for 14 percent of the worldwide total.

"Considerable variance" in flight volume from one region to another must be considered before conclusions are drawn from accident information, the report said, noting that the three regions with the most traffic — North America with 35 percent, Asia with 25 percent and Europe with 24 percent — each had a smaller share of the global accident total — North America with 29 percent, and Asia and Europe, each with 20 percent.

Oceania accounted for 3 percent of worldwide air traffic and 4 percent of accidents, the report said.

Accident Statistics and Accident Rates, 2010

U.N. Region	Departures	Accidents		Fatal Accidents
		Number	Rate*	
Africa	1,013,063	17	16.8	3
Asia	7,629,403	24	3.1	9
Europe	7,263,218	24	3.3	2
Latin America and the Caribbean	2,976,575	16	5.4	5
North America	10,624,134	35	3.3	0
Oceania	1,050,120	5	4.8	0
World	**30,556,513**	**121**	**4.0**	**19**

*The accident rate is defined by the number of accidents per million departures.

Source: International Civil Aviation Organization

Table 1

'Consistent Goal'

The report emphasized the importance of cooperation as a "consistent goal and recognized strength of the aviation community. To keep pace with expansion and progress sector-wide, ICAO remains focused on the implementation and development of new safety initiatives."

The report highlighted safety improvements involving member states, aircraft manufacturers and safety organizations, and outlined a series of "assistance success stories" that it said demonstrated the "cooperative spirit of ICAO's member states."

As examples, the report cited the cooperative effort by the Airport Authority of India and ICAO to conduct training programs in airport management and airport security for personnel from Mauritius, Nigeria, Philippines, South Africa, Tajikistan, Thailand and Uganda, as well as ongoing assistance from the French Civil Aviation Authority to aid Cambodia in the development of regulations for the certification of airports and to train Cambodian airport inspectors.

The report also singled out Flight Safety Foundation's recent update of its *Approach and Landing Accident Reduction Tool Kit*, a multimedia resource on compact disc to be used by safety professionals and training organizations to prevent approach and landing accidents, including those involving controlled flight into terrain.

The Tool Kit updates, as well as a Foundation study on runway excursions, were distributed to ICAO member states.

Safety Audits

The document noted the role of ICAO's Universal Safety Oversight Audit Programme (USOAP) in promoting "the systematic implementation of ICAO standards and recommended practices." USOAP had, by the end of 2010, completed audits of 93 percent of ICAO member states; operators in those states account for 99 percent of air traffic worldwide.

Thirteen member states — five in Africa, four in Asia, two in Oceania and one each in the European region and the Latin America and Caribbean region — had not been audited, the report said.

"Effective state oversight capabilities, as measured by the USOAP, provide a proactive indicator of safety performance," the report said. "The rate of effective implementation was shown to correlate with accident rates."

In 2011, ICAO began transitioning USOAP to a continuous monitoring approach (CMA), which the report said "represents a long-term, flexible, cost-effective and sustainable method of identifying safety deficiencies, assessing associated risks, developing assistance strategies and prioritizing improvements.

"The CMA aims to provide a continuous report of a state's effective implementation, as opposed to the snapshot audit conducted once every six years under the comprehensive systems approach."

Note

1. The report's data involved scheduled commercial aircraft with a maximum takeoff weight of more than 2,250 kg (4,960 lb).

Curbing a KILLER

BY RANDY GIBB, WILLIAM ERCOLINE AND LAUREN SCHARFF

It's time to eliminate an age-old cause of fatal accidents: spatial disorientation.

© Getty Images Inc.

The aviation community needs to re-energize its efforts to increase awareness, training and research regarding the potentially fatal consequences of spatial disorientation. There are still far too many examples of pilots falling prey to this age-old killer. At a time when technology adds more to the pilot's toolbox of information and capabilities, impediments to information processing and attention are not being addressed sufficiently.

Spatial disorientation occurs when a pilot fails to properly sense the aircraft's motion, position or attitude relative to the horizon and the earth's surface. Spatial disorientation can happen to any pilot at any time, regardless of his or her flying experience, and often is associated with fatigue, distraction, highly demanding cognitive tasks and/or degraded visual conditions.

In 2008 and 2009, the U.S. Air Force lost two F-16s, an F-15E and three of the four pilots. These accidents involved pilots flying highly demanding night missions while wearing night vision goggles. All four pilots had the best training, equipment and technology available, yet they may have succumbed to sensory illusions that disabled them from properly orienting themselves within their environment.

In the last few years, there has been an alarming increase in the number of commercial aircraft accidents occurring at night while on climb-out over water. In January 2004, a Flash Airlines aircraft descended into the Red Sea minutes after takeoff on a moonless night from Sharm el Sheikh International Airport in Egypt; 148 people were killed. In May 2007, a Kenya Airways aircraft crashed into a swamp after spatial disorientation and loss of control occurred during climb-out on a dark night on departure from Douala Airport in Cameroon; all 114 people aboard perished. In January 2010, all 90 people aboard were killed when an Ethiopian Airlines aircraft crashed into the Mediterranean Sea shortly after takeoff on a dark and stormy night from Beirut International Airport in Lebanon.

Disagreement and Denial

These accidents demonstrate the tragic consequences of spatial disorientation. They are not isolated cases. There are many more documented accounts of in-flight sensory confusion that led to loss of life. However, it is almost as if the aviation community has accepted spatial disorientation as a cost of doing business.

Many people may not be aware of the seriousness of spatial disorientation because of inaccurate and under-reporting. Two factors contribute to this problem: a lack of consensus on what should be termed spatial disorientation and how to categorize mishaps; and the difficulty of "getting in someone's head" to understand what happened, particularly when the pilot did not survive the accident. These factors have produced disagreement about the "causes" of many accidents, including those cited above.

Most pilots underestimate the likelihood of spatial disorientation and believe it won't happen to them. Additionally, some have experienced and survived spatial disorientation and believe that they can do so again.

However, consider how often accidents are reported using descriptions that include "poor weather" (e.g., visual flight into suddenly degraded visual conditions), "controlled flight into terrain," "loss of control" or "loss of situational awareness." It is common for news stories to report the cause of an airplane accident simply as "pilot error." Is it really pilot error if the aircraft's orientation could not be accurately processed by the visual and vestibular sensory capabilities of the pilot? Possibly, a better description would be: "The pilot's sensory and perceptual capabilities were exceeded."

Cognitive Overload

Many people both within and outside the aviation community believe that advances in technology have reduced, and will further reduce, the likelihood of aviation mishaps, including those caused by spatial disorientation. Yet, spatial disorientation still accounts for nearly 25 to 33 percent of all accidents. Given the inaccurate and under-reporting of spatial disorientation, that estimate most likely is low.

While technology certainly has helped make some aspects of aviation safer, the addition of new instrument displays has increased the cognitive load experienced by pilots. More sources, layers and types of information are being added with little consideration of the very real limits of human information processing. Recall that one of the risk factors for spatial disorientation is cognitive task saturation.

Fortunately, there are ways to reduce the likelihood of spatial disorientation. For example, research on improved training has demonstrated that specialized simulators with engineered scenarios can greatly improve pilots' recognition of situations that may lead to spatial disorientation and teach risk-mitigation procedures. However, more research is needed to further investigate pilot interactions with new technologies and to help develop displays that reduce, rather than increase, cognitive load.

Several countries in Asia and Europe have already committed to efforts to reduce spatial disorientation mishaps in aviation. In the United States, an effort led by the Air Force and the Navy is reinvigorating resources to achieve the same goal. However, for meaningful progress to be made, long-term commitment and funding are needed.

Let's not wait for yet another tragic aircraft accident to remind us of what we already know: Spatial disorientation is a killer. We must commit to its prevention. Awareness is the first and most important step in making the sky safer for us all.

Col. Randy Gibb, Ph.D., is a pilot and a senior military professor at the U.S. Air Force Institute of Technology. William Ercoline, Ph.D., a former Air Force pilot, manages the San Antonio, Texas, office of Wyle's Science, Technology and Engineering Group. Lauren Scharff, Ph.D., is a professor of psychology at the Air Force Academy. This article is based on "Spatial Disorientation: Decades of Pilot Fatalities," Aviation, Space, & Environmental Medicine, *July 2011.*

BY RICK DARBY

Thai Score

Thai Airways flight operations safety analysis finds a reluctance to conduct go-arounds.

Only one of 16 unstabilized approaches flown by flight crews of Thai Airways in the first quarter of 2011 resulted in a go-around, according to data from the company's Flight Safety Investigation Department.[1] An increase in false — also called nuisance or non-safety-critical — enhanced ground proximity warning system (EGPWS) warnings was also seen during the period.

Safety-related events in a Thai Airways study were categorized as involving flight safety, ground safety or cabin safety. Ground safety events were the least frequent — totaling 20 in the January–March study period. They included "two reports of high breakaway thrust at Suvarnabhumi Airport [Bangkok]"; 10 reports of an aircraft parked beyond the "T" mark; absence of red traffic cones around caution areas such as under aircraft wings and engines; inaccurate calculation of zero fuel weight; aircraft center of gravity beyond the aft limit; maintenance workers' misunderstanding of pushback clearances; and defective disembarkation stairs.

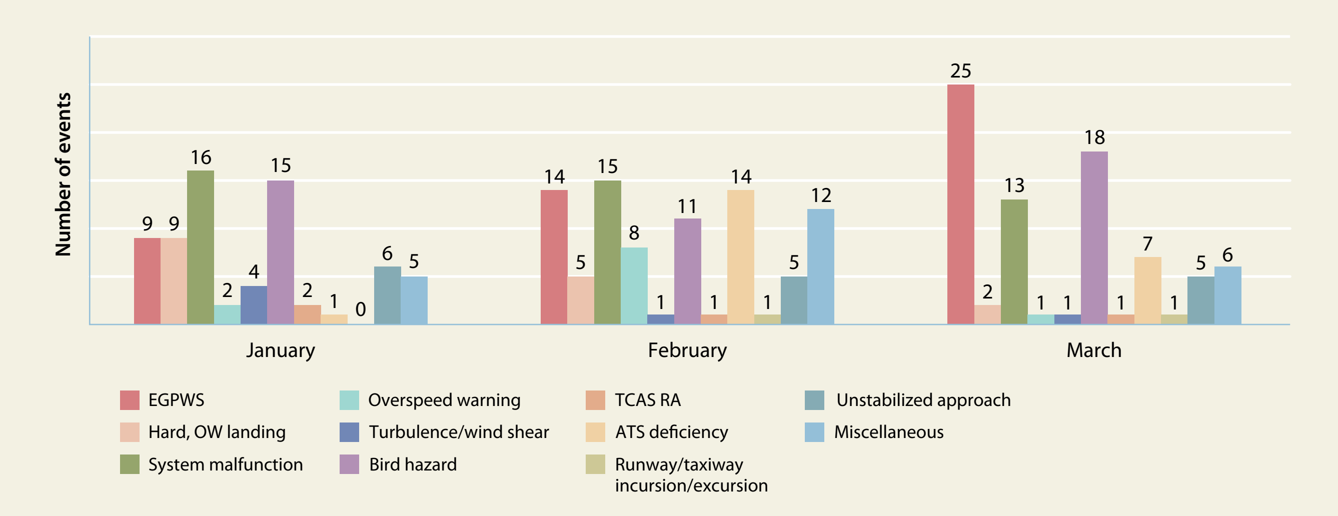
Cabin safety events totaled 28, mostly "unruly, intoxicated passengers and passenger disobedience to safety regulations," the summary says. Also reported were crew and passenger illness and injury, whose leading causes were "turbulence and worn-out equipment."

The greatest number of safety-related events — 236 — were in the flight safety category. Of those, the most-reported events, 48, concerned EGPWS bird hazards, 44 events; and system malfunctions, 44 events (Figure 1).

'Any pilot who complies with SOP will be given a special recognition.'

Concerning the pilots' reluctance to go around during unstabilized approaches, the summary says, "As our pilots were inclined to land the aircraft instead of making a go-around, the Flight Operations Safety Department therefore initiated a road map to a Non-Stabilized Approach Reduction Program, which aimed to make Thai [Airways] safer … by supporting a no-fault go-around policy and attempting to embed the new mindset in all our pilots that go-around is a maneuver performed to avoid risk." The program says that if an approach does not meet company criteria for a stabilized approach published in the operations manual, a go-around is standard operating procedure (SOP). "Any pilot who complies with SOP will be given a special recognition," the department says.

Thai Airways Flight Safety–Related Events, January–March 2011



ATS = air traffic service; EGPWS = enhanced ground proximity warning system; OW = overweight; TCAS RA = traffic alert and collision avoidance system resolution advisory

Source: Thai Airways

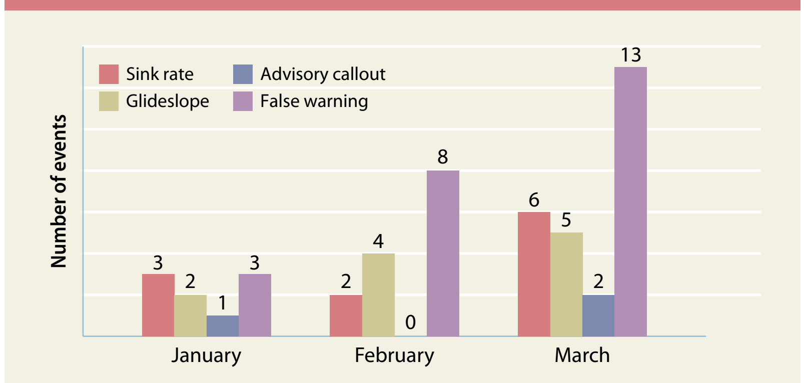
Figure 1

Sixteen overweight landings were reported, defined as "a landing made at a gross weight in excess of the maximum design landing weight for a particular aircraft." The summary says, "In January and February, we [received reports of] a rather high number of overweight landing cases. We can draw a conclusion from the reports that the short-cut route and tail wind component led the aircraft to land overweight. … Pilots can avoid an overweight landing by … extending landing configuration [early] or requesting holding to prevent any possible damage to the aircraft structure."

Among the 48 EGPWS events, the largest portion was categorized as false warnings, mainly of "terrain closure" and "unsafe terrain clearance" types (Figure 2). "Significantly, the record showed a dramatic increase in false warning events," the summary says. "The number in February was almost thrice that number in January, while the number in March tallied nearly twice the number of February."

Most of the warnings to pull up because of flight too close to terrain were activated in a single Airbus A330, the summary said. A technician inspected the aircraft and found a fault in the global positioning system sensor unit. Otherwise, the most prevalent EGPWS warnings were for "sink rate" and "glideslope."

Thai Airways EGPWS Events, by Warning Mode, January–March 2011



EGPWS = enhanced ground proximity warning system

Source: Thai Airways

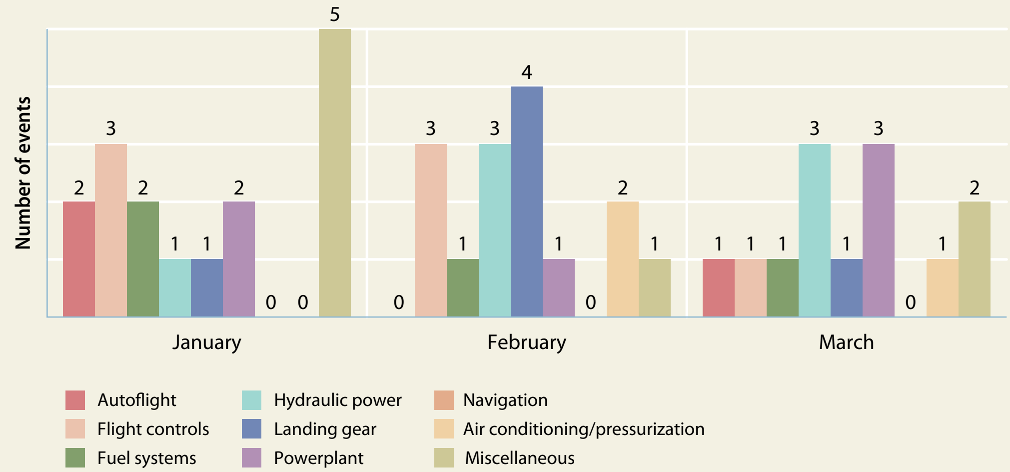
Figure 2

The summary also looked at the nature of system malfunctions reported during the study period (Figure 3, p. 50). It ascribed the large number of "miscellaneous" malfunctions in

January to a repeated "false warning from a cargo door system" on one aircraft, resulting in diversions and turnbacks.

As a result of the malfunctions, pilots responded with ground turnbacks in 27 percent of the three-month total of these maneuvers, with air turnbacks in 25 percent and rejected takeoffs in 14 percent (Figure 4). Most of the flights, 34 percent, were continued safely, the summary says.

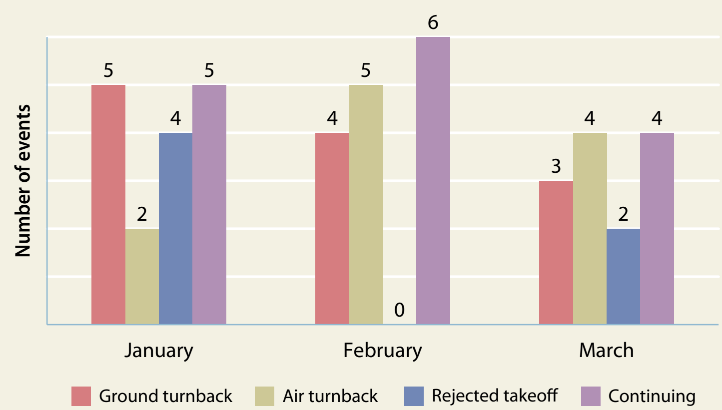
Thai Airways System Malfunction, by Type, January–March 2011



Source: Thai Airways

Figure 3

Thai Airways Aircraft Maneuvers Due to System Malfunction, January–March 2011



Source: Thai Airways

Figure 4

Thai Airways experienced 44 bird strikes in the study period. Most bird strike cases, 27 reported, were caused by single, small birds, followed by single medium-size birds, 11 reported. "There were two bird strike cases in this quarter that caused damage to the aircraft," the summary says. "In January, a medium-sized bird struck the middle of a nose radome and caused a crack. The other bird impact occurred in February, when the aircraft had to abort takeoff after hitting the single large bird and having the fan blades of engine no. 2 damaged and requiring its replacement."

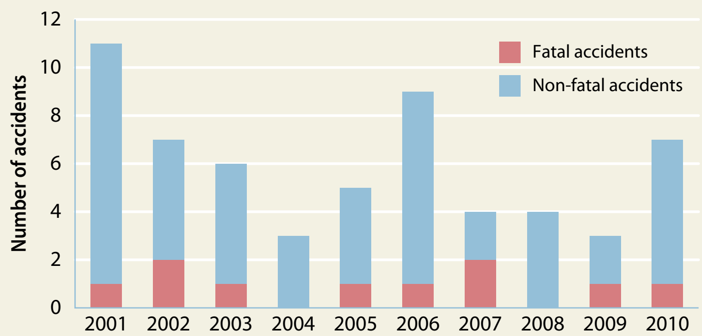
According to the department's records, 41 percent of reported bird strikes occurred during the landing phase of flight, 30 percent during takeoff, 20 percent during approach and 9 percent during initial climb.

The Year After Air France 447

A report from the other side of the world provided a window into French aviation safety.[2] The Direction Générale de l'Aviation Civile (DGAC) says that a single fatal accident occurred in French public transport aviation in 2010, the year following the loss of Air France 447. That accident involved an Écureuil AS 350 helicopter in the Antarctic; its pilot and three passengers were killed. Four airplane accidents involving French air carriers, three occurring in France, were nonfatal.[3]

"The fatal accident rate per million flight hours averaged over five years … came down to about 0.27, against 0.40 a year earlier," the report says. "It is one of the best values recorded during the past 20 years."

French Public Transport Aircraft Accidents, 2001–2010

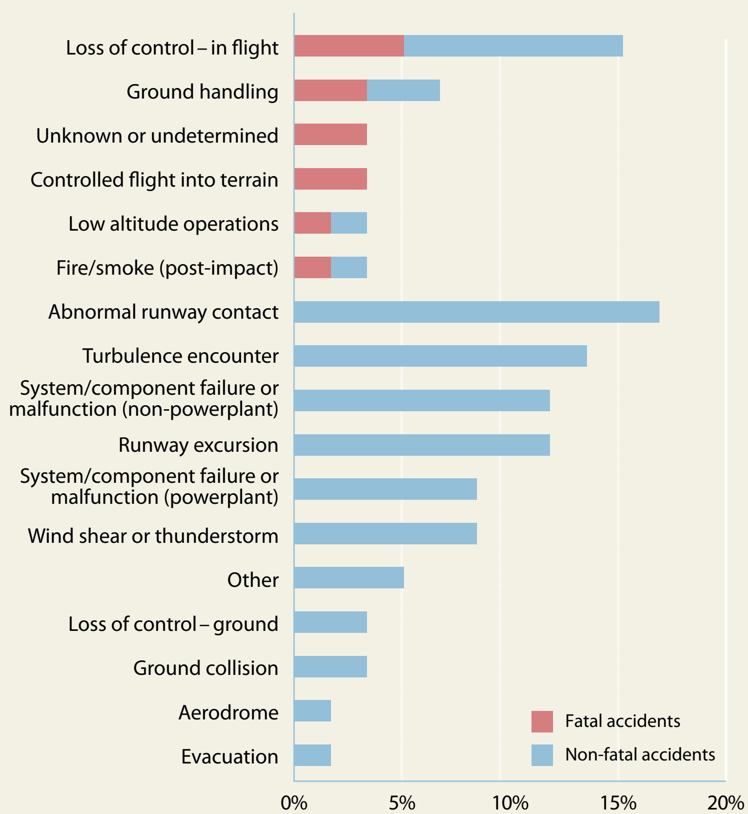


Note: For accidents involving two aircraft, the same description was used for each aircraft, and the descriptions were counted only once.

Source: French Bureau d'Enquêtes et d'Analyses

Figure 5

CAST-ICAO Categories, French Public Transport Aircraft Accidents, 2000–2010



CAST-ICAO = U.S. Commercial Aviation Safety Team-International Civil Aviation Organization

Source: French Bureau d'Enquêtes et d'Analyses

Figure 6

The report lists 17 serious incidents during the year involving French public transport aircraft that were investigated by the Bureau d'Enquêtes et d'Analyses (BEA). Five occurred during takeoff, five en route, three during approach, three while taxiing and one during landing. All but one occurred in France.

Between 2001 and 2010, the BEA investigated 10 fatal accidents in French public transport, with 283 total fatalities. "The average annual number of fatal accidents was one during the period, with values ranging from zero to two," the report says (Figure 5).[4] In two years, 2004 and 2008, no one died in French public transport aviation accidents, and there was only one fatality each year in 2003 and 2005.

Accidents from 2000 through 2010 were categorized according to the U.S. Commercial Aviation Safety Team-International Civil Aviation Organization (ICAO) taxonomy (Figure 6). Among fatal accidents, the most frequent category was "loss of control–in flight," followed closely by "ground handling," "unknown or undetermined," and "controlled flight into terrain."

The most frequent category of non-fatal accidents was "abnormal runway contact," followed by "turbulence encounter."

The BEA investigated two accidents, both non-fatal, and eight incidents involving non-French air carriers in 2010.

Notes

1. Thai Airways, Flight Safety Investigation Department. "Statistical Summary of Air Safety Reports," *Thai Flight Safety Information* Volume 31(3), July–September 2011. The data concern only Thai Airways flights, not other air carriers operating in Thailand, and are based on written reports by pilots.
2. DGAC. "Rapport sur la Sécurité Aérienne — 2010." In French only. Available on the Internet at <bit.ly/cyT7TN>.
3. Airplane accident data concerned airplanes with more than 19 seats. Accident and incident definitions are based on ICAO Annex 13, *Aircraft Accident and Incident Investigation*.
4. The additional accidents shown in the chart for 2010, besides those mentioned, involved balloons.

Measures of Countermeasures

Evaluation of a flight attendant fatigue-fighting program shows promise.

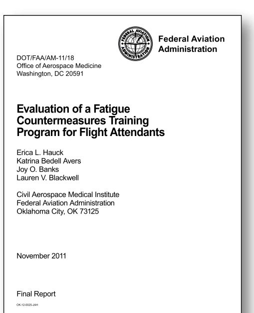
BY RICK DARBY

REPORTS

Cognitive, Affective, Behavioral

Evaluation of a Fatigue Countermeasures Training Program for Flight Attendants

Hauck, Erica L.; Avers, Katrina Bedell; Banks, Joy O.; Blackwell, Lauren V. U.S. Federal Aviation Administration (FAA) Civil Aerospace Medical Institute. DOT/FAA/AM-11/18. November 2011. 14 pp. Tables, figures, references. Available through the Internet at <www.faa.gov/library/reports/medical/oamtechreports/2010s/media/201118.pdf>.


Federal Aviation Administration

DOT/FAA/AM-11/18
Office of Aerospace Medicine
Washington, DC 20591

Evaluation of a Fatigue Countermeasures Training Program for Flight Attendants

Erica L. Hauck
Katrina Bedell Avers
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November 2011

Final Report

OK-12-0025-JAH

Flight attendants work for the safety of passengers but face physiological challenges that leave them vulnerable to a mismatch between the body's circadian rhythms, or "internal clock," and the demands of the job. Their schedules vary, their duty periods can be longer than those of people who work in offices, they often cross time zones and work at night, and they can experience unscheduled duty when on call. Such factors call for fatigue mitigation.

This report describes research evaluating a comprehensive fatigue countermeasures training program for flight attendants. Researchers analyzed existing fatigue training programs for content, conducted a scientific literature study and consulted subject specialists to develop a training program to evaluate.

"A total of 50 domestically based flight attendants volunteered to attend a one-day training event," the report says. "Ten flight attendants participated in the first training event, 23 participated in the second and 17 participated in the third." Two flight attendants were dropped from the analysis because it was determined that they had extensive pre-existing knowledge of fatigue and fatigue countermeasures, which might have skewed the results.

"Flight attendants participated in the fatigue countermeasures training as a part of a one-day event hosted by the FAA," the report says. "Prior to arrival, flight attendants were asked to complete an online survey that included questions and the various … pre-test measures. The training lasted approximately three hours and was followed by administration of post-test measures. All participants were provided with a handout of the training materials and tools to aid fatigue prevention and management.

"Approximately six weeks after the initial training, participants were contacted via email and asked to complete a follow-up survey."

Criteria for evaluation of the results included cognitive, affective and behavioral outcomes:

"Cognitive outcomes included declarative and self-knowledge, while affective outcomes included motivation and attitude. The behavioral outcome measured involved skill acquisition or the individual's use of learned fatigue countermeasures."

Overall, the report says, the results demonstrate the effectiveness of a thoroughly developed, comprehensive training program.

"As a result of the training, participants improved their knowledge of basic fatigue information and strategy use; they acquired new information, were able to articulate awareness and exhibited greater recognition of effective fatigue countermeasure strategies," the report says. "Participants also showed improvements in their self-efficacy [belief in one's own ability] for addressing fatigue and the strength of their attitudes toward fatigue and the importance they place on fatigue management."

Information, awareness and attitude are important precursors to improvement, but did the training program result in *behavior* that would tend to counteract fatigue among the flight attendants? On the whole, pre-test and post-test results appeared to validate this outcome.

"Training participants demonstrated changes in the level of fatigue experienced and the number of fatigue countermeasure strategies they used," the report says. "For example, 41.2 percent of flight attendants utilized naps for fatigue management following training, as compared to only 27.8 percent prior to training. Flight attendants even received more nightly sleep as a result of training, increasing from 6.78 hours per night to 7.37 hours."

Training effectiveness was "clearly demonstrated" in cognitive outcomes and skill acquisition, the report says. But although flight attendant attitudes about the need to counter fatigue and belief in their ability to do so improved between the baseline and the post-test scores, the score for motivation was not statistically significant, with the mean actually declining from pre-test to post-test. Unusually among the cognitive and affective variables, the mean then increased at the time of the six-week follow-up survey.

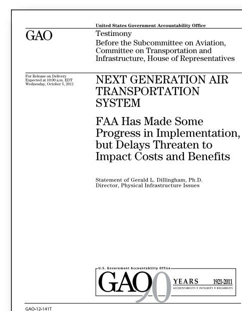
"The lack of significant improvement in motivation may suggest that the information presented during training was somehow overwhelming for participants," the report says. It seems understandable that after the participant took a test, underwent the training and took another test, the knowledge would be there, but the drive to put it into practice left temporarily on the shelf.

"Additional training outcomes regarding sleepiness, physical symptoms, work-family conflict and family-work conflict were not found to be significantly different following training," the report says. "It is possible that fatigue simply does not affect these outcomes; alternatively, the four- to six-week time frame may have been insufficient to observe significant changes. This may highlight the challenges of fatigue management faced in flight operations and warrants further attention."

Keeping the Pace … or Not

Next Generation Air Transportation System: FAA Has Made Some Progress in Implementation, But Delays Threaten to Impact Costs and Benefits

Dillingham, Gerald L. U.S. Government Accountability Office (GAO). GAO-12-141T. October 5, 2011. 10 pp. Available on the Internet at <www.gao.gov/products/GAO-12-141T>.


United States Government Accountability Office

GAO

Testimony

Before the Subcommittee on Aviation, Committee on Transportation and Infrastructure, House of Representatives

For Release on Delivery Expected at 10:00 a.m. EDT Wednesday, October 5, 2011

NEXT GENERATION AIR TRANSPORTATION SYSTEM

FAA Has Made Some Progress in Implementation, but Delays Threaten to Impact Costs and Benefits

Statement of Gerald L. Dillingham, Ph.D.
Director, Physical Infrastructure Issues

U.S. Government Accountability Office GAO 90 YEARS 1921-2011 ACCOUNTABILITY • INTEGRITY • RELIABILITY

GAO-12-141T

Testifying before the U.S. House Subcommittee on Aviation, Dillingham — GAO director of civil aviation issues — commented on the state of play in the U.S. Federal Aviation Administration's (FAA's) Next Generation Air Transportation System (NextGen). NextGen represents a nearly complete revision of air traffic control procedures, using satellite-based surveillance instead of ground-based radar, performance-based navigation rather than step-by-step instructions by controllers and replacing most voice communications with data links.

"Over the years, concerns have been raised by Congress and other stakeholders that despite years of efforts and billions of dollars spent, FAA has not made sufficient progress in deploying systems and producing benefits," 'Due to the integrated nature of NextGen, many of its component systems are mutually dependent on one or more other systems.'

Dillingham said. His testimony discussed the results and improvements to NextGen to date and ongoing issues that will affect NextGen implementation.

On a positive note, Dillingham said that:

- "FAA has set performance goals for NextGen through 2018, including goals to improve the throughput of air traffic at key airports by 12 percent over 2009 levels, reduce delays by 27 percent from 2009 levels, and achieve a 5 percent reduction in average taxi time at key airports."
- "FAA has begun work to streamline its procedure approval processes — including its environmental reviews of new procedures — and has expanded its capacity to develop new performance-based navigation routes and procedures. In 2010, FAA produced over 200 performance-based navigation routes and procedures, exceeding its goal of 112. FAA reports thousands of gallons of fuel savings from the performance-based navigation routes in operation at Atlanta and the continuous descents being used into Los Angeles and San Francisco."

However, Dillingham said, airlines have complained that the FAA's routes and procedures so far have not been optimal.

"To address these concerns, FAA has undertaken thorough reviews in a number of areas," Dillingham said.

"FAA has completed initial work to identify improvements needed in the airspace in Washington, D.C.; North Texas; Charlotte, North Carolina; Northern California; and Houston, Texas — focusing on routes and procedures that will produce benefits for operators," he said. "While the specific benefits from this work are not yet fully known, FAA expects to achieve measurable reductions in miles flown, fuel burn and emissions from these actions. In addition, airport surface management capabilities — such as shared surface surveillance data and new techniques to manage the movement of aircraft on the ground — installed in Boston and New York have saved thousands of gallons of fuel and thousands of hours of taxi-out time, according to FAA."

In addition, some NextGen and related programs are projected to be completed on time and on budget, he said. They include such critical programs as automatic dependent surveillance-broadcast (ADS-B), the satellite-based information broadcasting system; collaborative air traffic management and systems to manage airspace and flight information; system-wide information management, the "information management architecture" for the national airspace system; and time-based flow management, designed to integrate airport and air traffic control information.

One exception, Dillingham said, is en route automation modernization (ERAM): "Delays in implementing the ERAM program are projected to increase costs by $330 million, as well as an estimated $7 million to $10 million per month in additional costs to continue maintaining the system that ERAM was meant to replace. Moreover, due to the integrated nature of NextGen, many of its component systems are mutually dependent on one or more other systems. For example, ERAM is critical to the delivery of ADS-B, because ADS-B requires the use of some ERAM functions."

Additional challenges to NextGen include these, Dillingham said:

- "Delays to NextGen programs, and potential reductions in the budget for NextGen activities, could delay the schedule for harmonization with Europe's air traffic management modernization efforts and the realization of these benefits. FAA officials indicated that the need to address funding reductions takes precedence over previously agreed upon schedules, including those previously coordinated with Europe."
- "FAA and the National Aeronautics and Space Administration (NASA) — the primary agencies responsible for integrating human factors issues into NextGen —

must ensure that human factors issues are addressed so that controllers, pilots and others will operate NextGen components in a safe and efficient manner. Failure to do so could delay implementation of NextGen. We recently reported that FAA has not fully integrated human factors into the development of some aviation systems."

- "FAA has embarked on an initiative to restructure a number of organizations within the agency. We have previously reported on problems with FAA's management and oversight of NextGen acquisitions and implementation. … While elimination of duplicative committees and focus on accountability for NextGen implementation is a positive step, it remains to be seen whether this latest reorganization will produce the desired results."

Keeping pace with NextGen's rollout schedule is important to maintain credibility with the airline industry that will need to invest in the corresponding avionics, Dillingham said.

"As we have previously reported, a past FAA program's cancellation contributed to skepticism about FAA's commitment to follow through with its plans," he said. "That industry skepticism, which we have found lingers today, could delay the time when significant NextGen benefits — such as increased capacity and more direct, fuel-saving routes — are realized."

BOOKS

Staying Current

Commercial Aviation Safety

Rodrigues, Clarence C.; Cusick, Stephen K. McGraw-Hill, 2011. Fifth edition. 368 pp. Figures, tables, references, index.

This is the updated edition of a textbook that has been published for more than two decades. Regulatory issues discussed are largely confined to U.S. agencies and the International Civil Aviation Organization (ICAO), but otherwise the contents are applicable to commercial aviation wherever it is found.

The authors say, "This edition updates, revises and makes current the aviation safety and security information contained in previous editions; establishes new changes in the format and content of the chapters to make the flow of information progressive and logical; and broadens the field of study to include regulatory information on ICAO and safety management systems (SMS) that is essential to the practicing aviation professional."

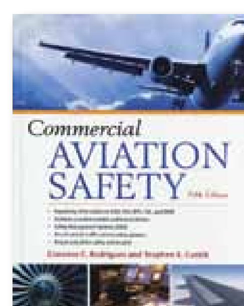
The following are examples of the updated material in the new edition.

- Chapter 4, about reporting and recording safety data: "The ICAO five basic traits of an effective safety reporting system have been added. Information from previous editions has been revised and updated, and additional information about LOSA [line operations safety audit] and AQP [the FAA advanced qualification program for pilot and flight attendant training] has been added."

- Chapter 6, about accident causation models: "Information on Dr. James Reason's 'Swiss cheese' model of accident causation has been expanded and updated from the latest ICAO safety documentation. The SHELL model, another widely used conceptual tool, has been added."

- Chapter 9, on aircraft safety systems, "has been revised to include recent developments in jet engine design and new cockpit enhancements from Boeing and Airbus on their latest aircraft models."

- "Chapter 13 on aviation safety management systems is new. The chapter discusses the evolution of SMS principles and explains safety risk management and safety assurance as the heart of an effective SMS organization. The chapter concludes with a brief discussion of the future of the SMS process in commercial aviation safety."



Head-Down at a Hot Spot

Misunderstood taxi information and distraction led to a runway incursion.

BY MARK LACAGNINA

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

JETS

Stop Bar Lights Recommended

Boeing 737, Airbus A319. No damage. No injuries.

A Boeing 737-800 with 99 passengers and six crewmembers inadvertently was taxied beyond the assigned runway-holding position and into the path of an Airbus A319 that was on short final approach to Dublin (Ireland) International Airport with 125 passengers and five crewmembers the morning of Oct. 16, 2010.

The A319 flight crew had spotted the encroaching 737 and had initiated a go-around less than 200 ft above the ground and 0.4 nm (0.7 km) from the A319's projected runway-touchdown point, said the report on the serious incident by Ireland's Air Accident Investigation Unit (AAIU).

The AAIU concluded that the incursion was caused by the 737 crew's noncompliance with the taxi clearance limit issued by the airport ground movements controller and their entrance onto the active runway without permission.

Factors contributing to the serious incident were the crew's misinterpretation of published airport information, their distraction by "head-down cockpit tasks" while taxiing and the absence of a company standard operating procedure (SOP) requiring the crew to conduct a verbal cross-check before entering a runway, the report said.

The incursion occurred in an area designated on the airport chart as an "incursion hot spot, a location which requires heightened attention by crews," the report said. In what was described as an unusual and complex configuration, Dublin International's southernmost taxiway, E1, provides access from the aprons on the east side of the airport to the departure thresholds of both Runway 28 and Runway 34, which branch out from a common paved area on the south side of the airport.

Weather conditions were described as good when the incident occurred, and Runway 28 was being used for both arrivals and departures. In a written report filed after the incident, the commander told investigators that while preparing the aircraft for a flight to Istanbul, Turkey, he and his copilot had discussed information published in a Jeppesen Airport Briefing, which stated that holding positions are established on all taxiways that intersect runways at Dublin International.

The briefing also said, "A further holding position is established on Runway 16/34." This statement referred to a holding position that is applicable to aircraft taxiing south on Runway 16 for departure from Runway 28; the holding position is north of the intersection of Taxiway E1 and Runway 16/34.

However, the commander said that they interpreted the word "further" to mean "ahead," the report said. As a result, the pilots expected to see one set of holding-position markings on Taxiway E1 that were applicable to Runway 34 and then to see another set of markings ahead on Runway 34 that were applicable to Runway 28.

When the 737 crew reported ready to taxi from the apron, the surface movements controller told them to taxi to E1 and "hold short runway two eight." As the aircraft neared the taxiway, the controller again instructed the crew to hold short of Runway 28 and told them to monitor the tower radio frequency. The crew acknowledged both "hold short" instructions.

The commander said that he was "doing mandatory head-down tasks" when the aircraft entered E1 and "had quick sight" of the holding-position markings on the taxiway. He said that, based on the misinterpretation of the airport-briefing information, he believed that the markings were applicable only to Runway 34 and "continued for the holding point [for] Runway 28, which was supposed to be on Runway 34."

The 737 was on the runway centerline at the approach threshold when "all of a sudden, we recognized that when we penetrated into Runway 34, we also penetrated Runway 28," the commander said.

Meanwhile, the air movements controller had issued a landing clearance to the Airbus crew, who were inbound from Cologne, Germany. The A319 was 1.7 nm (3.1 km) from the projected touchdown point when the crew acknowledged the clearance. The crew then radioed, "We're going around. There's [an aircraft] entering the runway." This radio transmission coincided with a go-around instruction by the controller, who also had detected the conflict.

The 737 crew heard the A319 crew's call and began taxiing the 737 toward Taxiway E2, to vacate the runway. The A319 passed about 300 ft above the 737 during the go-around. While climbing straight ahead to 3,000 ft in compliance with the missed approach procedure, the crew received a traffic-alert and collision avoidance system (TCAS) advisory applicable to an aircraft that had previously departed from Runway 28. The report said that there was no conflict; the A319 was at 2,100 ft, and the other aircraft was at 2,600 ft and 3 nm (6 km) ahead. The A319 subsequently was landed without further incident on Runway 28. The 737 meanwhile had departed uneventfully for its flight to Istanbul.

Following the incident, airport and government authorities took action in response to AAIU recommendations to include additional information in the *Aeronautical Information Publication Ireland* to clarify the holding position locations for Dublin's Runway 28 and Runway 34. In response to another recommendation for stop bar lights at the holding position on Taxiway E1, the authorities said that installation of stop bar lights already was in progress when the incident occurred and that the lights were expected to be in operation in October 2011.

Installation of stop bar lights already was in progress when the incident occurred.

The AAIU also issued a recommendation to the operator of the 737 to establish procedures requiring the handling pilot to maintain an "external look-out at all times while taxiing" and requiring both pilots to "verbally cross-check with each other that they have received the appropriate clearance to cross or enter a runway, whether active or non-active," before entering a runway.

Drenched on Short Final

Airbus A320-232. Minor damage. No injuries.

Inbound from Toronto with 179 passengers and seven crewmembers, the flight crew was cleared to conduct the VOR ILS (VHF omnidirectional radio, instrument landing system) approach to Runway 06 at Varadero, Cuba, the night of Jan. 31, 2010. The airport was reporting winds variable from 350 degrees to 070 degrees at 8 kt, 1,000 m (5/8 mi) visibility in heavy rain and a broken ceiling at 1,600 ft.

"The flight was following a Boeing 737 that was approximately 20 nm [37 km] ahead on the same approach," said the report by the Transportation Safety Board of Canada. "Except for a few rain showers to the left of its track, there was no significant weather showing on the aircraft's weather radar."

The A320 was turning onto final approach when the 737 crew conducted a missed approach. "When the flight crew of the 737 called the ACC [Havana area control center] to advise them of the go-around, they did not provide a reason or offer a pilot report," the report said. "In addition, no information was requested by or issued to the crew of [the A320] regarding the reason for the go-around of the preceding aircraft."

The A320 veered off the right side of the runway at 130 kt.

The approach was stabilized when the A320 descended below 1,000 ft. The crew established visual contact with the runway environment shortly thereafter and was cleared to land. The airport traffic controller also advised that the winds were from 060 degrees at 12 kt.

"Throughout the last 400 ft of the approach, the flight data recorder (FDR) indicated the wind was at 045 degrees at 15 kt and decreased in speed to 10 kt at touchdown," the report said.

Rainfall intensity increased as the aircraft descended. The FDR data indicated that the approach remained stable as the A320 descended below the decision height. However, the aircraft began to deviate below the glideslope and drift right after the captain, the pilot flying, disengaged the autopilot. The aircraft crossed the runway threshold at 20 ft and in a nearly 11-degree right bank.

"Just prior to touchdown, the precipitation intensified and the visibility decreased to the point where the crew lost most visual references," the report said. "Given the aircraft configuration, its low-energy state and position relative to the runway, a go-around was rejected as an option, and the captain committed to landing the aircraft."

The runway was covered with standing water when the aircraft touched down left of the centerline, about 640 ft (195 m) from the threshold, and banked 7 degrees right. The spoilers deployed automatically, the crew engaged the thrust reversers, and the captain applied left rudder as the aircraft began to veer right. "White streaks left by the tires are indicative of scouring action caused by some form of hydroplaning," the report said.

The A320 veered off the right side of the runway at 130 kt and tracked parallel to the runway on hard-packed grass and gravel for about 1,745 ft (532 m) before re-entering the runway at 40 kt. "The crew ascertained that the aircraft was fit to taxi to the gate and did so," the report said.

The crew reported the excursion to the controller and later to the airline. The aircraft was found to have sustained minor damage to its tires, fan blades in the right engine, the right air conditioning pack and a flap-track fairing.

The report noted that the crew had not used the windshield rain-repellent system when the rainfall intensified during the approach. "The system delivers a calibrated quantity of rain-repellent fluid which is dispersed evenly onto the windshield [and] restores visibility in seconds," the report said. However, the original fluid used by the system had been banned for environmental reasons in 1996. A replacement fluid that became available in 1998 required minor modification of the system.

The airline had reactivated the rain-repellent systems on its Airbus fleet in 2008. "The crew of [the incident aircraft] was unaware that the capability had been put back into service," the report said. "No official memorandum or other formal means of communication from the company informing flight crews of the reactivation of the rain-repellent systems could be found."

Thrust Setting Error Cuts Margins

Boeing 737-700. No damage. No injuries.

Two qualified captains were assigned to ferry the 737 back to its home base in Nigeria after maintenance was completed at Southend Airport in Essex, England, the morning of Nov. 21, 2010. The designated commander, who was to serve as the pilot monitoring, encountered problems with transportation to the airport and arrived 90 minutes late. Meanwhile, the designated copilot had begun preparations for the flight.

The copilot conducted performance calculations for a maximum-thrust takeoff from Runway 24 and entered the data in the 737's flight management computer (FMC). When the commander finally joined the copilot on the flight deck, the flight was about two hours late.

"The two captains reviewed the FMC programmed data in accordance with the operator's SOPs and confirmed that it was correct," said the report by the U.K. Air Accidents Investigation Branch (AAIB). "The aircraft engines were then started, and the crew received clearance to taxi."

Weather conditions were clear, with surface winds from 360 degrees at 5 kt and a temperature of 7 degrees C (45 degrees F).

As the crew taxied toward Runway 24, they were advised by air traffic control (ATC) that the runway in use had been changed to Runway 06. While the commander continued to taxi the aircraft, the copilot reprogrammed the FMC "with some urgency," the report said. "Reprogramming the FMC with the new runway deleted the previously entered performance data, thus allowing an 'assumed' temperature to be entered for a reduced-thrust takeoff, should it be required."

According to the report, the copilot entered an assumed temperature of about 50 degrees C, which was suitable for the longer runways typically used by the crew in Africa but 21 degrees higher than the maximum assumed temperature appropriate for the conditions at Essex. The result was a takeoff thrust setting of 86 percent N_1, which was insufficient for the runway length.

Moreover, the crew did not back-taxi on the runway to use the full available takeoff distance of 4,785 ft (1,458 m) but began the takeoff from the displaced threshold, leaving 600 ft (183 m) of runway behind.

As the 737 reached 100 kt, the commander perceived that the acceleration was too slow and called for maximum thrust. However, recorded flight data indicated that the thrust settings remained about 86 percent. The aircraft lifted off the runway and crossed the departure threshold at 150 ft.

The report said that although the aircraft was able to become airborne with both engines operating, calculations performed by Boeing indicated that the crew would not have been able to stop the aircraft on the runway after rejecting the takeoff just before reaching V_1 — the aircraft would have overrun the runway at 60 kt. The manufacturer also determined that if the crew had continued the takeoff after an engine failed one second before V_1, the 737 would not have become airborne before reaching the end of the runway.

Excess Speed, Short Runway

Eclipse 500. Substantial damage. No injuries.

The pilot had conducted several long, private flights with various passengers before landing the very light jet at Wings Field in Philadelphia to refuel before returning with one passenger to Brandywine Airport in West Chester, Pennsylvania, U.S., the evening of July 30, 2008.

Clear skies and calm winds prevailed when the airplane took off about 1830 local time for the five-minute flight to West Chester. The pilot told investigators that he was "a little high" on the visual approach to Brandywine's 3,097-ft (944-m) Runway 27 and "dipped down."

"As he passed the runway threshold, his speed was 'a little high,' but he thought it was manageable," said a report issued by the U.S. National Transportation Safety Board (NTSB) in September 2011.

The Eclipse touched down about 14 kt above the appropriate landing speed. "Skid marks from the accident airplane began approximately 868 ft [265 m] beyond the displaced threshold and continued for about 2,229 ft [679 m] until they left the paved portion of the runway," the report said.

The landing gear separated, the wings were bent and sections of the airframe were fractured and crushed when the airplane traveled down a 40-ft (12-m) embankment, crossed a service road and came to a stop against trees and a chain-link fence. A fuel tank was breached, but there was no fire. "Neither of the two occupants received any injuries during the impact sequence or subsequent egress," the report said.

TURBOPROPS

Snow Triggers Control Loss

Pilatus PC-12/45. Destroyed. Two fatalities.

Snow was falling heavily when the single turboprop was pulled out of its heated hangar at Yampa Valley Airport in Hayden, Colorado, U.S., the morning of Jan. 11, 2009. The pilot conducted a preflight inspection before boarding the airplane with his passenger. They remained inside the PC-12 while it was refueled for the intended business flight to Chino, California.

The pilot declined to have the airplane deiced before departure.

The manager of the airport's fixed base operation said that the pilot declined his recommendation to have the airplane deiced before departure. The PC-12 then was towed to the taxiway to prevent it from becoming stuck in the snow on the ramp.

"Line crewmembers reported seeing an accumulation of wet snow on the airplane's wings," the NTSB report said. "One of the crewmembers described the accumulation as 'probably a good inch of slushy, wet snow.'"

The airplane had been outside in the heavy snow about 22 minutes when the pilot began the takeoff from the 9,998-ft (3,047-m) runway with a 4-kt tail wind and 3/4 mi (1,200-m) visibility. Two line crewmembers said that the PC-12 appeared to accelerate slowly and rolled about 4,000 ft (1,219 m) before lifting off and entering a shallow right turn. The airplane then was lost from sight.

A search was initiated after the pilot did not establish radio communication with ATC. The wreckage was found about 1 mi (2 km) from the airport. Recorded ATC radar data indicated that the airplane had entered "an ever-tightening right turn until it impacted the ground," the report said.

NTSB concluded that the probable cause of the accident was "the pilot's loss of control due to snow/ice contamination on the airplane's lifting surfaces as a result of his decision not to deice the airplane before departure."

Passengers Jump After Engine Fails

Cessna 208. Substantial damage. No injuries.

The engine lost power as the Caravan was climbing through 12,500 ft to drop 15 parachutists near Cairns (Queensland, Australia) Airport the morning of Dec. 31, 2009. "The pilot reported that there were no cockpit warnings, vibrations or other indications of the impending engine failure," said the report by the Australian Transport Safety Bureau (ATSB). "The parachutists exited the aircraft, and the pilot completed a glide approach and uneventful landing at Cairns Airport."

Investigators determined that the failure of the Pratt & Whitney PT6A-114 engine likely was precipitated by the fracture of unapproved compressor blades that had been installed during an overhaul about four years earlier. The engine had accumulated 1,926 hours and 3,002 cycles since the overhaul. The manufacturer recommends overhauls every 3,600 hours.

The report said that the failed blades were approved for several PT6A model engines but not for the -114 and others with higher operating temperatures that would cause them to be "more susceptible to thermally induced microstructural decay."

Unlocked Door Separates

Beech King Air 300. Substantial damage. No injuries.

The King Air was climbing through 7,000 ft after departing from Minneapolis–St. Paul (Minnesota, U.S.) International Airport the evening of Dec. 10, 2010, when the pilot advised ATC of a pressurization problem and his intention to return to the airport. "He did not report that the cabin entry door had separated from the airplane," the NTSB report said.

The pilot landed the airplane without further incident. Examination of the King Air revealed a 4-in (10-cm) hole in the rear fuselage. The cabin door was found several weeks later about 6 mi (10 km) from the airport. "The door handle was in the latch position and not in the lock position," the report said. "No mechanical anomalies were noted with the door. … The door-open annunciator light was functional."

Slowdown Leads to Stall

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

Weather conditions at Lorain County Regional Airport in Elyria, Ohio, U.S., the afternoon of Jan. 18, 2010, included surface winds from 240 degrees at 9 kt, 2 mi (3,200 m) visibility in mist and a 500-ft overcast. Inbound from Florida, the pilot conducted a go-around on his first ILS approach to Runway 07 because the airplane was too high.

While receiving ATC radar vectors for a second ILS approach, "the pilot requested that the controller extend the outbound leg to provide more time to get established on the inbound course," said the NTSB report. "The radar track data indicated that the airplane was about 11 mi [18 km] from the airport before it turned inbound to intercept the localizer course."

The controller cleared the pilot for the approach and told him to change to the airport's advisory frequency. Analysis of recorded ATC radar data indicated that the MU-2 crossed the final approach fix 60 ft too low and continued to descend, with airspeed decreasing from about 130 kt to below 100 kt. "The ILS approach flight profile indicates that 20 degrees of flaps should be used at the glideslope intercept while maintaining 120 kt minimum airspeed," the report said.

A witness waiting for the airplane to arrive saw it descend out of the clouds in a nose-low attitude and then roll into a steep turn, banked almost 90 degrees right. He said the airplane was "definitely out of control" when it descended rapidly to the ground about a half mile from the runway threshold.

NTSB concluded that the probable cause of the accident was an aerodynamic stall that resulted from "the pilot's failure to maintain adequate airspeed."

PISTON AIRPLANES

Suitable Airport Bypassed

Beech B60 Duke. Destroyed. Two fatalities.

Shortly after the pilot leveled the airplane at 6,000 ft, about 15 minutes after departing from Huntsville (Alabama, U.S.) International Airport the afternoon of Jan. 18, 2010, the right engine failed catastrophically. The pilot reported the engine failure to ATC and said, "We've got control, but we're going to need to land."

The pilot also told the controller that he had feathered the right propeller but was "having a hard time holding altitude." The controller advised the pilot that there was an airport with a 5,000-ft (1,524-m) runway about 10 nm (19 km) away, but the pilot requested clearance to return to Huntsville, which was 30 nm (56 km) away, the NTSB report said.

ATC radar data indicated that the Duke gradually descended until radar contact was lost at 800 ft. The pilot had been cleared for a straight-in landing at Huntsville. As the airplane neared the airport, one witness observed that the right engine cowling was "propped up." Another witness saw the airplane strike treetops and "nose-dive straight into the ground" about 3 mi (5 km) from the airport.

Examination of the right engine showed that the no. 2 cylinder had separated due to the propagation of fatigue cracks.

Last-Minute Maneuvers

Britten-Norman Trislander. Minor damage. No injuries.

While holding for takeoff from Guernsey, Channel Islands, for a commercial flight with five passengers to Alderney the morning of Jan. 17, 2011, the pilot was advised by ATC that Alderney was reporting 3 km (2 mi) visibility and a broken ceiling at 300 ft. The reported visibility exceeded the 1,200 m (3/4 mi) required for the nondirectional beacon (NDB) approach, but the ceiling was below the published minimum descent height of 390 ft.

"Because the weather at both Guernsey and Jersey was above applicable minimums and the pilot had plenty of fuel, he decided he would attempt an approach to assess the conditions himself," said the AAIB report.

During the NDB approach, the Trislander was descending through 1,000 ft about 3 nm (6 km) from the runway when the Alderney airport traffic controller cleared the pilot to land and advised that there were broken clouds at 200 ft and a few clouds at less than 100 ft. Shortly thereafter, the controller said that the visibility had decreased to about 1,200 m in fog. The pilot replied, "I haven't got anything yet."

Several seconds later, the aircraft was about 230 ft above ground level and 680 m (2,231 ft) from the runway threshold when the pilot radioed, "Got the lights." He then made a left turn and a steep right turn to align the airplane with the runway. The aircraft touched down on the right main landing gear, and the wing tip scraped the runway.

"With a surface wind from the left, the pilot felt uncomfortable and decided to go around," the report said. The aircraft veered off the right edge of the runway before becoming airborne.

The pilot was positioning the Trislander for another NDB approach when the controller advised that runway visual range had decreased to 325 m (1,100 ft). The pilot then asked to fly a holding pattern, but the controller replied that the company had just requested that the aircraft return to Guernsey. "The return flight was uneventful, and the aircraft landed safely," the report said.

Fuel Stop Bypassed

Beech 58P Baron. Substantial damage. One fatality.

The Baron was en route from Morristown, New Jersey, U.S., to a planned fuel stop in West Virginia the night of Jan. 5, 2011, when the pilot decided not to stop for fuel but to continue to the destination, Alabaster, Alabama. Visual meteorological conditions had been forecast for Alabaster's Shelby County Airport, but nearing the destination after more than five hours in flight, the pilot found that the airport had 2 mi (3,200 m) visibility in drizzle and an overcast at 300 ft.

The pilot received clearance to divert to his planned alternate, Birmingham, Alabama, and was cleared to conduct the ILS approach to Runway 24. "The airplane initially intercepted the localizer for the approach but did not intercept the glideslope," the NTSB report said. The Baron then deviated left of the localizer and descended below the glideslope.

The pilot confirmed that he was not established on the ILS, and the approach controller provided instructions for a missed approach. The report said that the pilot likely had become spatially disoriented; he acknowledged the controller's instructions but did not turn to the assigned heading or climb to the assigned altitude.

The Baron crashed on a street in a residential area about 0.5 mi (0.8 km) from the runway. Examination of the airplane revealed no preimpact malfunctions.

HELICOPTERS

Disoriented Turn-Around

Eurocopter AS 350-B. Substantial damage. Two minor injuries.

The AS 350 was among four helicopters chartered to transport passengers from Parramatta, New South Wales, Australia, to attend an automobile race in Bathurst the morning of Oct. 10, 2010. During a preflight briefing, some of the pilots expressed concern about the weather conditions, but no formal risk assessment was performed for the visual flight rules operation, the ATSB report said.

"Once under way, two of the line pilots continued to voice their concerns [about] the weather over the company's radio frequency," the report said. "However, the chief pilot requested that the flight continue."

The chief pilot, who was flying the lead helicopter, attempted to climb "toward a patch of blue sky" but, about 10 minutes after departure, "decided that they would not be able to find a way through the cloud and instructed all pilots to return" to the Parramatta heliport, the report said.

The AS 350 pilot was completing the turn back to the heliport when the helicopter entered clouds. The pilot became spatially disoriented, and the helicopter descended and struck trees. Two of the five passengers sustained minor injuries.

Too Heavy to Hover

Robinson R44. Substantial damage. Four minor injuries.

The pilot told investigators that the helicopter encountered a downdraft during takeoff from a hilltop helipad in Aguadilla, Puerto Rico, on Aug. 8, 2010. "He stated that he attempted to compensate for the wind with a collective [control] input, but the helicopter descended and struck the downsloping hillside," the NTSB report said.

The report said that analysis of the existing environmental conditions and the performance data in the R44's operating handbook indicated that the helicopter was 94 lb (43 kg) over maximum gross weight and 120 lb (54 kg) over the maximum allowable weight for hovering out of ground effect.

Preliminary Reports, October–November 2011

Date	Location	Aircraft Type	Loss Type	Injuries
Oct. 3	Newnan, Georgia, U.S.	Dassault Falcon 20	major	none
The Falcon rolled down an embankment and struck a light pole after its brakes failed while being repositioned for maintenance.				
Oct. 4	Lutselk'e, Northwest Territories, Canada	Cessna 208 Caravan	total	2 fatal, 2 serious
The Caravan struck high terrain during a scheduled visual flight rules flight from Yellowknife.				
Oct. 4	New York, New York, U.S.	Bell 206	total	2 fatal, 2 serious, 1 minor/none
The pilot was attempting to return to the East 34th Street Heliport with a control problem when the helicopter descended into the East River.				
Oct. 12	Port Gentil, Gabon	Embraer 120 Brasilia	total	30 minor/none
The Brasilia overran the runway while landing with low visibility in heavy rain.				
Oct. 13	Madang, Papua New Guinea	de Havilland Dash 8	total	28 fatal, 2 serious, 2 minor/none
Thunderstorm activity was reported when the Dash 8 crashed in a forest during descent to land at Madang.				
Oct. 14	Xakanaka, Botswana	Cessna 208 Caravan	total	8 fatal, 1 serious, 3 minor/none
Visual meteorological conditions (VMC) prevailed when the 208 crashed on takeoff for a scheduled flight.				
Oct. 18	Baglung, Nepal	Britten-Norman Islander	total	6 fatal
Night instrument meteorological conditions prevailed when the Islander struck a hillside during an emergency medical services (EMS) flight.				
Oct. 27	Vancouver, British Columbia, Canada	Beech King Air 100	total	1 fatal, 3 serious, 5 minor/none
The King Air rolled left, pitched nose-down and crashed short of the runway after the pilot reported a fluctuating left-engine oil pressure indication and that he was returning to the airport.				
Oct. 28	Toulouse, France	Piper Cheyenne	total	3 fatal, 1 serious
The Cheyenne crashed about 650 m (2,133 ft) from the runway during a night landing.				
Oct. 31	Key West, Florida, U.S.	Gulfstream G150	major	4 minor/none
The G150 overran the runway after the brakes failed on landing.				
Nov. 1	Warsaw, Poland	Boeing 767	major	231 none
The 767 was landed on its belly after the flight crew was unable to extend the landing gear. A hydraulic system failure reportedly had occurred soon after the airplane departed from Newark, New Jersey, U.S.				
Nov. 3	Key West, Florida, U.S.	Cessna Citation II	minor	5 minor/none
The Citation overran the runway and came to a stop in an engineered material arresting system after the brakes malfunctioned on landing.				
Nov. 8	Salt Lake City, Utah, U.S.	Learjet 55	major	7 minor/none
The Learjet veered off the runway when the pilots rejected the takeoff after a tire burst.				
Nov. 9	Raddusa, Italy	Eurocopter AS 365	total	1 fatal, 4 serious
The helicopter was on an EMS flight when it struck a hillside in fog.				
Nov. 10	Tangshan, China	Cessna 208 Caravan	total	2 minor/none
The 208 was destroyed in a forced landing on a road after a mechanical failure occurred during a survey flight.				
Nov. 10	Molokai, Hawaii, U.S.	Eurocopter EC 130	total	5 fatal
The helicopter struck high terrain during a commercial sightseeing flight.				
Nov. 11	Santa Catarina Ayotzingo, Mexico	Eurocopter AS 332	total	8 fatal
Adverse weather conditions were reported where the Super Puma struck high terrain during a flight from Mexico City to Cuernavaca.				
Nov. 16	Flint, Michigan, U.S.	Piaggio P180 Avanti	total	4 minor
The pilots reported an engine problem and diverted to Flint, where the Avanti veered off the runway on landing and overturned.				
Nov. 21	Talcha, Nepal	Cessna 208 Caravan	total	1 serious, 10 minor/none
A pilot was seriously injured when the Caravan veered off the runway on landing and caught fire.				
Nov. 23	Sugapa, Indonesia	Cessna 208 Caravan	total	1 fatal, 1 serious
The 208 struck a mountain after the pilots rejected a landing because of pedestrians on the runway.				
Nov. 23	Apache Junction, Arizona, U.S.	Rockwell 690	total	6 fatal
The Turbo Commander struck a mountain shortly after a night takeoff from Mesa, Arizona.				

This information is subject to change as the investigations of the accidents and incidents are completed.

Source: Ascend

Selected Smoke, Fire and Fumes Events in the United States, August–October 2011

Date	Flight Phase	Classification	Subclassification	Aircraft	Operator Name
8/1/2011	Descent	Smoke in cabin	Emergency descent and landing	Boeing 737	Southwest Airlines
On final approach, descending through 6,500 ft, the gasper fan turned on with a strong odor of smoke that was detected by flight attendants. The gasper fan turned off, an emergency was declared, and an emergency landing was conducted.					
8/3/2011	Climb	Smoke, odor in cockpit	Unscheduled landing	ATR 42	Hyannis Air Service
After takeoff and after turning on the bleed air, the crew reported observing a higher than normal no. 1 bleed system duct temperature, accompanied by a burning odor in the cockpit. As a precaution, they returned to the departure airport and requested maintenance to inspect the aircraft. Maintenance deferred the item and later re-secured a loose turbine inlet control valve hose clamp.					
8/7/2011	Descent	Burning odor	Deactivated system/circuit	Boeing 757	US Airways
A "RECIRCULATING FAN INOP" light illuminated with the switch positioned to "ON." An electrical burning odor was experienced on the descent into Dublin. Maintenance removed and replaced one recirculating fan.					
8/29/2011	Not stated	Fumes/smoke in cabin	Declared emergency	Boeing 737	Southwest Airlines
At Flight Level (FL) 340 (about 34,000 ft), hydraulic fumes and smoke were reported in the cabin. The crew declared an emergency and landed the aircraft without incident. Maintenance removed and replaced the hydraulic air pressure module.					
9/4/2011	Cruise	Burning odor/smoke in cockpit	Landed without incident	McDonnell Douglas DC-8	Air Transport International
The overhead cockpit climate control unit emitted a burning odor when turned on. The crew landed without further incident. Maintenance inspected and cleaned the overhead climate control unit fan.					
9/7/2011	Climb	Smoke/odor in cabin and cockpit	Emergency descent and landing	Boeing 727	Federal Express
A faint electrical odor was detected after departure. The odor worsened after 10 minutes and level-off at FL 320 and became very irritating on initial descent. The flight crew donned oxygen masks. Once the aircraft was landed and depressurized, the crew removed masks and found that the odor was mostly gone. Maintenance ran both packs, three engines, all electrical components, hydraulics, fans, and aircraft accessories. They inspected upper and lower cargo compartments, the wheel well bay, aft stairwell and electronics bay. Maintenance could not detect or duplicate the phenomenon.					
9/10/2011	Cruise	Smoke/fumes in cabin and cockpit	Continued flight	Boeing 747	Atlas Air
A "RECIRCULATION FAN LWR-RT" status message was combined with fumes throughout the entire airplane. Maintenance pulled the recirculation fan circuit breaker and found the right recirculation fan unserviceable.					
9/12/2011	Not stated	Smoke/arcing in cockpit	Deactivated system/circuit	Boeing 737	US Airways
The crew reported electrical arcing from the right side sliding window frame to the cable leading to window no. 2 right. Maintenance removed and replaced the right side window connector and pins.					
9/26/2011	Cruise	Electrical odor in cockpit	Unscheduled landing	ATR 72	Executive Air Charter
During cruise at 17,000 ft, there was a strong electrical odor on the flight deck. The flight crew consulted with the flight attendants, who confirmed the odor. During descent, the fumes dispersed. Maintenance opened all overhead stowage compartments and inspected electrical connections. No faults were found. They opened avionics racks access doors and the forward avionics compartment and ran up both engines with all electrical systems operating, anti-ice and deicing systems operating for 30 minutes. No faults or electrical odor were noticed.					
10/1/2011	Cruise	Smoke/arcing in cockpit	Landed without incident	Bombardier CL-600	Atlantic Southeast Airlines
During flight, the crew noticed electrical arcing briefly at the top left half of the captain's side window. The arcing stopped in 2–3 seconds, immediately followed by "L WINDOW HEAT" caution. The crew followed the quick reference handbook, except that the left window was not reset "ON."					
10/7/2011	Cruise	Smoke in cockpit and cabin	Unscheduled landing	Boeing 747	Evergreen International
En route at FL 380, the first officer smelled smoke. The crew donned oxygen masks as a precaution and the first officer ran the appropriate checklist. The crew located the odor source as the main battery area, and what appeared to be smoke was coming out of louver vents. The voltage on the battery showed 23 to 24 volts with no amperage. The smoke then appeared to have stopped with just an occasional whiff of odor. The crew determined that there was no immediate danger or failure except the battery voltage and did not declare an emergency, although the flight was diverted. The rest of the flight was normal. Maintenance interchanged the aircraft's main and auxiliary power unit (APU) batteries as well as main and APU battery chargers.					
10/7/2011	Approach	Smoke/electrical odor in cockpit	Landed without incident	Bombardier CL-600	Air Wisconsin
An electrical odor was detected in the cockpit. The odor did not appear to be coming from gaspers and was not present in the cabin area. Maintenance operated all electrical equipment and lights while operating the engines, and isolated the electrical odor source. They inspected the left pack assembly and found the Y-duct disconnected and cracked. The duct was replaced, and the left coalescer bag was cleaned.					

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