AeroSafety WORLD

PILOT MULTITASKING
Risks real, benefits few

THE PROMISE OF ASIAS
System-level safety data arrive

OUTSIDE THE BOX
Deployable CVR/FDR modules

ARFF RESOURCES
Upgrades tough to justify

RUNWAY EXCURSIONS
KEEPING IT ON THE PAVEMENT

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

AUGUST 2009

AGAINST The Tide

I know that a lot of people turn to this page looking for some insight or inspiration about aviation safety. I hate to disappoint, but at least once a year, I believe I should give you some insight into this organization, letting you know what you can expect from us.

This is the toughest economic climate the Foundation has endured since it started in 1947. The good news is that in spite of the tough times, we are surviving while at the same time preparing to grow. By the time you read this, you should be able to use our new Web site. It is part of an effort to modernize our infrastructure with a new generation of communication tools. Travel will be tough for safety professionals for a long time, but with these new electronic tools, the Foundation, I hope, will remain a place where the aviation safety community comes together.

If you have not already noticed, our reach has been steadily expanding. A team of volunteers for months now has been producing a Chinese language edition of this magazine, which is available for download on our Web site. Some articles also are being translated into Russian, and we hope to see a Spanish version in the not-too-distant future. Recent economics may have caused the industry to contract, but the Foundation's reach has been extended.

It is not enough to build new communication channels; we have to have something to say. Some of you who are International Air Transport Association members probably have seen the newly minted IATA/FSF *Runway Excursion Risk Reduction Toolkit*. Even if you are not an IATA member you will be able to get this information from FSF and IATA. Also, an updated *Approach and Landing Accident Reduction Tool Kit* will be available from the Foundation in the coming months.

You also can expect to see your Foundation cited in the press more than ever. Many members have asked us to be the voice of reason for the international media, so we work daily with major media outlets around the world to help them produce better-informed aviation safety stories. In the first six months of the year, the Foundation has been quoted in various news media more than 10,000 times and in more languages than we can count. Our head office may be in the United States, but our voice is heard all over the world. I hope it is the voice of reason.

It takes money to keep these things happening. We have been blessed with a few major contributions over the last several years, but we can't leave future contributions to chance. For that reason, Susan Lausch has joined us as our new director of development. It will be her job to communicate the value of the Foundation to economic decision makers and donors. It also will be her job to listen to you and keep us technical people going in the direction the members need us to go. You can help the Foundation by helping her. Please let her know how the Foundation earns your membership and the things it needs to do to appeal to more people and add more value. You can contact Susan at development@flightsafety.org. She will be looking forward to hearing from you, and I will be grateful for your support.

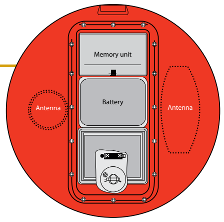
William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

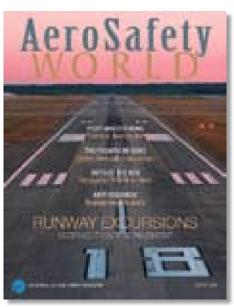
contents

August2009 Vol 4 Issue 8

features



departments



About the Cover
Report details excursion risks and prevention tools.
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Share Your Knowledge

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

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

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Subscriptions: Subscribe to *AeroSafety World* and become an individual member of Flight Safety Foundation. One year subscription for 12 issues includes postage and handling — US$350. Special Introductory Rate — $310. Single issues are available for $30 for members, $50 for nonmembers. For more information, please contact the membership department, Flight Safety Foundation, 601 Madison St., Suite 300, Alexandria, VA 22314-1756 USA, +1 703.739.6700 or membership@flightsafety.org.

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VIRTUAL Face

Much of what Flight Safety Foundation does is related to communications, the gathering and retransmitting of safety-enhancing information to the global aviation community. Our ability to fulfill this function is directly related to our ability to be effective in reducing the risks of accidents.

A little more than three years ago, the Foundation took a big step in changing how it communicates by creating this journal. The combination of seven specialist publications into a single colorful, glossy magazine signaled a change in attitude. The previous publications' style reflected the engineer-driven birth of the Foundation. Eventually, some members of the Foundation's board of governors began to believe that a change was needed in the style of the FSF publications, which led to my joining the organization and the creation of this magazine.

By most accounts, *AeroSafety World* is considered a success, increasing the number of people who read and pass along material originating at or passing through the Foundation, some of it stories from the magazine staff, some material from safety specialists throughout the industry and some created by committees and working groups coordinated by the Foundation. In this issue, you can find material from all three sources.

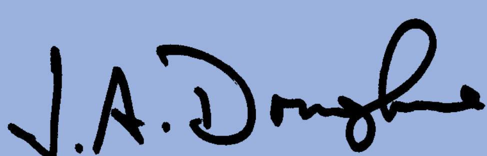
The Foundation's Web site, however, has lagged, presenting the same FSF face to the world for nearly a decade in an era when a Web site three years old is thought to be antique. The material on the site has evolved with the workings of the Foundation, but getting to that material has not been easy, with the viewer forced to work through the pages covered in dense text to find the correct links.

Beginning in September, however, the Foundation will present a new virtual face to the world as the new FSF Web site is launched.

The home page announces the change immediately, with a wide view and an uncluttered design colored from a palette keyed to our new logo. The site focus is based on what people historically have come to <www.flightsafety.org> to view, so the magazine, the subject of tens of thousands of downloads every month, is front and center, next to a new graphic that, when clicked, expands to a map of the world where the Foundation's major safety concerns, affiliated organizations and regional office are identified, with links to more data. Above the magazine is a row of large navigation tabs that are easier to operate and more helpful than the old style menus. At the top of the page is information about the Foundation and various ways to communicate with us. And the middle dark blue bar has buttons leading to information on joining Flight Safety Foundation, our store and a place where those considering donating to our safety cause can examine the contribution options available.

At the center bottom of the home page is an innovation for the Foundation, a news section, featuring aviation safety news from our associate Aviation Safety Network, plus general media stories from respected aviation specialist journalists. To the left of the news is a listing of those elements of the site viewed by the largest number of visitors; on the bottom right are our upcoming seminars and what is new at the Foundation.

We hope, once you have had time to get to know the site, our improvements enhance your ability to find out what we have to communicate.



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

Optional Ob/Gyn Items in Emergency Medical Kit

Thank you for your very informative article, "Special Delivery" (*ASW*, 5/09). The article is wonderfully well written and researched. I enjoyed reading it very much.

I would like to offer a comment on one paragraph in the longer version on the FSF Web site. You are correct that enhanced emergency medical kits (EEMKs) have been required equipment aboard U.S. Federal Aviation Regulations Part 121 air carrier operations since April 2004. However, the obstetrics/gynecology items you listed are recommendations of the Aerospace Medical Association (AsMA) and do not reflect what is federally mandated in EEMKs. While U.S. air carriers may very well carry these items in addition to the EEMK, they are not required to do so. The FAA's complete list of required EEMK items can be found at <www.airweb.faa.gov/Regulatory_and_Guidance_Library/rgFAR.nsf/0/129DB265D2422DEE86256A65006505A2?OpenDocument&Highlight=defibrillators>.

Mark Liao

(Editor's note: *Liao, a paramedic certified by the U.S. National Registry of Emergency Medical Technicians, is right. The story has been corrected so that both the text and ASW's citation of an AsMA journal article note the distinction.)*

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

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

AUG. 18–19 ➤ GA Flight Data Monitoring Conference. Embry-Riddle Aeronautical University, University of North Dakota and CAP Aviation Consulting Group. Daytona Beach, Florida, U.S. Dale Sullivan, <dale.sullivan@erau.edu>, +1 386.226.6849.

AUG. 18–20 ➤ Human Factors in Aviation Maintenance Course. Southern California Safety Institute. San Pedro, California, U.S. Rick Anglemyer, <rick.anglemyer@scsi-inc.com>, <www.scsi-inc.com/HFAM.html>, 800.545.3766, ext. 103; +1 310.517.8844, ext. 103.

AUG. 25–26 ➤ A Practical Approach to Safety Management Systems. Curt Lewis and Associates with Beyond Risk Management. Phoenix. Brendan Kapuscinski, <brml@uniserve.com>, <www.regonline.ca/63382_753183J>, +1 403.804.9745.

AUG. 26–27 ➤ Safety Management System Overview Workshop. ATC Vantage. Denver. <registrations@atcvantage.com>, <www.atcvantage.com>, +1 727.410.4759.

AUG. 27–30 ➤ ARFF Annual Conference. Aircraft Rescue & Firefighting Working Group. Dallas. <info@arffwg.org>, <www.arffwg.org>, +1 817.409.1100.

SEPT. 2–3 ➤ Search and Rescue Summit 2009. *Rotor & Wing*. Reston, Virginia, U.S. Sarah Garwood, <sgarwood@accessintel.com>, <www.aviationtoday.com/sar>, +1 301.340.7136.

SEPT. 2–3 ➤ 21st FAA/ATA International Symposium on Human Factors in Maintenance and Ramp Safety. U.S. Federal Aviation Administration and Air Transport Association of America. San Diego. Sherri Brooks, <sherri.brooks@gmail.com>, <www.airlines.org/operationsandsafety/events/2009hfsymposium.htm>, +1 304.872.5670.

SEPT. 3–4 ➤ Setting Up and Leading a Technical and Safety Committee. International Federation of Air Line Pilots' Associations. Prague, Czech Republic. Gideon Ewers, <gideonewers@ifalpa.org>, <www.ifalpa.org/ifalpa-training.html>, +44 1932 579 041.

SEPT. 5–7 ➤ Accident/Incident Response Preparedness. Austrian Cockpit Association and USC Viterbi School of Engineering. Vienna. <www.aca.or.at>, +43 (0)51766 65799.

SEPT. 7–8 ➤ Safety Management Principles Course. AviAssist Foundation and Zambia Air Services Training Institute. Lusaka, Zambia. Tom Kok, <tom.kok@aviassist.org>, <www.aviassist.org>, +260 (0) 955 711205.

SEPT. 8–10 ➤ Asia Pacific Aviation Training Symposium. Halldale Media. Hong Kong. Jeremy Humphreys, <jeremy@halldale.com>, <www.halldale.com/APATS_AA.aspx>, +44 (0)1252 532009.

SEPT. 8–12 ➤ Aviation Safety Management Systems. Austrian Cockpit Association and USC Viterbi School of Engineering. Vienna. <www.aca.or.at>, +43 (0)51766 65799.

SEPT. 9–11 ➤ Sixth Annual FAA International Aviation Safety Forum. American Association of Airport Executives. Washington. Jacky Sher Raker, <jacky.raker@aaae.org>, <www.aaae.org/meetings/meetings_calendar/mtgdetails.cfm?MtgID=90902&RecID=723>, +1 703.824.0500.

SEPT. 9–25 ➤ Flight Operations Inspector Theory Training. U.K. Civil Aviation Authority. Gatwick Airport. Jenny Ollerhead, <training@caainternational.com>, <www.caainternational.com/site/cms/coursefinder.asp?chapter=134>, +44 (0)1293 573484.

SEPT. 13–15 ➤ Third Annual Aircraft and Airport Recovery Operations Conference and Exposition. American Association of Airport Executives, Memphis-Shelby County Airport Authority and Pavement Performance Products. Memphis, Tennessee, U.S. <aaaemeetings@aaae.org>, <events.aaae.org/sites/090604>, +1 703.824.0500.

SEPT. 14–17 ➤ Bird Strike North America Conference. Bird Strike Committee Canada. Victoria, British Columbia, Canada. Carol Liber, <events@theplanner.net>, <www.birdstrikecanada.com/CanadaConference.htm>, +1 604.276.7471.

SEPT. 14–18 ➤ ISASI 2009: Accident Prevention Beyond Investigations. International Society of Air Safety Investigators. Orlando, Florida, U.S. Sharon Morphew, <sharon.morphew@scsi-inc.com>, <www.isasi2009.org/index.html>.

SEPT. 21–24 ➤ 52nd Annual Non-Destructive Testing Forum . Air Transport Association of America. Atlanta. Mark Lopez, <mlopez@airlines.org>, <www.airlines.org/2009NDTForum>, +1 202.626.4125.

SEPT. 22–23 ➤ HFACS Workshop . Wiegmann, Shappell & Associates. Dallas. Diane Kim, <info@hfacs.com>, <www.hfacs.com>, 800.320.0833.

SEPT. 24–25 ➤ VLJ–Europe 2009. Air Taxi Association-Europe and MIU Events. Oxford, England. Alan Perry, <adp@miuevents>, <www.miuevents.com/vlj-e09>, +44 (0)20 8332 2211.

SEPT. 28–OCT. 1 ➤ 13th Annual Safety Standdown USA. Bombardier, National Business Aviation Association, U.S. Federal Aviation Administration and U.S. National Transportation Safety Board. Wichita, Kansas, U.S. <www.nbaa.org/events/safety-standdown/usa-2009>.

SEPT. 29–OCT. 1 ➤ Third International Helicopter Safety Symposium. International Helicopter Safety Team. Montreal. Somen Chowdhury, <schowdhury@bellhelicopter.textron.com>, +1 450.971.6500, ext. 2787; Kay Brackins, <kay@vtol.org>, +1 703.684.6777; <ihst.rotor.com/Default.aspx?tabid=1507&nnpg2918=1&language=en-US>.

SEPT. 29–OCT. 1 ➤ Wildlife Hazard Management Workshop. Embry-Riddle Aeronautical University. Athens, Greece. <training@erau.edu>, <worldwide.erau.edu/professional/wildlife-hazard-management.html>, +1 386.226.7694.

OCT. 1–2 ➤ Safety Management System Overview Workshop. ATC Vantage. Orlando, Florida, U.S. <registrations@atcvantage.com>, <www.atcvantage.com>, +1 727.410.4759.

OCT. 4–7 ➤ 54th ATCA Annual Conference and Exposition. Air Traffic Control Association. Washington. Claire Rusk, <claire.rusk@atca.org>, <www.memberservicecenter.org/irmweb/wc.dll/vaaleatca?id=vaaleatca&doc=events/event&kn=25>, +1 703.299.2430.

OCT. 30–31 ➤ Conference on International Aviation Liability and Insurance. Montreal. McGill University Institute of Air & Space Law. Mark Glynn, <liabilityconference.iasl@mcgill.ca>, <www.mcgill.ca/iasl>, +1 514.398.5095.

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

If you have a safety-related conference, seminar or meeting, we'll list it. Get the information to us early — we'll keep it on the calendar through the issue dated the month of the event. Send listings to Rick Darby at Flight Safety Foundation, 601 Madison St., Suite 300, Alexandria, VA 22314-1756 USA, or <darby@flightsafety.org>.

Be sure to include a phone number and/or an e-mail address for readers to contact you about the event.

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 1,170 individuals and member organizations in 142 countries.

MemberGuide

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Safety News

Pitot Probe Replacements

The European Aviation Safety Agency (EASA) has proposed requiring operators of Airbus A330s and A340s to replace the airplanes' Thales Avionics pitot probes.

The EASA said, in Proposed Airworthiness Directive (PAD) 09-099, that the action followed reports of "airspeed indication discrepancies" by flight crews of A330s and A340s during flights at high altitudes in inclement weather. Indications are that the crew of an Air France A330 was experiencing such problems before the airplane crashed into the Atlantic Ocean on June 1, 2009, during a flight from Rio de Janeiro, Brazil, to Paris. All 228 people in the airplane were killed. The investigation of the accident is continuing.


Brazilian Navy

A330s and A340s equipped with Thales pitot probes "appear to have a greater susceptibility to adverse environmental conditions" than those equipped with pitot probes manufactured by Goodrich, the EASA said.

"A new Thales pitot probe … has been designed which improves A320 airplane airspeed indication behavior in heavy rain conditions," the agency said. "This same pitot probe standard has been made available as optional installation on A330/A340 airplanes, and although this has shown an improvement over the previous … standard, it has not yet demonstrated the same level of robustness to withstand high-altitude ice crystals as the Goodrich … probe."

The EASA said it would accept comments on the PAD until Sept. 7, 2009. The PAD did not indicate how soon after that a final airworthiness directive would be issued but said that within four months after issuing the final directive, Goodrich pitot probes (part no. 0851HL) must be installed at the captain and standby positions in place of the older Thales pitot probes (part no. C16195AA). Probes at the first officer position also must be replaced, either with the same Goodrich probe or with a new Thales pitot probe (part no. C16195BA).

Obstacle Avoidance

The ground-based Obstacle Collision Avoidance System (OCAS) has been approved by the U.S. Federal Aviation Administration (FAA) as the first audio-visual warning system to be used in U.S. airspace to warn pilots against potential collisions with obstacles.

OCAS Inc. said that its system uses a "low-power ground-based radar" to track an aircraft's proximity to an obstacle such as a power line, tower or wind turbine. The system, which is installed on an obstacle, can detect an aircraft's proximity and track and, if a collision is likely, can warn the pilot with flashing lights and an audible alert. No additional equipment is required to be installed in an aircraft.

Ice Protection

New U.S. certification standards have been adopted to require a more timely activation of ice protection systems on transport category airplanes.

The new standards implemented by the Federal Aviation Administration (FAA) will require new transport aircraft designs to have either automatically activated ice protection systems or a method of alerting pilots to activate them. After their initial activation, the systems must either operate continuously, turn on and off automatically, or alert pilots to cycle them.

The certification change adds "another level of safety to prevent situations where pilots are either completely unaware of ice accumulation or don't think it's significant enough to warrant turning on their ice protection equipment," said FAA Administrator Randy Babbitt.


Ann Mullikin

The rule applies only to designs for new transport category airplanes and to significant changes in current designs that "affect the safety of flight in icing conditions," the FAA said. The agency is considering further rule making that would cover existing airplane designs.

English Training Guidelines

Two international organizations are finalizing guidelines for programs that teach aviation English.

The International Civil Aviation English Association (ICAEA) is working with the International Civil Aviation Organization (ICAO) to develop guidelines that recognize that training in aviation English "has specific objectives, content, criteria of proficiency, conditions of use, and professional and personal stakes which set it apart from the teaching of language in any other area of human activity," ICAO said in the *ICAO Journal* (Volume 64, No. 3).

Until now, there has been "no formal system of accreditation or qualification for schools or teachers developing and delivering aviation English training," ICAO said.

ICAO formally designated English as the language for international pilot-controller communications in 2003 and defined six levels of language proficiency — from "pre-elementary" at Level 1 to "expert" at Level 6. Requirements call for pilots and controllers to demonstrate at least "operational" Level 4 proficiency to be permitted to be involved in international flight operations after March 2011.

The *ICAO Journal* article quoted ICAEA President Philip Shawcross as saying that when the ICAO requirements were introduced in 2003, they "essentially required that an entire new training sector be established in a very short period of time. We began to see materials and techniques being employed that were not necessarily appropriate to the ultimate objective, and so it became an early goal for us not only to provide information and guidance to educators but also to the aviation decision makers

© iStockphoto/Andreas Kaspar

who were having to seek out suitable programs in the training marketplace."

The ICAEA guidelines will emphasize the importance of "plain language in an operational context [as] the prime focus of aviation English training," as well as the need for lesson content that is relevant to the pilot or controller group being trained.

Learjet Design Change Sought

Bombardier should be required to change the design of the thrust lever system in its Learjet 60 in the aftermath of a fatal Sept. 19, 2008, crash, the U.S. National Transportation Safety Board (NTSB) says.

Both pilots and two of the four passengers in the Global Exec Aviation Learjet were killed in the late-night crash, in which the airplane overran the runway during departure from Columbia, South Carolina, U.S.

The NTSB investigation of the accident is continuing, but an examination of the engines found "evidence consistent with high thrust … and indicated that the thrust reversers were stowed." The NTSB said that the findings prompted concern about "safety issues involving inadvertent stowage of the thrust reversers."

Bombardier

"In March 2009, Learjet published a Federal Aviation Administration (FAA)-approved temporary flight manual (TFM) change in procedures, which described improved methods for quickly recognizing and handling situations when inadvertent stowage occurs," the NTSB said. "However, the NTSB is concerned that Learjet 60 pilots are not sufficiently trained to recognize that a failure could occur during takeoff as well as landing phases of flight and could subsequently result in the loss of system logic control requirements for maintaining deployed thrust reversers during a rejected takeoff."

The NTSB issued six safety recommendations to the FAA, including a call for the agency to require the design change "so that the reverse lever positions in the cockpit match the positions of the thrust-reverser mechanisms at the engines when the thrust reversers stow." Another recommendation said the FAA should require training for Learjet 60 pilots "for takeoff as well as landing phases of flight on recognizing an inadvertent thrust reverser stowage, including the possibility that the stowage can occur when the requirements for deploying thrust reversers are not fully met, such as when the air/ground sensor squat switch circuits are damaged."

Hard Landings

Operators should provide more training in procedures for reporting suspected hard landings, the U.K. Civil Aviation Authority (CAA) says in a new flight operations division communication.

The communication was issued as a result of the U.K. Air Accidents Investigation Branch (AAIB) report on the hard landing of an Airbus A321 at Manchester Airport on July 18, 2008.

The AAIB said that the airplane was "not flared sufficiently" and the subsequent landing was "severe hard." Nevertheless, the AAIB said, "the possibility of a landing parameter exceedance was not reported by the crew following discussion with ground engineers who had been on the flight. The presence of a landing parameter exceedance report was identified after a further two sectors had been flown, when an unrelated inspection of the landing gear found a crack in a wing rib gear support lug."

The CAA said that data systems in this particular A321 were not configured to automatically generate exceedance reports; instead, the data management unit (DMU) had to be interrogated manually. The pilots believed that, because the DMU had not produced a report, there had been no hard landing.

The CAA said operators should "provide clear guidance and training to all staff to enable them to correctly report a suspected hard/heavy landing to enable investigation prior to any further operations."

The "primary trigger" for a hard/heavy landing report should be the aircraft commander's subjective evaluation of the event, the report said, adding, "It must be clear to crew and maintenance staff that all suspected hard/heavy landings must be reported before further flight to permit a full investigation and determination of continued airworthiness."

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Wind Farms vs. ATC

Eurocontrol is developing guidelines for the assessment and mitigation of the effects of wind farms on air traffic control surveillance systems.

"Wind turbines can potentially have a detrimental impact on the performance of surveillance systems used for air traffic control," Eurocontrol said. "A wind farm could cause the loss or corruption of the declared aircraft's position, or may create false targets. These create additional work for air traffic controllers and may also result in safety issues."

The proposed guidelines were developed in consultation with civil and military providers of surveillance systems in Europe, with input from Australia, Canada, Japan, New Zealand and the United States.

A comment period will continue through January 2010.

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In Other News …

The International Air Transport Association has signed a memorandum of understanding with **India** to "enhance the skills and knowledge of Indian civil aviation personnel to support the development of Indian aviation." … The Australian **Civil Aviation Safety Authority** (CASA) has begun a campaign to ensure that operators of model aircraft and rockets comply with safety rules that require them to remain away from airports and below 400 ft in controlled airspace, unless they have CASA's approval. The campaign follows an incident involving a model aircraft being flown near the Perth airport.

Compiled and edited by Linda Werfelman.

Keeping It on the Runway

BY RICK DARBY

A new product combines findings and tools developed by the Runway Safety Initiative for reducing runway excursions.

The long, straight pavement lies ahead, waiting to launch an airplane into the sky or welcome it to the ground. A runway is an invitation.

The invitation is accepted, the meeting takes place and nearly always everything goes well. But nothing in takeoffs or landings is guaranteed. When an airplane rolls past the end of the runway — an overrun — or off the side — a veer-off — the runway excursion puts its occupants at risk.[1] James M. Burin, Flight Safety Foundation (FSF) director of technical programs, reported that in 2008 six of the 19 major accidents involving commercial jets worldwide were runway excursions, four occurring on takeoff (*ASW*, 2/09, p. 18).[2]

A new joint product from Flight Safety Foundation and the International Air Transport Association (IATA), the *Runway Excursion Risk Reduction Toolkit*, promises to significantly help operators reduce the risk of runway excursions. The compact disc combines the final report of the FSF Runway Safety Initiative (RSI) and material from IATA. The tool kit is available from the Foundation and IATA; check the FSF Web site for ordering information.

The RSI report, "Reducing the Risk of Runway Excursions," summarizes the findings of two and one-half years of industry effort. The RSI effort brought together disciplines that included aircraft manufacturers, operators, management, pilots, regulators, researchers, airports and air traffic management organizations.

The team initially studied the data on three kinds of runway risk: runway incursions, runway excursions and runway confusion. It found that both incursion and confusion accidents had higher fatality rates than excursions. However, the proportion of excursions

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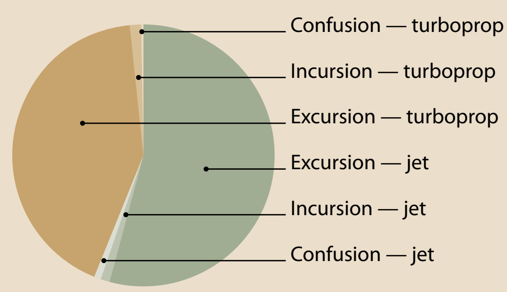
among runway-related accidents far exceeded those for incursion and confusion accidents (Figure 1). As a result, the number of fatal excursion accidents was substantially greater than the number of fatal incursion and confusion accidents (Figure 2). The RSI team decided that it would be most useful to focus its efforts on reducing excursion accidents.

Excursions are little noted in mainstream news media unless they involve fatalities or extensive injuries, or present spectacular photo and video opportunities. Perhaps there is a perception that excursions are not "crashes" but just low-consequence careless driving, the

Proportions of Runway-Related Accidents, 1995–2008

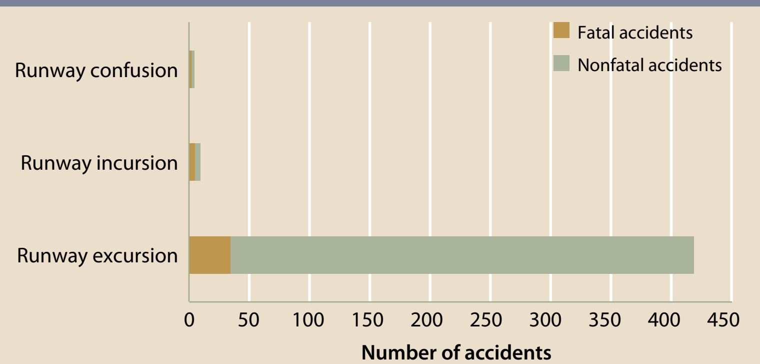


Note: Data represent commercial transport aircraft worldwide.

Source: *Runway Excursion Risk Reduction Toolkit*

Figure 1

Proportions of Fatal and Nonfatal Runway Accidents, 1995–2008



Note: Data represent commercial transport aircraft worldwide.

Source: *Runway Excursion Risk Reduction Toolkit*

Figure 2

aviation equivalent of automobile fender benders. However, every excursion has the potential for serious consequences. From 1995 through 2008, of 417 runway excursions by commercial transport aircraft, 34 involved fatalities and 712 people were killed.[3]

Although no accident can strictly be described as typical, an excursion that occurred on Sept. 19, 2008, gives an idea of what lies behind the statistics. A safety recommendation letter by the U.S. National Transportation Safety Board (NTSB) to the U.S. Federal Aviation Administration (FAA) described the occurrence.[4]

"A Bombardier Learjet 60 … overran Runway 11 while departing Columbia Metropolitan Airport, Columbia, South Carolina," the letter said. "The pilot, copilot and two of the four passengers were killed; the two other passengers were seriously injured. The aircraft was destroyed by postcrash fire. …

"According to witness interviews and the cockpit voice recorder transcript, the beginning of the takeoff roll appeared normal. However, sparks were observed as the airplane traveled along the runway. The airplane continued beyond the runway and through the approximately 1,000-ft [305-m] runway safety area and, beyond that, struck airport lighting, navigation facilities, a perimeter fence and concrete marker posts. The airplane then crossed a roadway and came to rest when it struck an embankment across the road from the airport."[5]

Sifting the Data

The RSI team studied a database of excursions to identify high-risk areas. The entire study, including the study basis, data set and constraints, can be found in a "Report on the Design and Analysis of a Runway Excursion Database," an appendix to the RSI report.

Among the findings were that landing excursions outnumbered takeoff excursions by about four to one; almost two-thirds of the takeoff excursions were overruns; landing excursion overruns and veer-offs occurred at nearly the same rate; and turboprops were involved in the highest percentage of takeoff excursions. In landing excursions, jets were involved in more excursions than turboprops.

The data were analyzed to determine the prevalence of various risk factors associated with takeoff excursions (Figure 3) and landing excursions (Figure 4).

"Multiple risk factors create a synergistic effect."

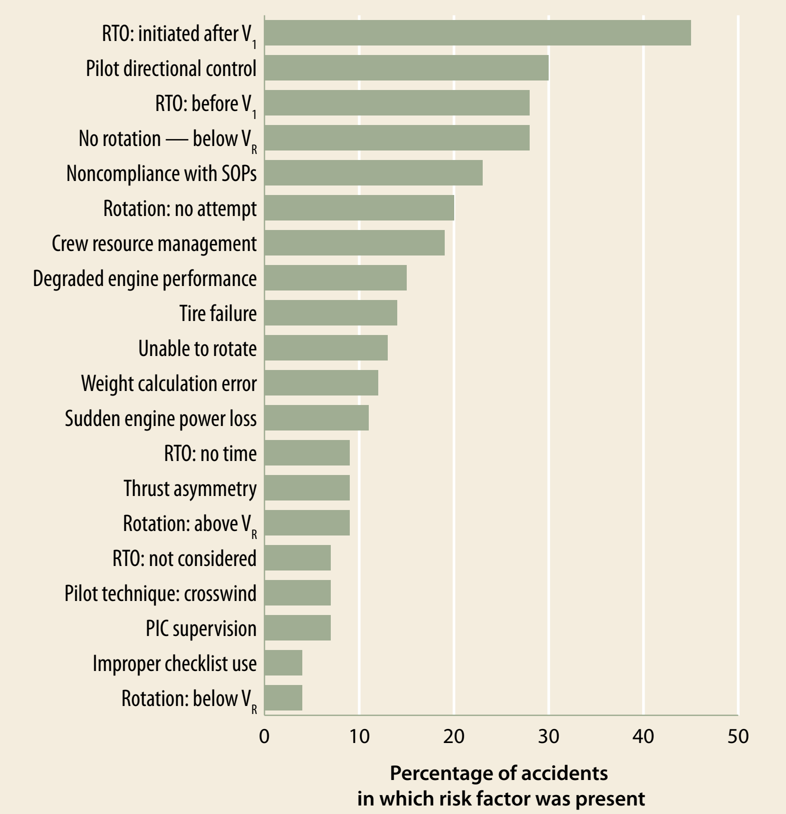
Risk factors were not confined to pilot actions or airplane mechanical problems. The following is a selection from the list — given in full in the RSI report section of the tool kit — of other factors boosting the odds of an excursion:

Air traffic management. Late runway changes during the approach, such as after the final approach fix; failure to provide timely or accurate wind and weather information to the crew; and failure to provide timely or accurate runway condition information to the crew.

Airport. Runways that are not constructed and maintained to maximize effective friction levels and drainage; incorrect or obscured runway markings; failure to allow use of the optimal runways for the prevailing wind; and an inadequate runway end safety area (RESA) or equivalent deceleration system.

Regulators. Lack of a regulatory requirement to give flight crews takeoff and landing data for all runway conditions in a consistent format.

Takeoff Excursion Risk Factors



CRM = crew resource management; PIC = pilot-in-command; RTO = rejected takeoff; SOPs = standard operating procedures

Note: Data represent commercial transport aircraft worldwide. A single excursion could have more than one risk factor.

Source: *Runway Excursion Risk Reduction Toolkit*

Figure 3

Double Trouble

Risk factors for excursions can be compounded. Two, or even more, sometimes coexist in a takeoff or landing.

"Multiple risk factors create a synergistic effect (i.e., two risk factors more than double the risk)," the report says. "Combining the effects of the risk indicators via a proper safety management system (SMS) methodology could effectively identify increased-risk operations."

Risk factors that showed up in the database analysis were cross-tabulated for veer-offs and overruns, both in takeoffs and landings. Four tables in the report show the degrees of interaction among factors.

"The small number of events comprising the takeoff excursions data set — made even smaller when considering only veer-offs — limits our ability to know whether differences in the tabulated values are significant," the report says. "However, it is interesting to note where there are associations of factors that may warrant further, more detailed study. For instance, aborts [rejected takeoffs] at or below V_1 often still resulted in a veer-off when there was an engine power loss, a runway contaminant or a crosswind. There is also some indication that the increased risks created by crosswinds and tail winds are magnified when gusts, turbulence or wind shear is present."

In the table showing takeoff overrun factor interactions, "the numbers in these data suggest that there might be interesting associations between engine power loss and aborts initiated above V_1, as well as an association between these high-speed aborts and the presence of runway contaminants," the report says.

Observations about risk interactions for landing excursion veer-offs and landing excursion overruns were based on a larger sample. The cross-tabulations showed that "the landing excursion data have some strong associations between pairs of factors," the report says. "For instance, … for veer-offs, the factor(s) 'touchdown long/fast' have little association with the other listed factors. However, … 'touchdown hard/bounce,' shows strong associations with many of the other factors."

Adopting Mitigations

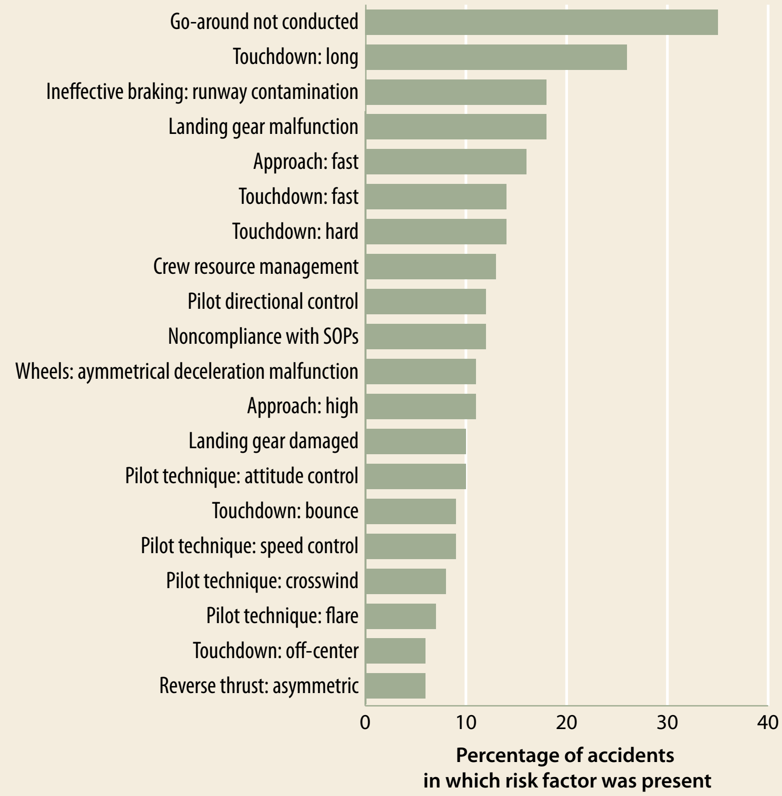
Following the descriptions of the research findings, the report delivers its payload: recommended mitigations. The prevention strategies embrace five stakeholder groups: flight operations, air traffic management, airport operators, aircraft manufacturers and regulators.

Here are samples, from an extensive list, in each category:

Flight operations. "Operators should define criteria that require a go-around"; "Operators should define and train the execution of the RTO [rejected takeoff] decision."

Airport operators. "Define criteria to determine when to close a runway to prevent runway

Landing Excursion Risk Factors



SOPs = standard operating procedures

Note: Data represent commercial transport aircraft worldwide. A single excursion could have more than one risk factor.

Source: *Runway Excursion Risk Reduction Toolkit*

Figure 4

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A Bangkok Airways ATR 72 skidded off the runway while landing in heavy rain on Aug. 5, 2009. The captain was killed and 11 occupants were injured.

excursions"; "Ensure that runways are constructed and maintained to ICAO [International Civil Aviation Organization] specifications, so that effective friction levels and drainage are achieved (e.g., runway grooving, porous friction overlay)."

Air traffic management. "Ensure all ATC/ATM [air traffic control/air traffic management] personnel understand the concept and benefits of a stabilized approach"; "Encourage joint familiarization programs between ATC/ATM personnel and pilots."

Regulators. "Develop a policy to standardize takeoff and landing data format as a function of runway condition."

Aircraft manufacturers. **"**Manufacturers should provide appropriate operational and performance information to operators that account for the spectrum of runway conditions they might experience."

The RSI report, "Reducing the Risk of Runway Excursions," describes the seriousness of the problem; the causal factors involved, distinguishing between overruns and veer-offs, and between takeoff excursions and landing excursions; the data through which the conclusions were reached; and detailed discussion of mitigations, conclusions and recommendations of the RSI team.

Appendix I is the FSF *Runway Excursion Risk Awareness Tool* (RERAT). Similar in principle to the FSF *Approach and Landing Risk Awareness Tool* (RAT), the RERAT lists factors that contribute to excursion risk on any given flight: for example, "No current/accurate weather/runway condition information," "High crosswinds/gusty winds" and "Nonprecision approach, especially with multiple step-downs."

The factors are categorized by headings such as "Flight Crew," "Airport" and "Environment." Warning symbols indicate the degree of risk severity for each factor. "Elements of this tool should be integrated, as appropriate, with the standard approach and departure briefings to improve awareness of factors that can increase the risk of a runway excursion," the RERAT says.

"Runway Excursion Risk Reduction Strategies" are included in a condensed format so that the RERAT can be used as a stand-alone tool when appropriate. The document includes the recommended elements of a stabilized approach, which are discussed in detail in the RSI report.

Briefing Notes

Appendix II of the RSI report consists of "Approach and Landing Briefing Notes" from the FSF *Approach and Landing Accident Reduction Tool Kit*, plus two new briefing notes from the RSI: "Pilot Braking Action Reports" and "Runway Condition Reporting."

The briefing notes summarize, thoroughly but concisely, the important points for topics, which are subdivided under broader headings including "Crew Coordination," "Altimeter and Altitude," "Descent and Approach," "Approach Hazards Awareness," "The Go-Around," "Approach Techniques" and "Landing Techniques."

Most of the briefing notes include summaries, references, further reading from FSF publications, and regulatory resources.

Appendix III is "Report on the Design and Analysis of a Runway Excursions Database," a detailed explanation of the database of runway excursion accidents from 1995 through March 2008, which formed the basis for the RSI report. Readers seeking to understand the methodology used to create the database and read an analysis of data in greater depth than the report provides will find this section of interest.

This appendix puts excursion risk factors under the microscope, dealing with specifics such as "wheel factors." It was found, for example, that "tire failures are often a consequence of rejected takeoffs, but 13 of the 16 'tire failure' citations in this field occurred during the takeoff roll and motivated the takeoff abort. The other three occurred during the abort process and contributed to the aircraft departing the runways."

Appendix IV, "Selected Flight Safety Foundation Publications," includes articles — mainly published in the past four years — bearing on the subject. They are all available on the Web site <www.flightsafety.org>.

An appendix titled "Additional Resources" includes reports from the Australian Transport Safety Bureau, the FAA and the Direction Générale de l'Aviation Civile, France.

The IATA contributions to the *Runway Excursion Risk Reduction Toolkit* include a "Video Introduction" in a Microsoft Windows media video (.wmv) file; an "Executive Introduction"; a "CEO and COO Brief"; "Preventing Runway Excursions"; "Preventing Runway Excursions, Pilots' Training Kit"; and "Air Carrier Self-Audit Checklist."

Additional supporting material from IATA comprises "ANSP [air navigation service provider] Roles in Runway Excursion Prevention"; "Engineered Materials Arresting System (EMAS)"; three files of runway excursion accident data from 2004 to 2008; a Boeing Co. document, "Runway Condition Reporting"; an Air France publication, "Runway Excursion Prevention"; "Technological Aids to Support the Runway Safety Initiative"; "Measure Runway Braking Conditions"; and several other documents.

From Deliberation to Product

"We knew we were going to concentrate on runway safety, but deciding to focus on runway excursions actually took a few meetings of deliberation by the team members," said Glenn Michael of the FAA, who was involved in the Runway Safety Initiative from its beginning. "Once the decision was made to work on excursions, the team was divided into functional groups to address specific causal factors of runway excursions. Mitigation strategies were then constructed to address risks associated with runway excursions."

Rob van Eekeren, a captain representing the International Federation of Air Line Pilots' Associations, recalled, "The process involved industry partners as well as international organizations, all with their own interests and agendas. Four meetings per year were scheduled with a two-year time frame. It proved to be an interesting challenge to get everybody focused on a common goal. This goal could not be and was not reached in one meeting alone. In fact, it took almost 18 months."

It was agreed to work along a data-driven approach. "Although in potential a lot of data were available — a runway excursion is always an incident and thus recorded — it had never been compiled in the runway safety field," van Eekeren said. "So the Foundation contracted with a data specialist. During the two-year process, more and more data became available. Another advantage was that these data could be used as a baseline so that the effects of future improvements could be checked.

"So during the whole process, the complete picture became more clear and at a point it was decided to leave the original, purely briefing note, format and switch to a more systematic approach. Detailed point-by-point discussions amongst the team members resulted in subgroup proposals which in turn were discussed in plenary sessions with the other groups."

The group studying approach risk factors had a head start because of the work that had been done in connection with the FSF *ALAR Tool Kit*. The runway group was faced with a "zillion years of history," as van Eekeren put it, on braking action problems. The airport study group started from ICAO Annex 14 recommendations for airport design.

"The challenge now was to go beyond existing material and produce new ideas and initiatives which could make a difference," van Eekeren said. "That takes time. The representatives also had to address their normal day-to-day jobs, and only as an RSI meeting approached was there significant activity. Even a special Web-based page created by the Foundation for communicating and posting ideas could not overcome this. It must be said, however, that inside each organization the subject of runway excursions became prominent in its own right. The allotted time limit was pressing and a leap forward was achieved during the last formal meeting in Brussels in 2009. A final meeting at the FSF office brought the final result."

Glenn Michael said, "This was an outstanding group of experts to work with and once we defined our goal, Jim Burin and [FSF Fellow] Earl Weener kept us on track and were fantastic at facilitating the overall process. This was a wonderful project to work on, and I am convinced that it will assist in runway safety efforts worldwide."

"It is not perfect and my feeling is that more innovation could have been realized," van Eeekeren said. "I'm sure my fellow RSI team members will share this feeling. Sometimes compromises are required to reach a result. Nevertheless, the RSI team was successful in identifying key areas and finding solutions for given problem areas. The Foundation did an outstanding job in raising worldwide awareness for runway excursions.

"I daresay that the awareness has reached the critical point, meaning that it is in so many heads now that runway safety will be addressed almost as a self-propelling process. This will undoubtedly lead to a process where we will see a reduction in the runway safety risk in the next five to 10 years. However, since there is no global coordination point or globally accepted plan, it might be expected that some runway safety measures will be done with the best intentions, but will fail. Others might prove highly successful."

Notes

1. The FSF Runway Safety Initiative defined a runway excursion as "when an aircraft on the runway surface departs the end or the side of the runway surface. Runway excursions can occur on takeoff or landing."
2. A major accident, which Flight Safety Foundation believes is the primary accident criterion for safety purposes, is defined as an accident that meets any of three conditions: First, the aircraft is destroyed or sustains major damage; second, there are multiple fatalities; third, there is one fatality and the aircraft is substantially damaged.
3. "Reducing the Risk of Runway Excursions," from the *Runway Excursion Risk Reduction Toolkit.*
4. NTSB. July 17, 2009. Available via the Internet at <www.ntsb.gov/recs/letters/2009/A09_55_60.pdf>.
5. The accident is still under investigation, but the NTSB's preliminary findings suggested inadvertent stowage of the thrust reversers and prompted a concern that "Learjet 60 pilots are not sufficiently trained to recognize that a failure could occur during takeoff as well as landing phases of flight and could subsequently result in the loss of [thrust reverser] system logic control requirements for maintaining deployed thrust reversers during a rejected takeoff."

BY LOUKIA D. LOUKOPOULOS, R. KEY DISMUKES AND IMMANUEL BARSHI

As we started the taxi, I called for the taxi checklist but became confused about the route and queried the first officer to help me clear up the discrepancy. We discussed the route and continued the taxi. … We were cleared for takeoff from Runway 1, but the flight attendant call chime wasn't working. I had called for the 'Before Takeoff' checklist, but this was interrupted by the communications glitch. After affirming the flight attendants were ready, we verbally confirmed the 'Before Takeoff' checklist. On takeoff, rotation and liftoff were sluggish. At 100–150 ft, as I continued to rotate, we got the stick shaker. The first officer noticed the no-flap condition and placed the flaps to 5. … We wrote up the takeoff configuration warning horn but found the circuit breaker popped at the gate.[1]

Is this an example of recklessness? Complacency? Absent-mindedness? Complex operating conditions? Complicated operating procedures? Insufficient crew experience? Or something as subtle as multitasking?

During another flight, in February 2009, a crew rejected their takeoff from Birmingham (England) International Airport at 155 kt after finding it impossible to rotate the aircraft. The investigation revealed that "a number of distractions, combined with unusual demands imposed by the poor weather, led to a breakdown of normal procedures and also allowed a missed action [stabilizer trim set for takeoff] to go unchecked."[2]

Are these incidents exceptions to usual practice or symptoms of widerspread vulnerability? What do they say about the progress of an industry that has suffered at least three catastrophic accidents when a takeoff configuration

The Perils of Multitasking

Pilots overestimate their abilities, as well as the benefits of doing several things at once.

© Chris Sorensen Photography

warning system failed to alert the crew that they were attempting to take off without having set the flaps?[3,4,5]

In reviewing categories of accidents for 2008 — spurred in part by the fatal Aug. 20 crash of a Spanair McDonnell Douglas MD-82 during an attempted takeoff from Madrid, apparently with improperly set flaps, according to preliminary reports[6] — Flight Safety Foundation decried the "unwelcome return of the no-flaps takeoff" and concluded that "we are not making much progress in reducing the risk of these [types of loss of control] high-fatality accidents" (*ASW*, 02/09, p. 18).

A quick search of the U.S. National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS) database reveals more than 50 reports of attempted no-flaps takeoffs in the last decade, as well as reports of incorrectly set trim, airspeed and heading bugs; cockpit windows not latched; and other omissions. In many of these events, the crew was saved by the proverbial bell — a takeoff configuration warning horn. That bell cannot be relied on to always work, however.

What leaves expert, conscientious pilots — and their passengers — hanging by the thread of a last line of defense, such as a warning horn or a checklist?

Articles abound in the daily news about a multitasking society and the dangers inherent in our natural drive to have more than one thing going on at once.[7,8,9,10] Most people know they should not talk on their cell phone while driving, although many do it anyway.[11,12] But what does multitasking have to do with pilots on an airline flight deck?

Complex Operations

In 2000, we embarked on a research project sponsored by NASA and the U.S. Federal Aviation Administration (FAA) to characterize the nature and demands of routine flight operations. Preliminary findings[13] raised red flags for an industry that, like many others, had unsuspectingly accepted multitasking as a normal state of affairs.

We argued that commercial and public pressures, organizational and social demands, and the increase in air traffic, mixed with a healthy dose of pilots' overestimation of their own abilities, were creating situations that were considered routine, although they concealed appreciable risk.

Our research at the Flight Cognition Laboratory at NASA's Ames Research Center in California is based on a combination of methodologies that through the years have included laboratory experiments, structured interviews and surveys, in-depth analyses of flight manuals, participation and observation of ground and flight training, incident and accident report analyses, and many hours of cockpit jump seat observations during passenger-carrying operations. Taking advantage of these sources of data, we systematically analyzed and contrasted cockpit operations in theory and in reality.[14]

Take any carrier's flight operations manual (FOM) and draw out the flow of activities required of each pilot from moment to moment while the aircraft is taxied from the gate to the runway for takeoff, and you will see the theoretical, "ideal" taxi phase of flight (Figure 1, p. 20).

The crew's activities can be traced from the moment the captain requests that the first officer obtain taxi clearance until the aircraft is lined up with the runway centerline, ready for takeoff. There are a number of procedures that pilots conduct individually, two checklists conducted by pilots together, monitoring requirements and other pieces of information from external sources. In the ideal world, everything occurs at specific, predictable moments as the taxi phase of flight unfolds.

This is the way activities are laid out in the manuals, the way cockpit tasks are taught in training, and the way pilots are expected to perform, on the line. The activity-tracing exercise can be repeated for every phase of flight, and in each case, the ideal perspective portrays crew activities as linear, or following a prescribed sequence; predictable; and under the moment-to-moment control of the crew.

The real world is not as straightforward. Observation of flight crews, from the vantage point of the cockpit jump seat, helps us understand the full ramifications of that. During our observations, we recorded every event that caused some perturbation — or disruption — of the ideal sequence of activities of the two pilots. It did not take long to realize that the real operational world is more complex and more dynamic than represented in writing and in training.

Let's look at the taxi phase of flight in more detail, as it often unfolds in the real operating environment. The base layer (grayed-out and in the background of Figure 2, p. 21) is the ideal representation depicted in Figure 1. Another layer has been added, formed by some of the many disruptions that were observed from the jump seat during routine flights. Ovals contain some of the possible, additional demands that are not explicitly expressed in the FOMs.

The disruptions listed in each oval carried additional task demands for attention and action. Ice or snow on the ground meant that the captain deferred calling for flaps prior to taxi to avoid contaminating the wing surfaces with slush, continued with other taxi activities, performed the taxi checklist calling for verification of the flaps setting, and remembered to set the flaps right before takeoff. Encountering a busy frequency meant that the first officer had to continue monitoring all radio calls in order to "jump in" when the frequency became available, all while monitoring the captain, maintaining situational awareness and carrying out other pre-taxi preparations.

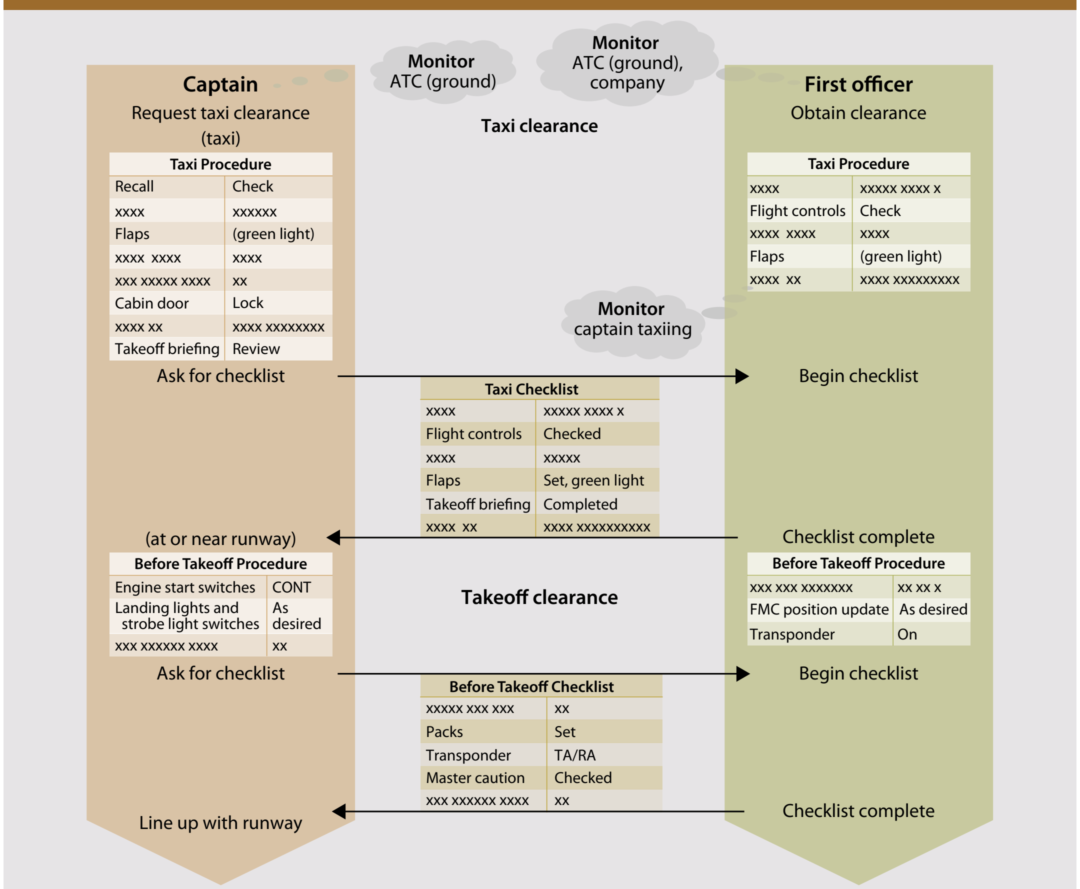
Again, the exercise can be repeated for each phase of flight. The resulting "real" picture reveals activities that are much more fluid, convoluted and variable than in theory: Activities are dynamic and not so linear, are unpredictable, and are not fully under the control of the pilots. Pilots are routinely forced to deviate from their linear, well-practiced and habitual execution of procedures. Neither the nature nor the timing of tasks and events can be anticipated with certainty. Essential information and/or the individuals required to perform some activities are not always available when expected. Tasks often must be initiated earlier or later than planned. Pilots must continually find ways to fit more than the "ideal" activities into the allotted time.

One implication of the real picture is that there is considerably more work than the ideal perspective suggests. But it is not just a question of workload quantity. It is also a question of workload management. Responding to the multiple, concurrent demands of flight operations requires interweaving new activities with old ones, deferring or suspending some tasks while performing others, responding to unexpected interruptions and delays and unpredictable demands imposed by external agents — all while monitoring everything that is going on. This is multitasking in a pilot's world.

Limitations

People often feel they are perfectly capable of performing several tasks simultaneously. There seems to be a popular myth that humans are good multitaskers. In reality, however, human ability to process more than one stream of information at a time and respond accordingly is severely limited. Truly simultaneous performance is possible only when tasks are highly practiced and rehearsed extensively together. Performance in this situation becomes largely automatic, making few demands on the brain's limited capacities for

'Ideal' Taxi Phase of Flight[1]



ATC = air traffic control; CONT = continuous; FMC = flight management computer; TA/RA = traffic advisory/resolution advisory

1. The 'ideal' phase represents that described in a flight operations manual.

Source: Loukopoulos, L.D.; Dismukes, R.K.; Barshi, I. *The Multitasking Myth: Handling Complexity in Real-World Operations*. Burlington, Vermont, U.S.: Ashgate Publishing Co. 2009.

Figure 1

attention and working memory. But when an individual tries multitasking in a situation that involves novel tasks, complex decision making, monitoring, or overriding habits, it all falls apart.

In principle, pilots, like all people, have limited choices when called to multitask: They can interweave steps of one task with steps of other tasks, or defer one task until the other task is completed, or even purposefully omit one task. The choice and the degree to which any of these proves successful depend on the interaction of the characteristics of the tasks being performed, human information processing attributes, and the experience, skill and goals of the individual — always within the context of prevailing standard operating procedures and operational restrictions. However, the approach people take to multitasking demands is not necessarily deliberate or well thought out.

During our observations, we spent many hours watching pilots handle routine multitasking situations, apparently without much effort or many errors — but we became increasingly uneasy with the risks they were unknowingly accepting each time they were called to react in ad hoc, inventive ways. Too many of these seemingly benign situations bore a striking resemblance to stories recounted by pilots in incident reports or that we read about in accident reports.[15]

For example, the crew cited in the first paragraph of this article received a stick shaker warning after rotation and realized they had inadvertently omitted setting the flaps to the takeoff position. This crew had been multitasking, attempting to concurrently address a discrepancy in their route and an inoperative call chime.

The crew in the Birmingham event rejected their takeoff, after finding it impossible to rotate the aircraft, because they had inadvertently omitted setting the stabilizer trim for takeoff. This crew was also multitasking: They had to deice the aircraft, were preoccupied by the weather conditions, were trying to meet a takeoff time constraint, and were focused on remembering (which they did) to set the flaps, which they had deferred earlier because of the slushy conditions.

The Madrid accident apparently resulted from the crew's inadvertent omission of setting the flaps for takeoff, coupled with the failure of the takeoff configuration warning system. Was this crew also multitasking? There

'Real'[1] Taxi Phase of Flight

APU = auxiliary power unit

1. The 'real' phase represents the findings of jump seat observers.

Source: Loukopoulos, L.D.; Dismukes, R.K.; Barshi, I. *The Multitasking Myth: Handling Complexity in Real-World Operations*. Burlington, Vermont, U.S.: Ashgate Publishing Co. 2009.

Figure 2

are indications that the crew was distracted by an overheating probe, and had to return to the gate for maintenance, receive additional fuel, and start the engines anew.

Our research has focused on key aspects of human cognition that lie at the heart of multitasking, namely remembering to perform tasks that must be deferred (prospective memory), automatic processing and switching attention between tasks. There is considerable scientific evidence that pilots, like all people, are highly vulnerable to inadvertent but potentially deadly omissions when a situation leads them to defer a task that normally is performed at a particular time and place. Deferring a task breaks up the normal sequence of habitual actions and removes environmental cues that help pilots remember what to do next.

Interruptions create especially dangerous prospective memory situations — by requiring pilots to remember to resume the deferred, interrupted task — but are so commonplace that pilots may not recognize the threat. Interruptions typically disrupt the chain of procedure execution so abruptly that pilots turn immediately to the source of interruption without noting the point where the procedure was suspended, without forming an explicit intention to resume the suspended procedure, or without creating salient cues to remind themselves to resume the interrupted task. Certain phases of flight such as taxi-out and approach are often so busy that it is extremely difficult for pilots to pause long enough to review whether they have completed deferred or interrupted tasks.

Pilots also are highly vulnerable to errors of omission when they must attempt to interweave two or more tasks — performing a few steps of a task such as flight management system (FMS) data entry, switching attention to another task such as monitoring taxi progress, back and forth. Much of the time pilots can interweave tasks without problems, but if one task becomes demanding— the FMS does not accept the input, for example — their attention is absorbed by these demands, and they forget to switch attention to other tasks. Monitoring, a crucial defense against threats and errors, often falls by the wayside when pilots must interweave it with demanding tasks. In fact, monitoring is far more difficult to maintain consistently than most pilots realize, as evidenced by studies of automation monitoring.[16,17]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A crane lifts the wreckage of a Spanair McDonnell Douglas MD-82 that crashed in August 2008 during takeoff from Madrid.

Dispelling the Myth

There is no single best technique to manage the challenges posed by multitasking in flight operations, but we have suggested various things that pilots and organizations can do.[18] First, we must dispel the myth that multitasking comes easily to humans, especially to pilots with "the right stuff." We must help pilots recognize typical multitasking situations that create vulnerability to error even in the most routine aspects of operations. Organizations must take a close look at the difference between the ideal perspective and the real nature of actual flight operations and adjust procedures, training and expectations accordingly.

Fortunately, both individual pilots and organizations can reduce the peril of multitasking. Pilots can treat interruptions, suspending tasks, deferring tasks or performing tasks out of normal sequence as red flags. When interrupted, they can reduce vulnerability by pausing momentarily to mentally note the point at which the procedure is interrupted and by reminding themselves to return to that place later, before addressing the interruption. When suspending or deferring tasks, they can identify when and where they intend to perform the task; create salient reminder cues, such as putting an empty coffee cup over the throttles when they have deferred setting the flaps to their takeoff position; and ask the other pilot to help remember. When forced to interweave tasks, such as monitoring and data entry, pilots can bolster their implicit intention to not stay head-down too long by explicitly noting to themselves the need to perform only a few steps of the one task before checking the status of the other task.

At the organizational level, we were greatly encouraged when one of the air carriers participating in our research, inspired by our preliminary findings, undertook a comprehensive review of all normal cockpit procedures. After months of analysis, that carrier's review committee devised procedural modifications to reduce multitasking demands in daily operations and to help crew performance become resilient in the face of inevitable disruptions of the ideal flow of procedure execution. The revised procedures demonstrated substantial decrease in error rates.

Although the risks of multitasking have been widely underestimated by both individual pilots and flight organizations, we are confident that by taking decisive action, the industry can make substantial progress in protecting pilots from these risks and reducing the types of accidents that have been associated with them.

For more information and to download relevant presentations and publications, visit <human-factors.arc.nasa.gov/flightcognition>.

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R. Key Dismukes is the chief scientist for aerospace human factors at the Human-System Integration Division at NASA Ames Research Center.

Immanuel Barshi is a research psychologist at the Human-System Integration Division at NASA Ames Research Center.

Their book, The Multitasking Myth*, was reviewed in* ASW *in April 2009, on p. 53.*

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Thinking Outside THE (BLACK) BOX

Industry specialists are examining alternatives to the traditional method of delivering data that crash investigators need.

BY LINDA WERFELMAN

The fruitless search for the flight recorders from the Air France Airbus A330 that crashed into the Atlantic Ocean on June 1 has stirred new interest in the development of alternate methods of delivering vital black box data to accident investigators.[1]

One alternative — the deployable flight incident recorder — has been in use for decades on military aircraft; the future of a second alternative — transmission of flight data to a ground station — is intertwined with technological advances that are improving computer data transmission between air and ground.

"Both ideas have advantages and disadvantages that must be carefully evaluated," said Sandy Angers, a spokeswoman for Boeing Commercial Airplanes.

In almost all crashes, the flight data recorder (FDR) and cockpit voice recorder (CVR) are recovered without much difficulty. But on some occasions, as in the case of the Air France A330 and a Yemenia Airways A310 that crashed in the Indian Ocean on June 30, 2009,[2] the search has gone on for weeks or months — continuing even after the end of the 30-day period in which underwater locator beacons, or "pingers," transmit signals to alert searchers to the location of the boxes.

Historically, most accidents in which flight recorders have been pronounced "not recoverable" have not been in water but rather in "unusually inhospitable terrain, such as mountaintops," Angers said.

Years ago, recorders sometimes were so badly damaged by post-impact fire or by water that some of their information was irretrievable. In recent years, however, as solid-state digital media have replaced tapes, this has happened less frequently, said James Cash, the U.S. National Transportation Safety Board's (NTSB's) chief technical adviser for recorders.

"If anything, it's fire that did the recorders in," Cash said. "We've never lost one because of impact damage, but … older, tape-based units were more easily damaged by fire."

Closer Look

Current standards call for large commercial airplanes to be equipped with an FDR and a CVR installed separately — not in a single combined unit.

In the aftermath of the Air France crash, however, some in the industry pressed for a closer look at other methods of collecting flight data and of recovering the information in the event of a crash.

The deployable flight recorder (Figure 1, p. 26) was developed in response to a suggestion made in the 1960s by the National Research Council of Canada, which expressed concerns about locating aircraft that crashed in remote areas and proposed "some form of detachable and automatically

A deployable flight recorder — which incorporates a flight data recorder, cockpit voice recorder and emergency locator transmitter — is automatically ejected when sensors detect that the aircraft is crashing.

activated ELT [emergency locator transmitter] system."[3]

Deployable recorders were developed and have evolved into combined FDR/CVR units that incorporate an ELT. Such units have been installed for 25 years in military aircraft and in helicopters used in North Sea energy exploration. In that time, about 110 military aircraft equipped with deployable recorders have crashed, and all 110 recorders have been recovered for use by accident investigators, said Peter Connolly, vice president and general manager of DRS Technologies, which manufactures the devices.

The recorders are housed in an airfoil unit that is automatically ejected when on-board sensors determine that the aircraft is crashing.

"That's the smart part — it goes away from the crash," Connolly said.

The deployable recorder's ELT immediately transmits the aircraft identification number and its longitude and latitude to the Cospas-Sarsat Programme, the international network that coordinates the detection of distress signals. If the aircraft crashes in water, the airfoil unit floats.

Connolly noted that the concept of installing deployable flight recorders in commercial aircraft had been the subject of considerable discussion after the July 16, 1996, crash of a Trans World Airlines 747 into the Atlantic Ocean minutes after takeoff from Kennedy International Airport in New York.[4]

Three years later, P. Robert Austin, a DRS senior systems engineer, told an international transportation recorder symposium that proposals to modify flight recorder standards by requiring the installation of dual combined recorder systems in commercial transport aircraft should include a provision that one of the systems be a deployable FDR/CVR recorder.[5]

"The standards for the fixed and deployable components of the system should be compatible to optimize the probability of recovery of recorder information from one of the two systems under any conceivable crash scenario," Austin said.

Boeing's experience with deployable flight recorders on military 707s identified several issues requiring further consideration, Angers said, such as how to prevent a recorder from being ejected into the ground if the airplane is in a vertical attitude, how to avoid injuring anyone on the ground when a recorder deploys and how to avoid accidental deployment.

Even if deployable recorders are installed in an aircraft, Boeing's position is that the aircraft also must be equipped with standard, fixed recorders.

Michael Poole, chairman of the International Society of Air Safety

Investigators (ISASI) working group on flight recorders, agreed.

Poole, a former member of the Transportation Safety Board of Canada, said that he would encourage the use of deployable recorders — but only if the deployable unit was installed in an airplane that also was equipped with a traditional fixed recorder.

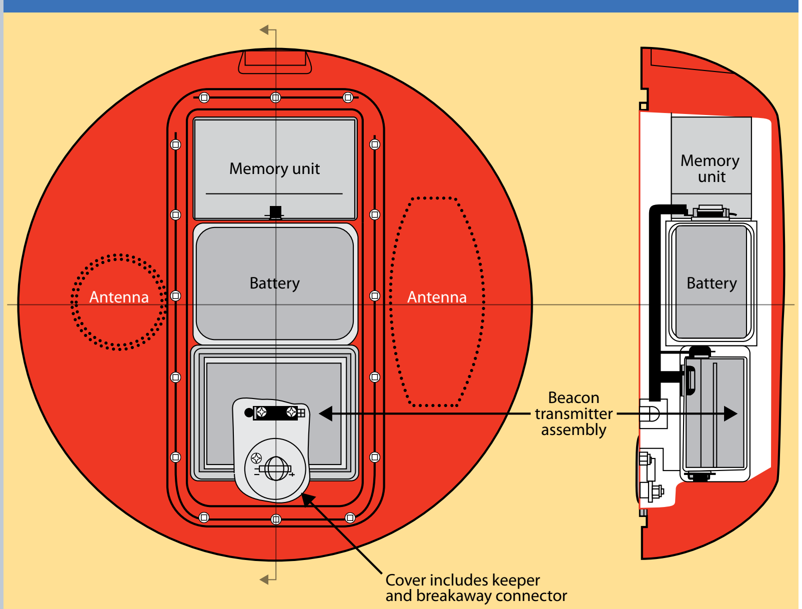
Poole noted the higher cost of installation and maintenance of deployable recorders, in comparison with standard, fixed recorders, and said he could foresee events — such as some types of runway overrun accidents — in which deployable recorders might fail to deploy away from the crash scene.

Manufacturer Initiatives

Both Airbus and Boeing have been examining the use not only of deployable recorders but also of other alternative technologies for collecting flight data.

Soon after the Air France crash, Airbus said it had begun a study to "reinforce flight data recovery capability," including an examination of the feasibility of extended data transmission.[6]

Deployable Flight Recorder



Source: DRS Technologies

Figure 1

"Various technical means for reinforcing flight data recovery and data transmission to ground centers are principally available," said Airbus President and CEO Tom Enders. "We will now study different options for viable commercial solutions, including those where our experience with real-time data transmission from our own test aircraft could support the further development of such solutions."

Airbus said that retrieving flight recorder data after an accident is a challenge for the aviation industry, in part because the air-to-ground data links used by aircraft communications addressing and reporting systems (ACARS) to transmit maintenance data "do not offer the bandwidth that would be needed for a fully real-time transmission of all the data stored in the [digital] FDR and CVR."

Angers said that Boeing recognizes similar difficulties.

"Although real-time data streaming is possible, an enormous amount of data is collected by flight data recorders," she said. "Current regulations require FDRs to record a minimum of 88 parameter groups. To meet this requirement, all current production airplanes record more than 1,000 individual parameters. Also, consider the fact that there are tens of thousands of commercial transport jets flying today. The current satellite system and ground architecture would be unable to support a large number of airplanes continuously streaming data."

Poole added that if CVR data were transmitted along with FDR information, bandwidth requirements would be even greater.

In addition, in some situations, especially those involving aircraft in unusual attitudes, it could be difficult, if not impossible, to maintain a constant link between an aircraft and a satellite, he said. Satellite transmissions also are affected by bad weather, and if a satellite went out of service for any reason, data would be lost, he added.

Other issues include where data would be stored, who would have access to it, how it would be maintained and by whom, and how to protect the privacy of pilots whose communications would be included in data transmissions.

"The concept sounds really elegant," Poole said. "But there are a lot of impediments."

Poole said that, although he does not believe the constant transmission of data from all large commercial airplanes can replace flight recorders, he would encourage the industry to implement a system that would allow satellite transmission of data from "an airplane in distress." In these situations, data transmission might be triggered by a pilot's "mayday" call, or by some on-board conditions that indicated the airplane was experiencing difficulty — as was the case for the Air France A330 through ACARS messages — or by some other action by the crew or air traffic control.

"You don't need all that bandwidth being used up with constant data transmissions, but with any airplane in distress, it's not a bad idea to send the data real-time going forward and transmit the recorded data back in time," Poole said.

Nevertheless, the NTSB's Cash said that the eventual alternative to the traditional black box most likely would involve some method of real-time data transmission, perhaps an event-triggered transmission of data to a ground station.

"Data link is going to get more attention," Cash said, noting the technological developments in recent years that have provided passengers with Internet access. "Airplanes already are being equipped with the hardware."

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Workers in Recife, Brazil, unload debris from an Air France A330 that crashed into the Atlantic Ocean during a flight from Rio de Janeiro to Paris on June 1. The airplane's flight recorders have not been located.

Notes

1. The second phase of the search for the A330's flight recorders ended in late August. At press time, the French Bureau d'Enquêtes et d'Analyses (BEA) was considering organizing a third search phase. The airplane crashed during a flight from Rio de Janeiro, Brazil, to Paris. All 228 passengers and crew were killed. The investigation of the accident is continuing.
2. Aviation Safety Network. *Accident Description*. < http://aviation-safety.net/database/record.php?id=20090630-0>. The Yemenia Airways A310-300 crashed off the coast of the Comoros Islands during an approach to the Mitsamiouli airport after a flight from Yemen. All but one of the 153 people in the airplane were killed. The wreckage sank in waters up to 4,000 ft deep, and at press time, news reports said that the airplane's flight recorders had been located but not recovered.
3. Austin, P. Robert. "The Use of Deployable Flight Recorders in Dual Combi Recorder Installations." Presentation to the International Symposium on Transportation Recorders, Arlington, Virginia, U.S. May 3–5, 1999.
4. The NTSB said the probable cause of the accident was "an explosion of the center wing fuel tank resulting from ignition of the flammable fuel/air mixture in the tank." The explosion probably was caused by a short circuit outside the tank that "allowed excessive voltage to enter it through electrical wiring associated with the fuel quantity indication system," the report said. The FDR and CVR were recovered one week after the crash by U.S. Navy divers.
5. Austin.
6. Airbus. *Airbus Launches Initiative to Reinforce Flight Data Recovery Capability*. July 2, 2009.

BY MARK LACAGNINA

The 737 stalled after the autothrottles disengaged without notice.

IDLE

Neither pilot was aware that the autothrottle system had disengaged with the thrust levers at idle during an instrument landing system (ILS) approach to Bournemouth (Hampshire, England) Airport. The Boeing 737-300 initially decelerated according to the flight crew's expectations. However, after final flap extension, the commander noticed that indicated airspeed had dropped 10 kt lower than the target speed. He was moving the thrust levers forward to initiate a go-around when the stall-warning system activated.

The flight crew's subsequent actions to avoid the impending stall were inadequate, said the U.K. Air Accidents Investigation Branch (AAIB) in its final report on the serious incident. As airspeed had decreased, the autopilot had increasingly trimmed the 737 nose-up to maintain the glideslope. The aircraft pitched up further as thrust from the underwing-mounted engines increased as the commander advanced the thrust levers.

The combination of the nose-up trim and the application of maximum thrust "overwhelmed" the elevator, the report said, but neither pilot considered retrimming the stabilizer. Both pilots were pushing their control columns against the stops when the aircraft finally stalled and descended in a steep nose-up attitude. The commander was able to recover from the upset only after reducing thrust to the go-around setting, which restored elevator authority.

None of the 132 passengers or five crewmembers was injured, and there was no damage. The AAIB's investigation of the Sept. 23, 2007, incident led to recommendations to ensure that flight crews are effectively alerted to the disengagement of an autoflight system and to clarify procedures for recovering from an impending stall.

Night Instrument Conditions

The aircraft was en route on a scheduled flight from Faro, Portugal. The commander, 56, had 11,280 flight hours, including 420 hours in type. He had served as a 757/767 first officer for the operator before upgrading as a 737 commander in 2006.[1] The first officer, 30, had 3,170 flight hours, including 845 hours in type. He had flown

twin-turboprop regional aircraft before being employed by the operator in 2006.

"Before departing Faro, the crew discussed the weather at Bournemouth, uplifted additional fuel to permit two approaches and decided on a full-flap (flap 40) landing," the report said.

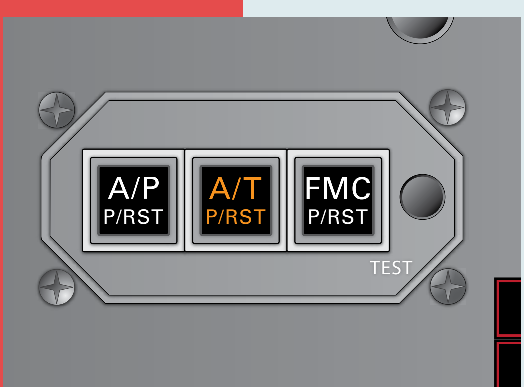
Night instrument meteorological conditions prevailed at Bournemouth, which is on the southern coast of England. Surface winds were from 220 degrees at 14 kt, visibility was 4,000 m (2 1/2 mi) in light rain, and the ceiling was overcast at 400 ft. Cleared to conduct the ILS approach to Runway 26, the crew calculated a landing reference speed (VREF) of 129 kt and decided to add six knots for the final approach.

As the autopilot captured the glideslope at 2,500 ft, the first officer, the pilot flying, asked the commander to extend the landing gear,

APPROACH

select flap 15 and begin the landing checklist. He also selected a lower speed on the mode control panel (MCP). The autothrottle system moved the thrust levers to idle to reduce airspeed to the selected value. About 20 seconds later, the autothrottles disengaged. "The disengagement was neither commanded nor recognized by the crew, and the thrust levers remained at idle throughout the approach," the report said.

The autothrottle (A/T) annunciator flashes so often during approach that it may be perceived as a nuisance message.



Susan Reed

Indicated airspeed initially decreased normally at about one knot per second. "As the speed decreased below 150 kt, flap 25 was selected," the report said. "The autopilot tracked the glideslope accurately, gradually increasing the pitch of the aircraft to minimize glideslope deviation and adjusting the stabilizer angle to keep the aircraft in trim."

The report said that the approach was stable and that there was no sign the crew was "rushing the approach." However, the pilots momentarily became distracted when the first officer increased the illumination of his map light to read a placard showing the flap limit speeds before asking the commander to select flap 40. About this time, airspeed began to decrease rapidly.

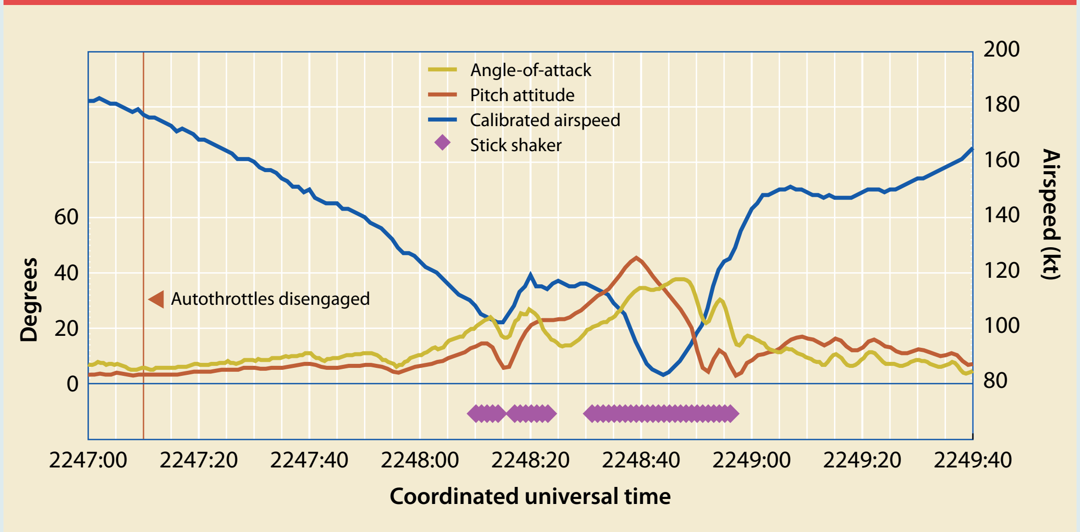
'I Have Control'

After selecting flap 40, the commander also selected 135 kt — the planned VREF plus 6 kt final approach speed — on the MCP and completed the landing checklist. "The commander stowed the checklist on top of the instrument panel, and when he looked down he saw an IAS [indicated airspeed] of 125 kt," the report said. "He called 'speed.' The [first officer] made a small forward movement with the thrust levers, and the commander called, 'I have control.'"

The aircraft was descending through 1,540 ft with a 12-degree nose-up pitch attitude and airspeed slowing below 110 kt when the commander moved the thrust levers full forward. As he did so, the stick shaker activated to warn of an impending stall (Figure 1, page 30). The commander engaged the autopilot's control wheel steering mode and moved his control column forward, reducing the pitch attitude to 5 degrees nose-up. "The stick shaker operation stopped, and the minimum airspeed was 101 kt," the report said. "A small, apparently unintended application of right aileron induced a right roll."

As engine low-pressure rotor speed (N_1) increased though 81 percent, the takeoff/go-around (TOGA) mode activated. "The autopilot

Selected Plots From QAR Data



QAR = quick access recorder

Source: U.K. Air Accidents Investigation Branch

Figure 1

full forward. "Both pilots reported [during post-incident interviews] that they had no pitch control authority," the report said.

Calibrated airspeed (CAS) decreased below 107 kt as the pitch attitude reached 36 degrees and the left bank increased beyond 13 degrees. The TOGA mode disengaged. A right rudder control input brought the wings level before the 737 stalled with a nose-up pitch attitude of 44 degrees.

disengaged, the pitch attitude started to increase again, and the stick shaker reactivated," the report said. "A corrective roll input was made to bring the aircraft wings-level, and although the control column was positioned fully forward, the nose-up pitch increased to 22 degrees."

N_1 increased to nearly 98 percent, which is above the rated go-around thrust setting of 94 percent. The pitch attitude stabilized briefly at 22 degrees, and the stick shaker ceased as airspeed increased to 118 kt. However, the pitch attitude again began to increase when the crew selected flap 15, the go-around setting.

"A small continuous left rudder input started a left roll," the report said. "As the flaps reached flap 15, the pitch angle was increasing through 27 degrees and the left roll was increasing through 7 degrees. The stick shaker reactivated, full nose-down elevator was still being applied, and the airspeed began to decay."

'Full Forward Stick'

The first officer called "high pitch," and the commander replied, "I have full forward stick." The first officer also held his control column

"With no change in elevator position, the pitch rate reversed from positive to negative although angle-of-attack continued to increase as the aircraft started to descend," the report said. "Despite reducing pitch, the airspeed continued to decrease for a further five seconds to a minimum recorded CAS of 82 kt when the pitch was 33 degrees nose-up."

The commander regained control after reducing N_1 to 86 percent. Pitch attitude decreased rapidly to 5 degrees nose-up, and airspeed increased to 147 kt. "The commander initially leveled the aircraft at 3,000 ft before climbing to 4,000 ft and self-positioning for a second approach," the report said. The commander remained as pilot flying during the second approach, which was conducted without further incident with the autopilot and autothrottles engaged. The 737 was landed at 2301 local time.

After taxiing to a stand and shutting down the engines, the commander told the operator's base engineer that there had been an incident and that, although he believed the aircraft was serviceable, the operator likely would want to review the recorded flight data. "No defects were entered in the technical log," the report said. "The engineer assured the commander that the operational flight data monitoring (OFDM) information was sent from the aircraft by an automatic mobile telephone-based data link."

Questions Unanswered

The next morning, the commander advised the operator's safety department of the incident and completed an air safety report (ASR). The AAIB report said that the ASR "contained limited information" and "did not depict the event accurately." Not realizing the seriousness of the incident, the operator did not file a mandatory occurrence report with the U.K. Civil Aviation Authority.

The OFDM analyst who read the ASR was not a pilot and flagged the event for further review by a pilot representative. An OFDM pilot representative was on duty in the safety department that day but was too busy with other tasks to review the incident aircraft's flight data. The report said that the seriousness of the incident was not identified and appropriate action was not taken until the next pilot representative came on duty again at the OFDM office 11 days later.

"[The aircraft] was not subjected to an engineering examination to ensure its continued airworthiness and remained in service throughout this period," the report said. Data recorded by the cockpit voice recorder and flight data recorder during the incident were overwritten, and the AAIB's incident investigation was limited to interviews and analysis of the flight data captured by the quick access recorder (QAR) for the OFDM program.

The investigation did not resolve why the autothrottle system disengaged during the approach. Manual disengagement is achieved by selecting the autothrottle switch on the glareshield panel to "OFF" or by pressing a pushbutton on either thrust lever. The QAR data indicated that neither of these actions had been taken.

The uncommanded disengagement of the autothrottle system could have resulted from detection of an internal fault by built-in test equipment. "Due to the delay in notification of the incident, the aircraft had completed more than 10 flights, and therefore the fault history information from the incident had been overwritten," the report said. Post-incident tests of the autothrottle system revealed no faults that could cause an uncommanded disengagement.

Why the pilots did not see the flashing red light on the instrument panel that warns of autothrottle disengagement also was unanswered. The annunciator is a small rectangular pushbutton lens in the upper center of the instrument panel. Labeled "A/T P/RST" —"autothrottle, push to reset" — the annunciator also generates a flashing amber caution light when airspeed is 10 kt above or 5 kt below the selected speed or decreases to "alpha floor," or 1.3 times the stalling speed.

"The autothrottle warning … flashes amber routinely for extended periods during the approach phase of flight," the report said. "It is likely that flight crews are subconsciously filtering out what is perceived as a nuisance message."

Investigators identified "a number of other events" that involved uncommanded and unrecognized autothrottle system disengagements in 737s. "Consequently, the efficacy of the autothrottle warning became of interest during the investigation," the report said, noting that the 737 did not have, and was not required to have, an aural indication of autothrottle disengagement.

As a result, AAIB recommended that Boeing and the U.S. Federal Aviation Administration review the effectiveness of the autothrottle system disengagement warnings in 300-, 400- and 500-series 737s and improve them if necessary. AAIB also called on the European Aviation Safety Agency to review Certification Standard 25 for transport category airplanes to "ensure that the disengagement of autoflight controls, including autothrottle, is suitably alerted to flight crews."

The incident investigation revealed that the flight crew did not apply nose-down trim to regain elevator authority. The flight crew training manual (FCTM) and the quick reference handbook (QRH) for the 737-300 both say that the first action in response to a stall warning or a stall is to apply full thrust. However, only the FCTM advises that the aircraft's nose will pitch up as the engines accelerate and that the stabilizer must be trimmed nose-down to assist in pitch control. "The [QRH] drill does not mention the use of pitch trim," the report said.

Based on this finding, AAIB called on Boeing to "clarify the wording of the approach-to-stall recovery [in the QRH] to ensure that pilots are aware that trimming forward may be required to enhance pitch control authority."

This article is based on AAIB Aircraft Accident Report 3/2009, "Report on the Serious Incident to Boeing 737-3Q8, Registration G-THOF, on Approach to Runway 26, Bournemouth Airport, Hampshire, on 23 September 2007."

Note

1. The operator was Thomsonfly, which became Thomson Airways in 2008.

BY WAYNE ROSENKRANS

COMMON CAUSE

U.S. airline participation in ASIAS triples with the prospect of access to system-level safety intelligence.

As the Aviation Safety Information Analysis and Sharing Program (ASIAS) approaches its second anniversary in October, signatory airlines have come to represent a substantial majority of commercial flights in the United States. The growth from seven to 22 participating airlines — despite the tough economic environment — signifies a long-anticipated advance in voluntary safety information sharing between the Federal Aviation Administration (FAA) and air carriers, several representatives say. Each company has signed a memorandum of understanding (MOU) that in effect enables exchanges of de-identified safety data, and several have furnished subject matter experts to ASIAS analytical working groups and to the development of safety enhancements under the Commercial Aviation Safety Team (CAST).

One attraction for the airlines is exclusive access to compelling ASIAS products. So far they include a directed study of terrain awareness and warning system (TAWS) alerts, a directed study of traffic-alert and collision avoidance system (TCAS II) resolution advisories (RAs); the

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capability to compare airline-level TAWS alerts and TCAS RAs with experiences of the whole group — called *benchmarking* — and the capability to benchmark specific airline versus aggregate experience of unstabilized approaches.

"Two years ago, it was very hard to envision that the program would get to this size and level of participation," says Don Gunther, vice president, safety, Continental Airlines; industry co-chair of CAST; and co-chair of the ASIAS executive board. "Airlines finally see a process that is functioning as designed — not just in the analysis but in the development of safety enhancements that are meaningful for the whole industry. I can't help but think that as ASIAS matures, we will continue to reach out to the international community to determine areas of concern and try to reduce aviation risk around the world, not just within the United States." The airline participants (Table 1) represent a diverse cross-section of U.S. major air carriers, regional air carriers and cargo operators.

The central premise of ASIAS is that the federal government and aviation stakeholders — given a conducive environment and ground rules — stand to benefit by cross-querying de-identified aggregate data distributed across airline network servers and associated data on government servers. This collaborative effort includes airline pilot unions, air traffic controller unions, airframe manufacturers, avionics manufacturers, maintenance and repair organizations, aviation industry associations and the Department of Defense.

The focus has been on known-risk monitoring, directed studies, benchmarking, research and development of analytical tools, and vulnerability discovery, said Jay Pardee, director of the FAA Office of Aviation Safety Analytical Services, and Michael Basehore, ASIAS program manager. The ASIAS Issue Analysis Team — comprising FAA employees, contractors and specialists lent by the industry — typically applies text-mining tools and data-mining tools to manually or automatically discover trends, atypical events, exceedances and aberrations in the large network of databases. "By September, we will have a 360-degree view — from the narrative data — of the controller's perspective, the pilot's or copilot's perspective and, where it is relevant, the maintenance technician's side of a particular issue," Pardee said. The work has produced various fusions of data, often computer-rendered as graphics that reveal safety insights, such as the image on page 34.

"We are developing the ability to see national-level trends either in flight operational quality assurance [FOQA] data or aviation safety action program [ASAP] data," Pardee said. "FOQA databases have grown beyond 5 million flights, and ASAP records exceed 50,000." The sheer volume of flights by current ASIAS participants — about 75 percent of all 2008 flights in the

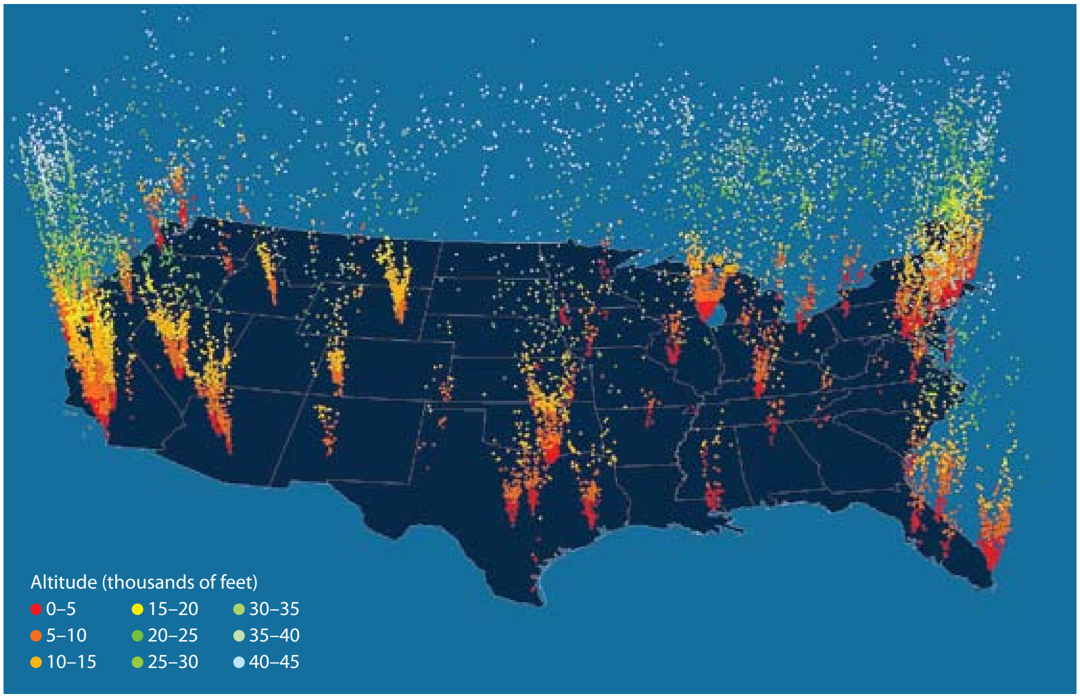
U.S. Airlines Participating in ASIAS, August 2009
AirTran Airways
Alaska Airlines
American Airlines
American Eagle
Atlantic Southeast Airlines
Chautauqua Airlines
Compass Airlines
Continental Airlines
Delta Air Lines
ExpressJet
Frontier Airlines
Gulfstream International Airlines
JetBlue Airways
Northwest Airlines
Republic Airways
Shuttle America
SkyWest Airlines
Southwest Airlines
Sun Country Airlines
United Airlines
UPS Airlines
US Airways

ASAPs = aviation safety action programs; ASIAS = Aviation Safety Information Analysis and Sharing Program; FOQA = flight operational quality assurance; MOU = memorandum of understanding

Note: Each airline has a FOQA program, or one or more ASAPs, or both, and has signed an MOU with the Center for Advanced Aviation System Development at the MITRE Corp., a federally funded research and development center, to provide network access to its de-identified data and to receive analytical reports from ASIAS.

Source: U.S. Federal Aviation Administration

Table 1



U.S. Federal Aviation Administration; MITRE Corp. Center for Advanced Aviation System Development

ASIAS analysts plotted 38,100 TCAS RAs from all sources in their network of databases, which at the time contained data from approximately 3 million flights, a subset of all U.S. flights in 2006–2008.

National Airspace System — increases the FAA's confidence that issues discovered are likely to be comparable and relevant to all operations.

ASIAS analysts essentially add a new dimension to what airlines learn from their own analysis of data through the FOQA programs of routine flight data monitoring, and the ASAPs designed for voluntary disclosure of safety issues by aviation professionals with non-punitive corrective action.

The Center for Advanced Aviation System Development at the MITRE Corp., a federally funded research and development center, provides the high-level architecture, synthesizes databases and conducts airline data analysis as a trusted intermediary between the participating airlines and the FAA. Twice a year, the FAA hosts FOQA/ASAP Infoshare meetings that enable all interested airlines to share and learn best practices.

ASIAS continues to evaluate advanced text-mining algorithms — such as the open source Mariana software[1] developed by the National Aeronautics and Space Administration (NASA) and other software used by participating airlines — for automatic classification of ASAP reports. "We are putting considerable energy and resources into advancing the science of text mining," Pardee said. "Today we can detect TAWS and TCAS alerts in either digital or narrative data. Being able to quickly pore through millions of records — that's going to be key."

The program's reputation was burnished last year by the directed study of alerts from TAWS equipment, such as the Honeywell enhanced ground proximity warning system (EGPWS). The study (*ASW,* 5/08, p. 25) was initiated "based on ASAP reports — flight crewmembers expressing concern about the numbers of EGPWS alerts, particularly Mode 2A ['Terrain, Terrain'] alerts on approach to mountainous-terrain airports," Pardee said.

The study got the attention of airlines partly because these data-driven processes proved up to the task of identifying issues that only the FAA could address. "Airline-level analyses of TAWS alerts would not have come up with the issue of inaccurate minimum vectoring altitudes [MVAs][2] around our airports … yet several MVAs were not appropriately designed, and a couple of key elements weren't addressed," Gunther said. "So the FAA is reworking those MVAs to make them more appropriate for the surrounding terrain."

FOQA and ASAP programs vary in their maturity, and all airlines should be open to continually improving them, he said. At Continental Airlines, better analytical tools and methods of deriving new data from actual FOQA parameter data — to evaluate unstabilized approaches, for example — are welcome products from ASIAS. "They might mean that we can do a better analysis and maybe refine some of our operational changes based on that analysis," Gunther said. Particularly for air carriers that have launched

FOQA programs in recent years, "these tools are going to be a tremendous boost," he said.

Nothing in the new ASIAS and CAST processes diminishes an airline's responsibility to implement corrective action with due diligence. "If we start to put out changes, change in itself is a threat," Gunther said. "We have to make sure there are no unintended consequences. Every airline has to ensure data integrity and, more importantly, look at proposed safety enhancements, and ensure it has thoroughly analyzed and addressed all the associated issues."

FAA Perspective

ASIAS products in 2008 and 2009 have been used exclusively within the ASIAS executive board and CAST under procedures and operations stipulations in the MOUs signed by the participating airlines and MITRE. Public release of more detailed information might be authorized after CAST completes and officially issues its safety enhancements, Pardee said.

As Gunther noted, one safety enhancement to reduce non-safety-critical TAWS alerts aims to improve the FAA's calculation of MVAs at each location where high numbers of TAWS alerts have been documented. The FAA already has searched all Federal Aviation Regulations Part 139 air carrier airports for the same "data fusion signature" first identified last year near Oakland, California.

"We've identified other locations that have similar issues, mountainous-terrain approaches, that would benefit from the knowledge learned from the initial study," Pardee said. "We will revisit those MVAs with some new tools that we developed in the process, and the FAA Air Traffic Organization will check and revise as necessary the MVAs at facilities with high numbers of TAWS alerts."

The variations in arrival tracks — including vectoring of arriving aircraft by FAA air traffic control (ATC) — noted by ASIAS analysts also have prompted the FAA to introduce airspace improvements based on more precise navigation technology as a second safety enhancement. "One test airport, Oakland, showed the benefits of creating an area navigation [RNAV] approach, which was able to provide more repeatable routing and more accurate approaches around the high-terrain obstacles," Pardee said. "Our evaluations showed that airport equipage there would support RNAV." At other airports, the FAA has pursued required navigation performance (RNP) approaches where supported by the existing airport equipment.

In the third safety enhancement, the FAA has urged air carriers to upgrade their TAWS software — both system logic and terrain database — to a minimum standard and install global positioning system (GPS) receivers. Later this year, CAST plans to publish details of these safety enhancements as a solution set on Revision 14 of CAST's compact disc of resources.

"In the interim, improved MVAs and airspace procedures should serve aircraft that can't be upgraded to new TAWS software and GPS immediately, vastly eliminating the number of non-safety-critical alerts," Pardee said. "With this solution set, we can eliminate more than 98 percent of these alerts."

Two recent additions to ASIAS analysts' data resources have been MITRE's capability to download en route radar track data on a daily basis from the FAA National Offload Program and the capability to receive data from airport surface detection equipment, model X (ASDE-X), the local radar data from the 39 largest air carrier airports. By the end of 2010, ASIAS plans to downlink TCAS RA data from 21 sensors located at terminal areas throughout the United States to meet FAA safety management system requirements related to TCAS II Version 7.1 software implementation (*ASW*, 4/09, p. 34).

TCAS Study Approved

In August, the ASIAS executive board approved the report of the second directed study, focused on TCAS RAs. "We have looked at all the major airports where airline concerns were expressed," Pardee said. "We literally have mapped — for all the arrivals, all the departures and every runway end in the United States — all of the TCAS RAs for a selected period of time, whether from ASAP data, FOQA data, radar data archives or radar tracks. It has been incredibly revealing. We also saw the effects of closely spaced parallel runways and of interactions with general aviation, including helicopter operations and general aviation training bases."

Developing mitigations for non-safety-critical TCAS RAs — especially in densely packed airspace in the Northeast — could prove far more challenging than TAWS alerts. "This one will be hard," Pardee said. "Short of redesigning the airspace, what other techniques or mitigation strategies might we have? Where we had local peaks of TCAS RAs, can we do something locally? Is there a systemic solution? Can we redesign the TCAS [II avionics] box? Can we change things operationally or airspace management-wise?"

The genesis of this study was the concerns expressed during Infoshare meetings. "We knew that several airlines had initiated TCAS RA studies on their own using FOQA data analysis,"

Example of ASIAS Benchmark for U.S. Airlines: Unstabilized Approach Criteria — Below 500 ft

Approach Element	Metric
Landing gear setting	Down and locked
Flap setting	Any movement of flap setting greater than 2 degrees
Low thrust	Less than 35% average N_1 for five seconds or more
Sink rate	Greater than 1,500 fpm for three seconds or more
High-speed approach	Greater than V_{REF} plus 30 kt for three seconds or more
Low-speed approach	Less than V_{REF} for three seconds or more
Above glide slope	Greater than one dot above glide slope centerline for five seconds or more
Below glide slope	Greater than one dot below glide slope centerline for five seconds or more
Localizer deviation	Greater than one dot deviation from localizer centerline for five seconds or more

ASAP = aviation safety action program; ASIAS = Aviation Safety Information Analysis and Sharing Program; FOQA = flight operational quality assurance; N_1 = engine compressor speed; V_{REF} = reference landing speed

Note: This subset of criteria for post-flight analysis was developed by ASIAS analysts and 22 U.S. airlines. The airlines have provided access to their de-identified digital and narrative data from routine flight operations. They, in turn, receive aggregate data from participating airline counterparts as benchmarks for airline-to-aggregate comparisons.

Source: U.S. Federal Aviation Administration

Table 2

Basehore said. "We also found that there were some geographical areas where there were a higher number of TCAS RAs than others, so that warranted another directed study."

To identify TCAS RAs, ASIAS analysts began with ASAP reports, but they lacked the exact locations. Validating and cross-referencing events with FOQA data partially addressed this gap. "It would have been wonderful if we had the ASAP report tied right to the FOQA data for a particular flight, but that's not going to happen with de-identified data, so we have to do it generically," Basehore recalled. The TCAS RA study already has yielded insights into U.S. airline pilot responses. "In the vast majority of the instances of the TCAS RAs, we saw what we considered the appropriate pilot response as derived from avionics measurements," Basehore said.

Unstabilized Approach Benchmark

Concerns about distinguishing stabilized from unstabilized approaches — and the need for national benchmarks — also were raised during Infoshare meetings. ASIAS analysts worked with airline specialists to develop and issue a set of consensus definitions (Table 2) and common research methods as a starting point. "ASIAS tells the airlines what parameters are being analyzed for an unstabilized approach, then enables them to calculate their own unstabilized approach metrics to compare against the aggregate of all participants' values," Basehore said.

ASIAS also has issued the first set of benchmarks, tailored to each participating airline, representing TAWS alerts, TCAS RAs and unstabilized approaches. The airlines have been asked to share with ASIAS, and their counterparts, any safety lessons learned from considering the benchmarks and implementing operational changes.

"We also can look at whether the flight crew actually went around if they did not meet the criteria that we have mutually defined as a stabilized approach," Basehore said. ASIAS is taking a second look at the data to help airlines prepare for such assessments, he said. Criteria actually used in airline flight operations — such as the elements of a stabilized approach recommended by Flight Safety Foundation <www.flightsafety.org/files/alar_bn7-1stablizedappr.pdf> — differ from the post-flight criteria that ASIAS analysts derive from FOQA data, he said.

Southwest Airlines Experience

The chance to study TCAS RAs at the national level emerged as the "perfect example" for most airlines of the possibilities of ASIAS, said Tim Logan, senior director, operational safety, and Don Carter, senior manager, flight safety programs, of Southwest Airlines.

"With ASIAS and the FAA Air Traffic Organization involved, we've had the ability to overlay more detail of the traffic in the area where TCAS RAs occurred and to know the cause — whether general aviation traffic or scheduled airline traffic operating under instrument flight rules [IFR]," Logan said. "We used to look at the Southwest Airlines flight data but we could never know what the conflicts were. Now we are able to pinpoint the location, and look at designing new approach areas, routes within visual flight rules corridors or IFR corridors, or similar kinds of fixes."

Southwest Airlines was among the ASIAS airline participants that received the first set of benchmarks. "We are still in the process of validating the data to be sure we are measuring the same thing on the same flights to get the same rates," Carter said.

The company has taken more time than expected to sort out validation and practical implications. "We are learning that benchmarks are not as easy as people thought they were going to be," Logan added. "I don't think people understood that if ASIAS publishes a benchmark across the industry, there are, first of all, different operators of different aircraft types, and different environments and quality of data sets coming off aircraft or from ASAP. Even for a simple measurement, such as whether or not there was a GPWS alert, there are difficulties because different systems have different data issues."

Airlines know from experience to discard the data if a GPWS or TAWS terrain alert was not a real alert, and ASIAS analysts who aggregate FOQA data have to take such false alerts into account so that they are not inadvertently included in aggregate data, he said.

Similarly, airline FOQA analysts have learned to assume that the quality of narrative-text information in ASAP reports varies and especially does not accurately represent the quantity of events. "We can only look at the aggregate, long-term trends to see if we've got an increase or a decrease," Logan said.

Another issue that participating airlines keep in mind is the possibility of problems with the validity of data generated by their peers. Such problems would be more likely if the level of FOQA program experience at an airline is below the average. If an airline does not realize that some information in its FOQA database is not valid, it cannot convey that fact to others, Carter said. "This is something that airlines learn over time," he said.

Trend analysis by the Southwest Airlines flight data analysis program already had shown "very encouraging" improvements in rates of stabilized approaches, reduction of non-safety-critical GPWS alerts and correct flight crew responses to GPWS alerts, Carter said. "The thing that we have never known, and until now have had to guess, is 'Does the number that we have now indicate an extremely safe operation — which we think it does — or does it simply indicate safer than it used to be, but there is still significant room for improvement?' Benchmarks allow us to see if we want to focus on previously identified issues or move on to others more critical for us."

The ASIAS airline participants have been careful about managing their own expectations of the program and influencing those of companies that have not signed up. "We have been very deliberate in indicating that this requires a lot of manpower, a lot of good hard analysis because we spend most of our time validating that what we are seeing is the true picture and actually represents a safety issue," Logan said. "Usually, when we get to that point, however, the answer — or at least the direction to go look — is pretty obvious. There has been a lot of angst among others in the industry asking 'Why has this taken so long?' It has taken so long because it is a new process, and we are trying to do it right to make sure that when we come out with a report on something as serious as TCAS RAs, we are definitely accurate and the report is usable."

False alerts and the frequent occurrence of alerts involving the same locations, flight phases or aircraft types must be taken seriously no matter how good an airline's safety record. "In areas where we got alerts, for example, some Southwest crews were just saying, 'Well, it's not a hazard right now, we are just going to continue,'" Logan said. "They didn't respond to the alert. The areas may have been places where ATC needs to route the airplanes around so that when crews get an alert, it is a real alert, and they react. ASIAS gives us the ability to know how often such alerts are happening, and that they are not just affecting one airline or one type of airplane."

The airline industry and the FAA may need periodic reminders to maintain an unwavering system-level focus at ASIAS, however, he added. "We have to stick to our guns to keep a methodical process of detailed analysis," Logan said. "Following every accident, the industry seems to react a little bit, but this program is not going to solve something at the push of a button. We need to keep the discipline and make sure that political pressures don't push us into an area that system-level analysis was really not designed to do."

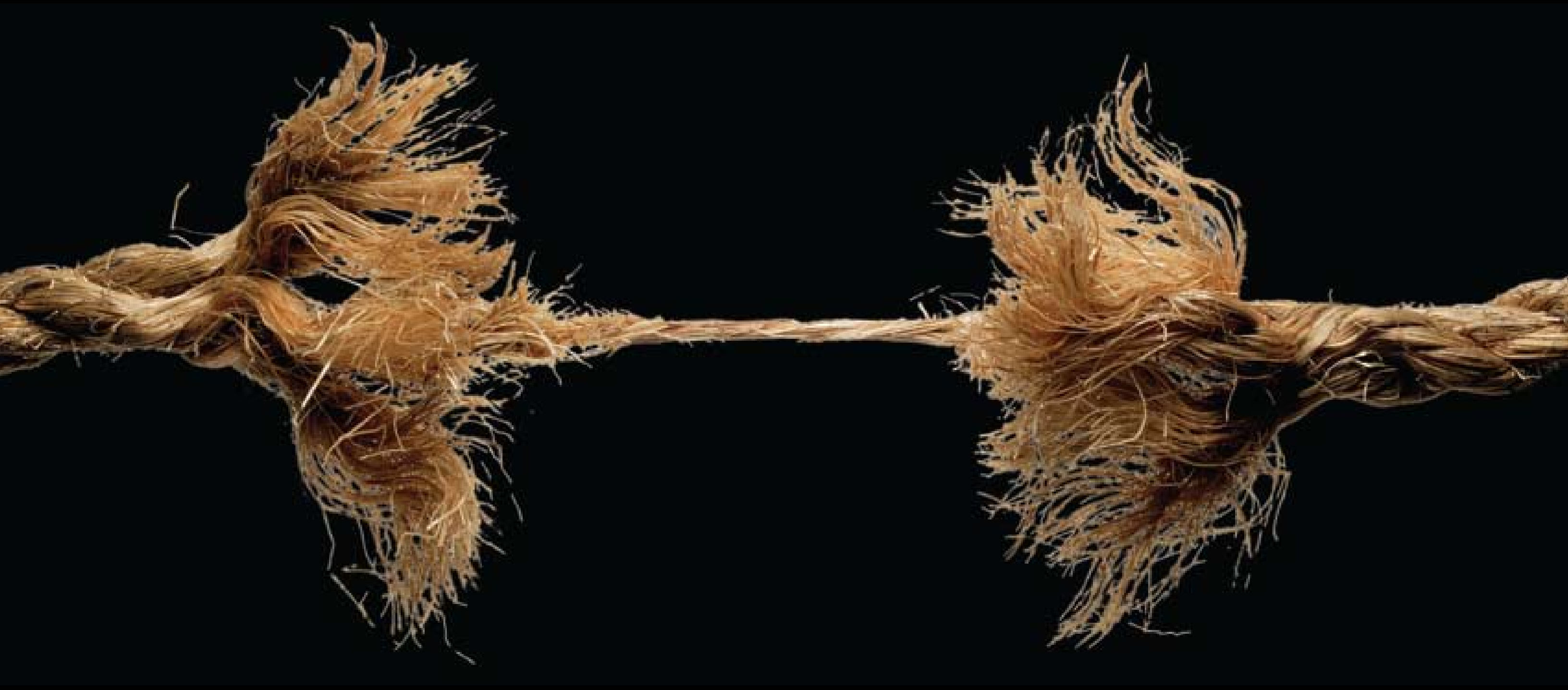
Notes

1. NASA said, "Mariana is an algorithm that can be applied to the text portion of reports, determining the likely categories that each report falls into, and calculating a confidence for each classification."
2. An MVA on an air traffic controller's display is a predetermined altitude, based only on a required 1,000 ft or 2,000 ft obstruction clearance, shown in an airspace sector.

Second of two parts

Stressed Out

BY CLARENCE E. RASH AND SHARON D. MANNING



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A range of physical and emotional factors can interfere with a pilot's cognitive process and degrade his decision-making skills.

Whenever pilots step onto a flight deck, they should ask themselves if they are fully capable of making the right decisions during the upcoming flight and taking the actions required in case of an emergency.

Decision making — the final step in the cognitive process[1] — is a factor in 30 to 40 percent of all commercial and general aviation aircraft accidents.[2,3] Any physical, physiological or emotional factor that degrades any portion of the cognitive process ultimately will degrade decision-making skills. When considered in the context of their effect on cognitive function in the operational flight environment, these factors often are referred to as "stressors."[4]

'Wear and Tear'

The term "stressor" is derived from "stress," a concept first identified in the early 20th century by Austrian endocrinologist Hans Selye. He identified what he believed was a consistent pattern of mind-body reactions that he called "the nonspecific response of the body to any demand."[5] He later referred to this pattern as the "rate of wear and tear on the body."

The definition of stress is necessarily broad: Stress is a normal, nonspecific physical, psychological and physiological response of the body to any demand placed upon it.

Prolonged stress may affect cognition — the process of perception, attention, memory, knowledge, problem solving and decision making — just as it affects emotions and behavior. This is a serious issue for pilots, because problems with judgment, attention or concentration present a great risk to the aircraft and the people in it. For example, under high-stress conditions, there is a tendency to oversimplify problem solving and decision making and to ignore important, relevant information —to "take the easy way out."

Many individuals under high-stress conditions tend to forget learned procedures and skills and revert to old habits that may not be appropriate. For example, they apply the techniques and knowledge acquired during previous training in other aircraft types.

Another stress-related cognitive error is perceptual tunneling — in which a pilot or an entire aircrew under high stress becomes focused on one stimulus, such as a warning signal, and neglects to attend to other important tasks or information.

Perceptual tunneling was at the heart of the Dec. 29, 1972, crash of an Eastern Air Lines Lockheed L-1011 in the Florida Everglades. The three-member flight crew declared a missed approach because they had no indication that the nose landing gear had extended, and then became so engrossed in identifying the problem with the position light system that they failed until seconds before the crash to notice that their airplane was no longer in level flight at 2,000 ft.[6]

In addition to affecting memory, judgment and attention, stress also can decrease hand-eye coordination and muscle control.

It is important to control stress by identifying and managing potential stressors. Stressors often are categorized as either external or internal.[7]

External stressors originate outside the individual and may be divided further into environmental and psychosocial subcategories (Table 1). In aviation, examples of environmental stressors are adverse flight conditions, cabin temperature extremes, glare or insufficient lighting, high noise levels and altitude effects. Psychosocial stressors relate to events or conditions that are linked to individual and family social characteristics, positions and roles, and include workplace conflict, a feeling of a lack of support from coworkers, and family-related stressors such as spousal conflict, problems with children, and illness or death of a relative.

Internal stressors originate within the individual and typically are considered to be within the individual's control. They may be divided into physiological and cognitive subcategories. Physiological stressors include poor diet, tobacco use, muscular fatigue, sleep

Classifying Stressors

External		Internal	
Environmental	**Psychosocial**	**Physiological**	**Cognitive**
Poor flight conditions	Workplace conflicts	Poor diet (Nutrition)	Lack of information
Extreme heat or cold	Family conflicts	Tobacco	Information overload
High noise level	Insufficient flight time	Muscular fatigue	Mental fatigue
Excessive vibration	Low job satisfaction	Sleep deprivation	Fear
Altitude effects	Feeling of lack of support	Alcohol	Feeling of helplessness
Crowded space	Lack of control	High blood pressure	Boredom
Air pollution	Spousal conflict	Prescription or over-the-counter medications	High workload
Humidity extremes	Family illness or death	Caffeine	
	Unrealistic expectations	Decreased vision	
	Financial problems	Hearing loss	
	Loneliness	Diseases	
	Devalued self-worth	Hunger	
		Thirst (Dehydration)	

Source: Clarence E. Rash and Sharon D. Manning

Table 1

deprivation, alcohol use and hearing loss. Cognitive stressors include boredom, high workload, information overload, a lack of information and emotions such as fear and hopelessness.

Making Rules

A few of these stressors have long been recognized for their degrading effects on cognitive function and, therefore, on decision-making skills. For this reason, civil aviation regulatory bodies have established rules regarding some of the more obvious stressors, including alcohol consumption and drug use, and continue to wrestle with the best methods of handling others, such as fatigue.

In the past, fatigue was addressed almost exclusively with rules limiting the number of hours worked in a given period. In recent years, however, specialists have begun to recognize other equally important contributors to fatigue such as inadequate sleep time, poor sleep quality, disruption of circadian rhythms, irregular work hours and the effects of commuting time.

Regulatory bodies have established rules regarding some of the more obvious stressors, including alcohol consumption and drug use, and continue to wrestle with the best methods of handling others, such as fatigue.

Fatigue typically causes an increase in reaction time, a decrease in accuracy and a reduction in attention. Fatigued pilots may exhibit a tendency to overlook or misplace sequential task elements, such as leaving out items on a checklist, or become so preoccupied with a single task that they neglect more critical tasks.

Fatigue also impairs memory. Although long-term memory is reasonably well preserved in the presence of fatigue, short-term memory and cognitive processing capacity are greatly reduced.[8] Communication also is impaired by fatigue; speech may become less clear, and fatigued pilots may be prone to misunderstanding messages. Fatigue invariably degrades decision-making skills, sometimes resulting in incorrect responses to emergency situations.

Hidden Stressors

A host of other factors — often misunderstood or ignored — have more subtle effects on cognitive performance. These factors include inadequate nutrition and exercise; use of prescription and over-the-counter medications; dehydration; tobacco use; exposure to heat and cold; noise; and vibration. As a result of their exposure to these factors, pilots may not be at their best while flying. Consequently, in an emergency, pilots may be unable to respond with the necessary reaction time, hand-eye coordination, communication skills or decision-making ability.

Poor nutrition and lack of exercise are stressful and make it more difficult to deal with other stresses. A proper diet provides the body with the essential vitamins and minerals and helps maintain cognitive function.

Medication

Most civil aviation regulations prohibit flying while taking any medication that might affect pilot performance and flight safety. Medical conditions and medications — even those that present no problems on the ground — can have adverse side effects that may vary with altitude.

Many common over-the-counter medications can significantly impair cognition, judgment or sensory inputs. For example, some medicines for colds and allergies contain ingredients that can cause drowsiness, short-term memory loss and blurred vision. Pilots should ask aeromedical specialists about the appropriateness of medications for use during flight and read all labels carefully.

When researchers from the U.S. Federal Aviation Administration (FAA) Civil Aeromedical Institute (now the Civil Aerospace Medical Institute) examined pathology samples from 1,683 pilots killed in aviation accidents from 1994 to 1998, they found over-the-counter medications more frequently than any other drugs.[9] Over-the-counter drugs were found in 301 samples, and prescription drugs in 240.

Smoking

The use of tobacco is widespread, although numerous studies have demonstrated an association between smoking and cardiovascular disease, various cancers, pulmonary disease and other ailments.[10]

Photo Illustration: © Chris Sorensen Photography; Diane Diederich/iStockphoto

As a stimulant, nicotine has been found to improve cognitive performance on attention and memory tasks,[11,12] and it appears to improve visual attention — both important in aviation.[13] Other studies have shown that nicotine may improve the ability to focus on auditory information and filter out background noise.[14,15]

However, other studies have found that:

- Cigarette smoking contributes to hypoxia — a problem that increases with altitude. Three cigarettes smoked at sea level increase the physiological altitude to between 5,000 and 8,000 ft. At altitude, complex tasks requiring decision making, use of mental strategies and memory retention can be more difficult than they are at sea level; for a pilot who is at an artificially high physiologic altitude because of smoking, the problem is compounded.[16]
- Smoking reduces visual acuity at night, and the effect increases with altitude. Night vision has been reported to decrease by 5 percent at 3,500 ft, by 20 percent at 10,000 ft and by 35 percent at 13,000 ft, if supplemental oxygen is not provided.[17]
- Cigarette smokers are nearly two times more likely than nonsmokers to experience hearing loss, especially at high frequencies.[18]
- The nicotine in cigarettes also is associated with transient dizziness and nausea, which can be aggravated by motion.[19]

Dehydration

Dehydration is a major contributor to fatigue and an accompanying decrease in mental and physical performance, and dehydrated pilots are at a higher risk than others for decompression sickness, spatial disorientation, visual illusions, airsickness and loss of situation awareness.[20]

Pilots with health problems and those in small aircraft without air conditioning are most susceptible, but the problem also can affect pilots who operate on the low-humidity flight decks of air carriers.

The first common indication of dehydration is thirst. By the time an individual senses thirst, however, he or she already is about 1.5 qt (1.6 L) low on water — or about 2 percent dehydrated — and more if he has been drinking caffeinated beverages or if he consumed alcohol the previous day. At a dehydration level of 3 percent, he may experience sleepiness, nausea, mental impairment, and mental and physical fatigue.

Psychosocial Stressors

Psychosocial stressors are those that involve relationships, career and finances, as well as the factors that influence these three areas, such as physical health. Psychosocial stress can be either positive — such as a promotion at work, marriage or the birth of a child — or negative — such as divorce or separation, death of a loved one or illness or injury to self or family. Good psychological health enhances pilot performance, and the presence of negative stressors affects performance. These stressors are distractions and can slow reaction times in assessments of critical situations and decision making.

While some stressors are well known to pilots, others go unrecognized. Civil aviation authorities and others have developed a number of personal checklists to aid pilots in evaluating themselves for stressors. For example, the FAA has developed an "I'm Safe" checklist for pilots to evaluate their readiness for flight (Table 2).[21]

'I'M SAFE' Checklist	
Illness	Do I have symptoms of an illness?
Medication	Have I been taking prescription or over-the-counter drugs?
Stress	Am I under psychological pressure from the job?
Alcohol	Have I been drinking within eight hours? Within 24 hours?
Fatigue	Am I tired and not adequately rested?
Eating	Have I eaten enough of the proper foods to keep adequately nourished during the entire flight?

Source: U.S. Federal Aviation Administration; Clarence E. Rash and Sharon D. Manning

Table 2

The mnemonic stands for being unimpaired by illness, medication, stress, alcohol, fatigue or eating (inadequate nourishment).

Dozens of stressors — originating from a variety of environmental, psychosocial, physiological and cognitive sources — may degrade cognitive processes and jeopardize decision-making skills. Vigilance by pilots can help prevent these stressors from putting flight operations at risk.

Clarence E. Rash is a research physicist with 30 years experience in military aviation research and development. He has authored over 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.*

Sharon D. Manning is a safety and occupational health specialist at the Aviation Branch Safety Office at Fort Rucker, Alabama, U.S., and has over 20 years experience in aviation safety.

Notes

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Unjustified RESOURCES

BY WAYNE ROSENKRANS

Accident analysis yields few cost-benefit insights into ARFF enhancements at U.S. airports.

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Proposals to increase aircraft rescue and fire fighting (ARFF) capability at most air carrier airports in the United States ideally would sail through government reviews. Missing so far, however, is sufficient confidence that lives would be saved by investing, for example, $3 billion initially and then spending $1 billion more per year than currently is budgeted. U.S. air carrier accident data from the past 11 years provide little guidance for deciding which international standards to adopt as new ARFF requirements, according to a report prepared for the U.S. Transportation Research Board (TRB) of the National Academies.[1]

"It is difficult to suggest what might happen in terms of future accidents," said the report, designed to supply recent accident survivability data and analyze the predominant ARFF cost factors. "With the very small number of accidents in passenger air carrier operations and the multiplicity of causes and outcomes, it is not possible to reach a conclusion from past accidents about how improved ARFF response times and capabilities would reduce accident mortality. However, the review of accidents … suggests that enhanced ARFF standards may have made a difference in the outcome for at most one individual."

A resolution of the U.S. Congress early this year called on the Federal Aviation Administration (FAA) to more closely align Federal Aviation Regulations (FARs) for ARFF with 2009 global consensus standards — especially NFPA 403, *Standard for Aircraft Rescue and Fire-Fighting Services at Airports, 2009 Edition,* published by the National Fire Protection Association (NFPA), and Annex 14, *Aerodrome Design and Operations,* of the International Civil Aviation Organization (ICAO). The research for TRB was limited to a representative sample of fire stations, ARFF vehicles and firefighters located at 476 U.S. airports categorized as Class I, II or III by FARs Part 139, *Certification of Airports,* based on the seating capacity of aircraft typically operating at the airport and whether the air service is scheduled or unscheduled. Table 1 shows the scale of ARFF operations for these classes.

"While the average airport has 26 firefighters and three vehicles, Class IA airports have 10 firefighters and two vehicles, and Class IE airports have 115 firefighters and seven vehicles," the report said. "NFPA standards apply to airport operators if the state where the airport is located or the airport operator has adopted those standards. … The FAA and the NFPA have worked together to adopt common standards whenever possible; however, there are areas where the FAA and NFPA differ significantly."

The major drivers of cost are the number of firefighters, airport fire stations and ARFF vehicles that enable firefighters to achieve a specified response time for the first ARFF vehicles to arrive at designated points on runways and begin applying extinguishing agents.

The FARs specify three minutes for the first vehicle to arrive at the midpoint of the farthest air carrier runway or other specified point of comparable distance on the movement area available to air carriers, and four minutes for all other required vehicles. This time period has been interpreted to mean with direct routes, dry pavement and good weather.

The NFPA standard requires the first vehicle to reach any point on the operational runway in two minutes or less with good visibility and surface conditions. The ICAO standard requires the first ARFF vehicle to reach any point on each operational runway within three minutes in optimum visibility and surface conditions.

The elements of any standard adopted become critical in building and staffing airport fire stations. The key finding of the 2009 research therefore was that "the NFPA two-minute runway response requirement could more than double the number of firefighters and ARFF vehicles at the 476 Part 139 airports considered in this study."

FAA, ICAO and NFPA also have standards for minimum ARFF vehicles on duty, and at least general guidance on the basis for determining the number of firefighters per shift. Neither the FAA nor ICAO specifies the number of firefighters on duty per shift, except to require a sufficient number of trained personnel as determined by the number of fire stations and ARFF vehicles to achieve the minimum response time adopted. In contrast, NFPA standards specify minimum shift-staffing requirements based on the class of airport (Table 2).

Current Firefighters and ARFF Vehicles at U.S. Air Carrier Airports[1]

	FAA Airport Class and ARFF Index[2]						
	IIIA/IIA	IA	IB	IC	ID	IE	Total
Airports	99	131	111	78	33	24	476
Firefighter count[3]	60	103	193	256	215	460	1,287
Average firefighters[4]	8	10	15	28	43	115	26
Estimated firefighters[5]	743	1,349	1,648	2,219	1,419	2,760	10,137
Vehicle count[3]	10	17	22	38	22	29	138
Average vehicles[4]	1	2	2	3	4	7	3
Estimated vehicles[5]	124	202	188	247	145	174	1,080

FAA = U.S. Federal Aviation Administration; ARFF = aircraft rescue and fire fighting

Notes

1. The table is based on 53 interviews completed during a February 2009 survey of airports regulated under Part 139, *Certification of Airports,* of U.S. Federal Aviation Regulations.
2. U.S. airports serving air carriers are certificated in one of four classes based on the passenger seating capacity of the typical aircraft and the scheduled or unscheduled nature of these flight operations. Generally, a Class I airport can serve all sizes of passenger aircraft, and a Class III airport can provide scheduled and unscheduled services for aircraft that have 30 or fewer seats. FAA ARFF indexes subdivide the Class I airports by the length of the longest aircraft conducting more than five scheduled departures per day (A less than 90 ft [27.4 m], B 90 ft but less than 126 ft [38.4 m], C 126 ft but less than 159 ft [48.5 m], D 159 ft but less than 200 ft [61 m] and E longer than 200 ft). Class II and III airports meet ARFF Index A as a minimum, and Class II airports may qualify for alternative means of compliance using local community fire fighting capability. Class IV airports were excluded from this study.
3. The count was provided during interviews with airport managers or other representatives.
4. The average was the number of firefighters/vehicles counted divided by the number of airports in the study sample.
5. Total firefighters and ARFF vehicles for all 476 airports were extrapolated.

Source: Richard Golaszewski, Benedict Castellano and Robert E. David

Table 1

Few Relevant Accidents

The researchers studied 23 FARs Part 121 air carrier aircraft accidents and 13 Part 135 commuter aircraft accidents during scheduled operations in the period Jan. 1, 1997, through Dec. 31, 2007. Three accidents in the Part 121 record and three accidents in the Part 135 record were considered relevant to ARFF response issues.

Applying Unmet ICAO and NFPA Standards for ARFF Response to U.S. Airports

	Airport Class and ARFF Index[1]						
	IIIA/IIA	IA	IB	IC	ID	IE	Total
Airports	99	131	111	78	33	24	476
Effect of ICAO three-minute runway response standard[2]							
Additional fire stations	50	24	34	46	13	24	190
Additional vehicles	25	12	94	78	26	48	283
Additional firefighters	124	83	589	559	198	420	1,973
Effect of NFPA minimum vehicles and firefighters standard[3]							
Additional vehicles	0	60	60	13	0	0	132
Additional firefighters	371	1,691	3,057	1,950	363	210	7,642
Effect of NFPA two-minute runway response standard[4]							
Additional fire stations	85	131	111	117	58	90	592
Additional vehicles	42	107	222	351	116	180	1,018
Additional firefighters	509	1,905	3,244	2,802	908	1,680	11,047
Effect of NFPA three-minute movement area response standard[5]							
Additional fire stations	28	24	43	46	25	60	225
Additional vehicles	0	71	102	124	33	120	450
Additional firefighters	283	1,870	3,099	2,152	330	960	8,694

ARFF = aircraft rescue and fire fighting; ICAO = International Civil Aviation Organization; NFPA = U.S. National Fire Protection Association; RRA = rapid response area

Notes

1. Table 1 (p. 44) explains FAA airport classes and ARFF indexes. The analysis in the study assumed that standards discussed would apply to ARFF satellite stations at Index D and Index E airports.
2. The ICAO standard requires that the first ARFF vehicle reach any point on an airport runway within three minutes.
3. NFPA 403, *Standard for Aircraft Rescue and Fire-Fighting Services at Airports,* 2009 Edition, sets the following minimum numbers of ARFF vehicles: one or two for the equivalent of FAA ARFF Index A, two for Index B, three for Index C and Index D, and four for Index E. The standard requires airports to have the following number of ARFF firefighters per shift: four or five for the equivalent of FAA ARFF Index A, six for Index B, seven for Index C, eight for Index D, and nine or 10 for Index E.
4. NFPA 403 requires the first ARFF vehicle to reach any point on an airport runway within two minutes and any point in the RRA within 2.5 minutes.
5. NFPA 403 requires the first ARFF vehicle to reach any point on an aircraft movement area beyond the runways or the RRA within three minutes.

Source: Richard Golaszewski, Benedict Castellano and Robert E. David

Table 2

The air carrier accidents of the period most relevant to ARFF response issues were American Airlines Flight 1420 on June 1, 1999, a McDonnell Douglas MD-82 that overran Runway 4R at Little Rock, Arkansas; Air Midwest Flight 5481 on Jan. 8, 2003, a Raytheon Beech 1900D that struck a maintenance hangar and terrain during takeoff with an incorrectly rigged elevator control system at Charlotte-Douglas International Airport, North Carolina, U.S.; and Comair Flight 1591 on Aug. 27, 2006, a Bombardier CRJ-100 that crashed during takeoff from the wrong runway at Lexington, Kentucky, U.S.

The report cited a finding by the National Transportation Safety Board (NTSB) that, although the Little Rock accident potentially was survivable for two fatally injured passengers, faster ARFF response would not have made the difference in saving their lives. "In one case, the passenger would have had to evacuate the aircraft immediately and, in the second case, the ARFF response team would have had to enter the aircraft instead of first suppressing the fire," the TRB report said.

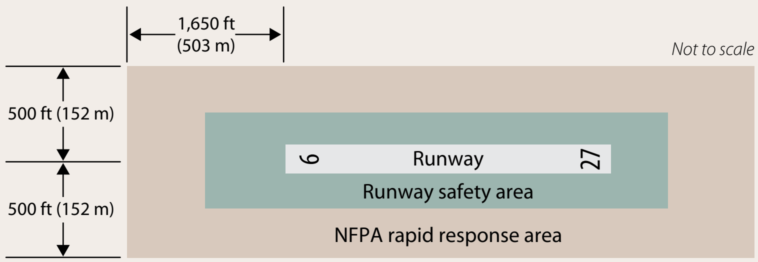
Faster ARFF response would not have altered the outcome in the Charlotte accident because NTSB "determined that all 21 people on board the aircraft died from 'multiple blunt injuries due to an airplane crash,'" the report said. Among passengers who survived the crash impact forces but died from smoke inhalation or thermal injuries in the Lexington accident, "the NTSB found it was not possible to determine how long these passengers survived, but noted that all of the passengers were found close to their seats," the report said. "The accident site was not directly accessible to ARFF vehicles from the runway end. It took the ARFF vehicles approximately 11 minutes to travel about 2.0 mi [3.2 km] by public roads, a dirt road with a significant incline and off-road terrain to reach the site." The Lexington accident site was outside NFPA's proposed rapid response area (RRA, Figure 1, page 46).

Cost Perspectives

The sample comprised 11 percent of all Class I, II and III airports, and was selected for geographic and airport size diversity. Data were collected about direct and indirect costs of enhancing their response capability, including factors such as training more firefighters. Data then were extrapolated to all 476 airports to estimate nationwide costs.

"It was not possible to estimate all costs; the most significant of these is the requirement to make the entire RRA accessible to ARFF vehicles within two minutes," the report said, citing construction and station relocation costs even when the airport owns

Rapid Response Area



ARFF = aircraft rescue and fire fighting; NFPA = U.S. National Fire Protection Association; RRA = rapid response area

Note

In NFPA's proposal, any point in the RRA located on airport property must be accessible to ARFF vehicles. The first responding ARFF vehicle must be able to reach these points within 2.5 minutes during conditions of optimum visibility and surface conditions, and other required ARFF vehicles would arrive at 30-second intervals. The dimensions of the RRA are the same for every runway regardless of the aircraft type used to determine the airport's ARFF index.

Source: Richard Golaszewski, Benedict Castellano and Robert E. David

Figure 1

sufficient land beyond the runway safety area. "Firefighter salaries represent the largest annual cost impact."

Twenty airports in the sample could not meet the ICAO three-minute response standard. Projected costs nationwide just to meet this standard were $36 million initially for ARFF vehicles, equipment and training with recurrent annual costs of $16.5 million.

Projected initial costs for additional ARFF vehicles, stations and firefighters to comply with unmet ICAO or NFPA standards represent a small fraction of the total cost impact over time. For example, "the NFPA two-minute runway response standard has the highest costs, with initial costs of $2.9 billion and annual operating and depreciation costs of $1 billion," the report said. "The NFPA three-minute response to taxiways, ramps and aprons (maneuvering area) has initial costs of $1.2 billion and annual operating and maintenance costs of $747.8 million."

Adoption of the NFPA two-minute response standard would require the most ARFF stations, ARFF vehicles and firefighters. "The 592 additional stations are estimated to cost $2 billion and the 1,018 vehicles are estimated to cost $708 million," the report said. "The largest increase in annual operating cost is $776.3 million for additional firefighters."

The NFPA three-minute movement-area response standard would require 225 new or relocated stations costing $823.3 million, 450 new ARFF vehicles costing $310 million and 8,694 additional firefighters at an annual cost of $635.4 million, the report said.

Adopting the NFPA standard for ARFF vehicles alone would generate a requirement for an additional 132 vehicles, primarily at Class IA and IB airports. "The initial costs of the vehicles are estimated at $67.1 million, while the costs of firefighter equipment and initial training are $76.4 million," the report said. The NFPA staffing requirement — typically adding four firefighters at Class IIA and IIIA airports and more than 20 at Class IB and IC airports — alone would generate added costs of $545.7 million annually in firefighter salaries and benefits.

U.S. airport managers, fire chiefs and other officials expressed logistical and safety concerns about adopting RRAs at their airports. The main concerns were geographic obstacles, including existing major roadways, and safety issues created by driving ARFF vehicles at least 37.5 mph (60.4 kph) across unpaved surfaces of an RRA to meet a response standard.

"Almost 75 percent of the [proposed] RRAs at the airports interviewed (95 of 129 runways) cannot meet the two-minute accessibility requirement as configured today," the report said. "The data gathered did not permit us to make an estimate of the costs needed to make the on-airport RRA specified by NFPA fully accessible to ARFF vehicles."

The TRB also considered the differences in standards for quantities of fire-suppressing agents, which were less significant. The researchers also estimated the costs of all enhancements per enplaned passenger at each of the representative airports.

The report notes that its cost estimates inevitably would vary from actual costs of proposed enhancements because of unknown variables, including assumptions about the future regulatory environment. "The actual increase in ARFF costs experienced by any airport would be based on the specific changes to Part 139, because FAA has the latitude to adopt all, some or none of the other industry standards," the report said.

Note

1. Golaszewski, Richard; Helledy, Gregson; Castellano, Benedict; David, Robert E. "How Proposed ARFF Standards Would Impact Airports." Airport Cooperative Research Program, U.S. Transportation Research Board of the National Academies. June 17, 2009.

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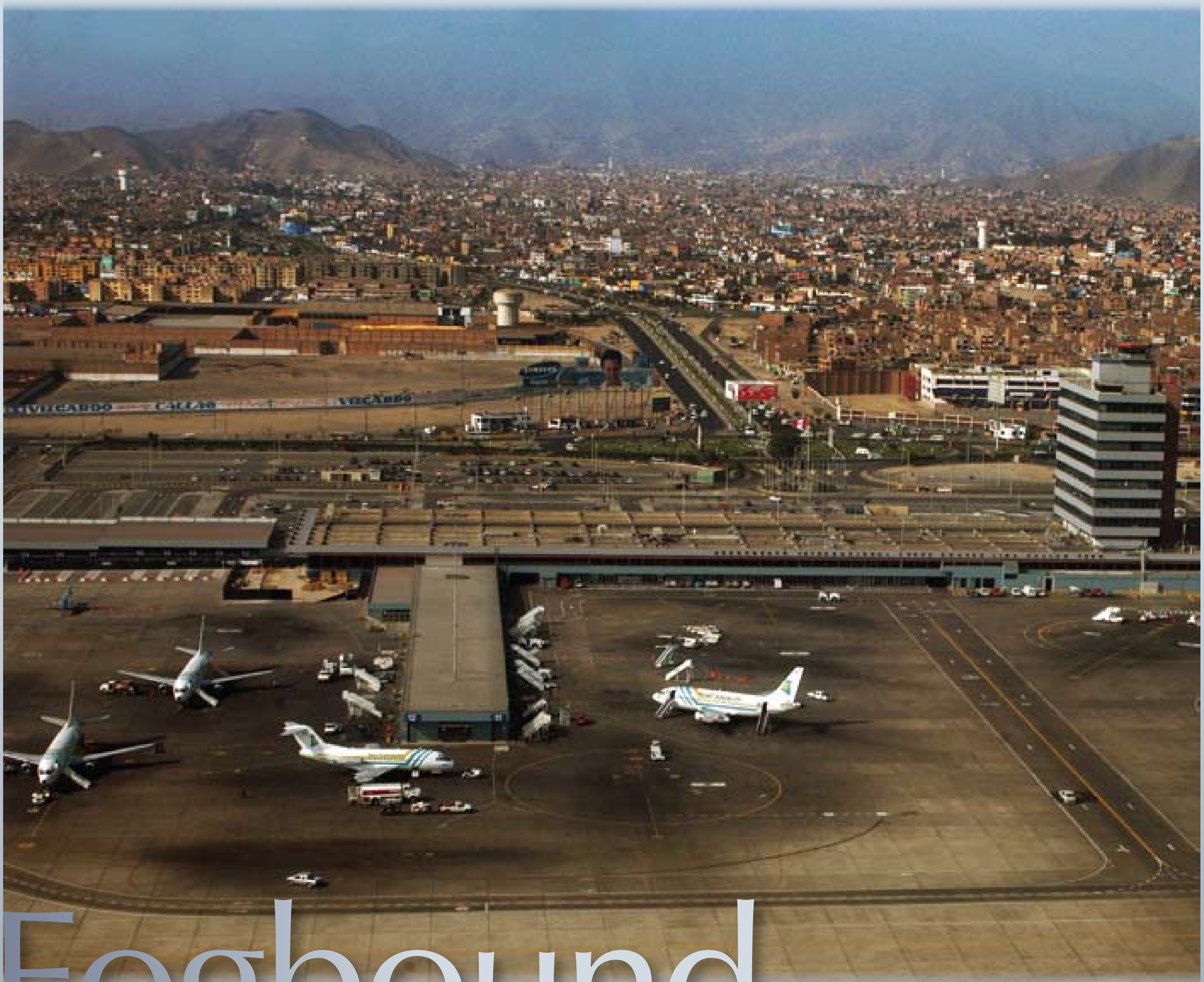

Fogbound

BY LESLIE JOSEPHS

A CAT III landing system provides hope for keeping Peru's key airport open during the busy tourist season.

A dense fog blanketed most of Peru's coastal capital in early May. Lima's Jorge Chávez International Airport was shut down for at least six days — four of them consecutively — grounding hundreds of flights, rerouting others and stranding thousands of passengers, many of them tourists who had traveled long distances to see the country's treasures.

Although usually not as severe, fog is always expected as Peru's autumn begins. While nighttime temperatures begin to dip significantly in May, the days are still warm and sunny. It is this gap in daytime and nighttime temperatures that generates the fog, which generally burns off by midday.

The density of the fog is sufficient to bring operations at the airport to a halt. With only a Category (CAT) II instrument landing system (ILS) in place, requiring a runway visual range of no less than 350 m (1,200 ft) and allowing

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aircraft to descend no lower than 100 ft without the appropriate references in sight, flight cancellations and delays sometimes persist for days on end.

Lima's airport has long needed a CAT IIIC landing system, which would allow suitably equipped aircraft and specially trained flight crews to land in zero visibility, at least partially alleviating the seasonal logjam. The sluggish pace of the Peruvian government's investment in the country's principal airport has proved to be a major headache for travelers and airlines alike.

No other airline has suffered more than Chile's LAN Airlines, whose local subsidiary LAN Peru controls 80 percent of the domestic market and whose domestic and international flights comprise more than half of Jorge Chávez's air traffic. "There's a lot of things that Peru should have but doesn't," said Jorge Vilches, general manager of LAN Peru. "It's something they're working on."

Indeed, the Peruvian government has now committed to purchasing the zero-zero landing equipment. The Ministry of Transportation and Telecommunications says that the CAT IIIC landing system should be up and running by May 2010.

The Peruvian Airport and Commercial Aviation Corp., or CORPAC, the government company that equips Peru's airports and oversees air traffic, estimates that the system will cost about $3.5 million, including training for airport staff — a modest investment for the region's so-called rising star. Peru had the highest economic growth rate in Latin America in 2008 — 9.8 percent. The country has one of the few economies in the region that is expected to grow this year.

Nevertheless, lagging investment in infrastructure is a common complaint in Peru, where the government is scrambling to draw investment in the construction and improvement of roads and ports.

"The government has not acted opportunely in implementing technology that is more efficient to allow planes to land in difficult conditions," said José Maslucán, a congressman who heads the Transportation Committee.

Peru is eager to position itself as a prime destination for foreign capital and foreign visitors. Despite the slow pace in approving the installation of a landing system that will enable year-round operations, the government has big plans for Lima's airport. It wants to have a second runway operating there within the next five years.

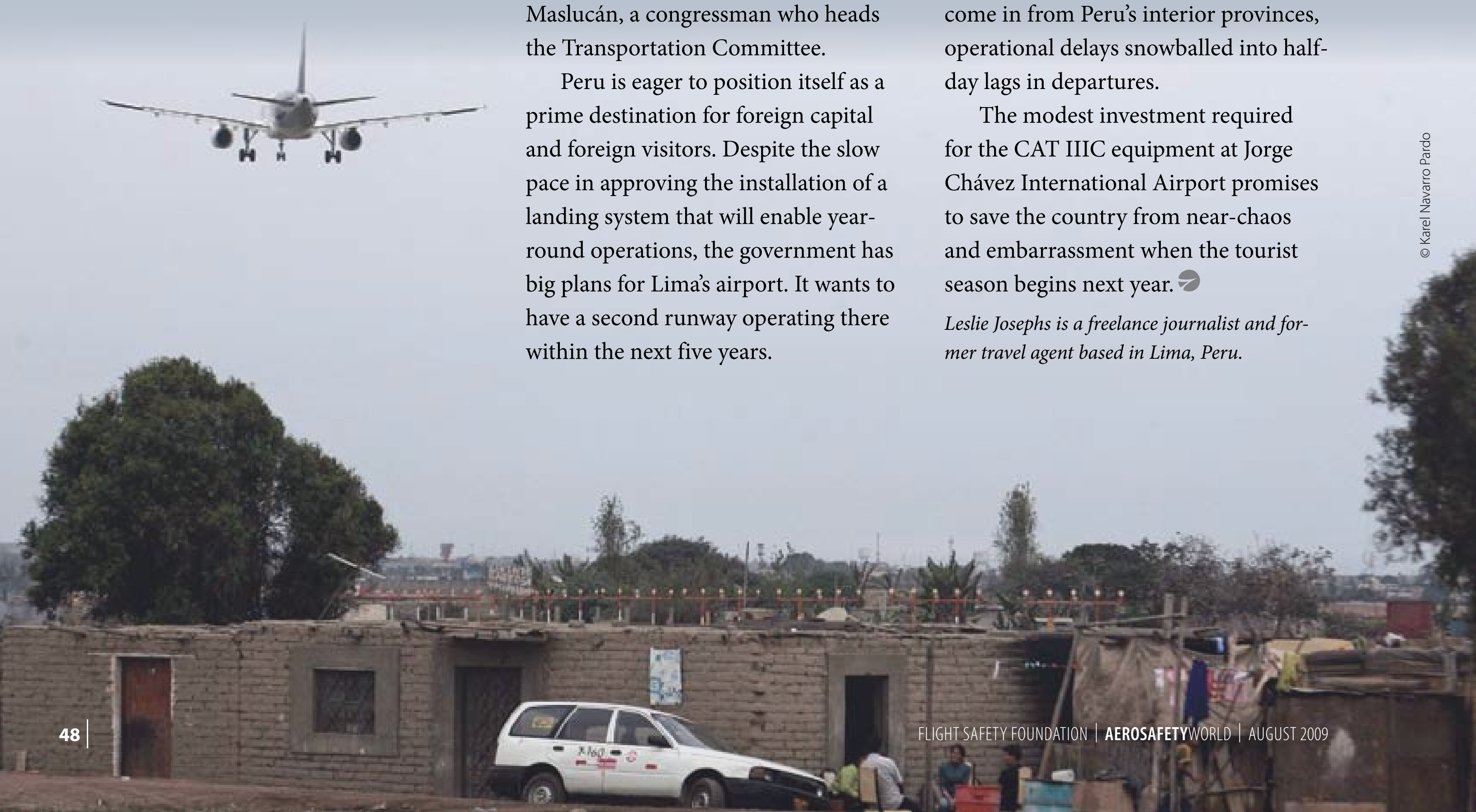
"Now more than ever, Peru needs to try to show the world that we're able to propel more air transit," Maslucán said.

Travel to Peru has indeed increased in recent years. The country's tourist destinations, particularly the no. 1 tourist site, the pre-Columbian Inca citadel of Machu Picchu, continue to draw hordes of visitors. Foreign visitors to Peru nearly doubled from 1.1 million in 2002 to 2.1 million last year, according to Peru's Foreign Trade and Tourism Ministry.

The economic impact of the seasonal fog that had virtually closed Jorge Chávez International Airport for hours and days on end has not been quantified. Around 230 flights typically go in and out of Jorge Chávez every day. This year, the fog could not have rolled in at a worse time. Between April 30 and May 4, 56 flights were canceled because of the fog. Friday, May 1, was a bank holiday and nearly all domestic flights were sold out. The airport was again closed for several hours each day on May 5–7. Because flights were unable to come in from Peru's interior provinces, operational delays snowballed into half-day lags in departures.

The modest investment required for the CAT IIIC equipment at Jorge Chávez International Airport promises to save the country from near-chaos and embarrassment when the tourist season begins next year.

Leslie Josephs is a freelance journalist and former travel agent based in Lima, Peru.



More Accidents, Fewer Fatalities

Runway excursions were prominent in 2008 commercial jet accidents worldwide.

BY RICK DARBY

Runway excursions, the focus of the FSF Runway Safety Initiative and the *Runway Excursion Risk Reduction Toolkit* (p. 12), were prominent among worldwide commercial aviation accidents in 2008, according to the latest data from Boeing Commercial Airplanes.[1,2] Initial approach, final approach and landing continued to be the most accident-prone phases of flight.

Boeing's data include accidents involving commercial jet airplanes heavier than 60,000 lb (27,216 kg) maximum gross weight, and exclude types manufactured in the Russian Federation or the Soviet Union. Limited data are presented for the most recent year, 2008, but more extensive data are supplied for trailing periods beginning in 1999 and 1959. The second period covers roughly the entire commercial jet transport era.

There were 283 accidents involving passenger airplanes in the world commercial jet fleet in 1999–2008 (Table 1). That compared with 286 in 1998–2007 and 285 in 1997–2006. Fatal accidents — 76 in the most recent 10-year period — represented an improvement for this type of operation over 1998–2007, when there were 78. But they exceeded the 75 in 1997–2006.

There was little change in accident numbers in any category compared with the 1998–2007 period, but the number of on-board fatalities in all passenger operations decreased from 5,105 to 4,670, a 9 percent reduction. The improvement was more pronounced in charter operations, from 57 in 1998–2007 to four in 1999–2008, a 93 percent reduction. On-board cargo flight fatalities were down 12 percent, from 42 to 37.

The 2008 accident total for all types of operations was 53, compared with 2007's 38, but last year's accidents resulted in 356 on-board fatalities (Table 2, p. 50) versus 576 in 2007. In 2006, there were 28 accidents and 498 on-board fatalities. Although the summary did not offer a breakdown of accidents by country of registry, a letter accompanying the publication said, "U.S. airlines had one on-board fatality in 2008, compared to their average of 44 on-board fatalities per year for the preceding 10-year period."

Of the 53 accidents, 16 — 30 percent — were runway excursions. Three of the

Accidents, Worldwide Commercial Jet Fleet, by Type of Operation

	All Accidents		Fatal Accidents		On-board Fatalities (External Fatalities)*	
Type of operation	1959–2008	1999–2008	1959–2008	1999–2008	1959–2008	1999–2008
Passenger	1,287	283	471	76	27,443 (776)	4,670 (175)
Scheduled	1,184	265	426	74	23,330	4,666
Charter	103	18	45	3	4,113	4
Cargo	231	79	69	13	238 (329)	37 (78)
Maintenance test, ferry, positioning, training and demonstration	112	8	42	2	196 (66)	10 (0)
Totals	**1,630**	**370**	**582**	**91**	**27,877 (1,171)**	**4,717 (253)**
U.S. and Canadian operators	513	73	174	14	6,154 (448)	366 (83)
Rest of the world	1,117	297	408	77	21,723 (723)	4,351 (170)
Totals	**1,630**	**370**	**582**	**91**	**27,877 (1,171)**	**4,717 (253)**

*External fatalities include ground fatalities and fatalities on other aircraft involved, such as helicopters or small general aviation airplanes, that are excluded.

Source: Boeing Commercial Airplanes

Table 1

2008 Airplane Accidents, Worldwide Jet Fleet

Date	Airline	Model	Accident Location	Phase of Flight	Description	Damage	Fatalities On-board (External)	Major Accident
Jan. 2	Iran Air	F-100	Tehran, Iran	Takeoff	Struck ground	Destroyed		●
Jan. 3	Atlas Blue	737-400	Deauville, France	Landing	Overrun	Substantial		
Jan. 8	Aigle Azur	A321	Algiers, Algeria	Landing	Hard landing, tail strike	Substantial		
Jan. 9	Blue Air	BAe 146	Bacau, Romania	Landing	Nose landing gear collapse	Substantial		
Jan. 15	Air France	A300-600	Paris	Landing	Veered off runway	Substantial		
Jan. 17	British Airways	777-200	London	Final approach	Landed short	Destroyed		●
Jan. 28	Merpati Nusantara Airlines	737-300	Merauke, Indonesia	Landing	Struck cow on landing roll	Substantial		
Feb. 1	Lloyd Aereo Boliviano	727-200	Near Trinidad, Bolivia	Final approach	After fuel exhaustion, landed in field	Destroyed		●
Feb. 2	Atlas Air	747-200	Lome, Togo	Climb	Cargo shifted, damaged aft pressure bulkhead	Substantial		
Feb. 7	Airlink QantasLink	717-200	Darwin, Australia	Landing	Hard landing	Substantial		
Feb. 25	Aeromexico	777-200	Mexico City	Taxi	Wing struck light pole	Substantial		
March 1	Dragonair	747-400	Manchester, England	Landing	Engines struck ground	Substantial		
March 10	Adam Air	737-400	Batam, Indonesia	Landing	Landing gear collapsed, veered off runway	Substantial		
March 10	Saudi Arabian Airlines	777-200	Near Riyadh, Saudi Arabia	Final approach	Landing gear failure	—		
March 14	Air Algerie	737-800	Setif, Algeria	Landing	Hard landing	Substantial		
March 24	Aerosvit Airlines	737-200	St. Petersburg, Russia	Taxi	Struck tug	Substantial		
March 25	Saudi Arabian Airlines	747-300	Dhaka, Bangladesh	Landing	Engine fire	Substantial		
April 15	Hewa Bora Airways	DC-9	Goma, Zaire	Takeoff	Overrun	Destroyed	3 (37)	●
April 22	Carpatair	BAe 146	Bucharest, Romania	Landing	Veered off runway	Substantial		
May 4	Airblue Limited	A321	Quetta, Pakistan	Landing	Tail strike	Substantial		
May 16	Asia Pacific Airlines	727-200	Pohnpei, Micronesia	Landing	Departed wet runway	Substantial		
May 24	Air Ivoire	A321	Cotonou, Benin	Landing	Hard landing	Substantial		
May 25	Kalitta Air	747-200	Brussels	Takeoff	Overrun	Destroyed		●
May 30	TACA International Airlines	A320	Tegucigalpa, Honduras	Landing	Overrun	Destroyed	3 (2)	●
June 6	Aerocondor	737-200	Near Pucallpa, Peru	Climb	Damaged horizontal stabilizer and elevator	Substantial		
June 10	Sudan Airways	A310	Khartoum, Sudan	Landing	Overrun	Destroyed	33	●
June 14	FedEx	DC-10	Near New York City	Descent	Airspeed loss, excessive-maneuver damage	Substantial		
June 18	Comair	737-200	Durban, South Africa	Landing	Veered off side of runway	Substantial		
June 19	China Eastern Airlines	A319	Near Changsha, China	Cruise	Cargo hold fire	Substantial		
June 28	ABX Air	767-200	San Francisco	Parked	Fire	Substantial		
July 2	Pakistan International Airlines	777-200	Near Milan, Italy	Descent	Severe hail damage	Substantial		
July 6	USA Jet Airlines	DC-9	Saltillo, Mexico	Final approach	Crashed and burned	Destroyed	1	●
July 7	Kalitta Air	747-200	Near Bogota, Colombia	Initial climb	Engine failure	Destroyed	(2)	●
July 14	Chanchangi Airlines	737-200	Port Harcourt, Nigeria	Landing	Overrun	Substantial		
July 25	Qantas	747-400	Near Manila, Philippines	Cruise	Depressurization	Substantial		
Aug. 5	Lufthansa	A320	Manchester, England	Taxi	Struck by taxiing airplane	Substantial		
Aug. 15	Jet2	737-300	Near Bergamo, Italy	Final approach	Hail storm damage	Substantial		
Aug. 20	Spanair	MD-82	Madrid	Takeoff	Crashed and burned	Destroyed	154	●
Aug. 24	ITEK AIR AirCompany	737-200	Near Bishkek, Kyrgyzstan	Final approach	Crashed and burned	Destroyed	64	●

Table 2

(continued next page)

2008 Airplane Accidents, Worldwide Jet Fleet

Date	Airline	Model	Accident Location	Phase of Flight	Description	Damage	Fatalities On-board (External)	Major Accident
Aug. 27	Sriwijaya Air	737-200	Jambi, Indonesia	Landing	Overrun	Substantial		
Aug. 30	CONVIASA	737-200	Near Latacunga, Ecuador	Descent	Crashed in mountainous terrain	Destroyed	3	●
Sept. 1	HeavyLift International Airlines	DC-8	El Fasher, Sudan	Landing	Hard landing	Substantial		
Sept. 14	Aeroflot-Nord	737-500	Near Perm, Russia	Initial approach	Crashed in darkness and poor weather	Destroyed	88	●
Sept. 22	ICARO	F-28	Quito, Ecuador	Takeoff	Overrun	Destroyed		●
Oct. 1	KD Avia	737-300	Kaliningrad, Russia	Landing	Gear-up landing	Substantial		
Oct. 7	Qantas	A330	Near Learmonth, Australia	Cruise	Autoflight-commanded pitch-down	—		
Oct. 16	Rutaca Airlines	737-200	Caracas, Venezuela	Landing	Veered off	Substantial		
Oct. 27	Cargo B Airlines	747-200	Brussels	Takeoff	Tail strike	Substantial		
Nov. 10	Ryanair	737-800	Rome	Final approach	Multiple bird strikes	Destroyed		●
Nov. 27	XL Airways Germany	A320	Near Perpignan, France	Initial approach	Broke up and struck sea	Destroyed	7	●
Dec. 15	Mesa Airlines	CRJ-700	Chicago	Landing	Left main landing gear retracted	Substantial		
Dec. 20	Continental Airlines	737-500	Denver	Takeoff	Veered off	Destroyed		●
Dec. 26	American Airlines	MD-83	Los Angeles	Taxi	Collision with tug	Substantial		
53 total accidents							**356 (41)**	**17**

Note: Airplanes manufactured in the Commonwealth of Independent States or the Soviet Union are excluded because of lack of operational data. Commercial airplanes used in military service are also excluded.

Source: Boeing Commercial Airplanes

Table 2

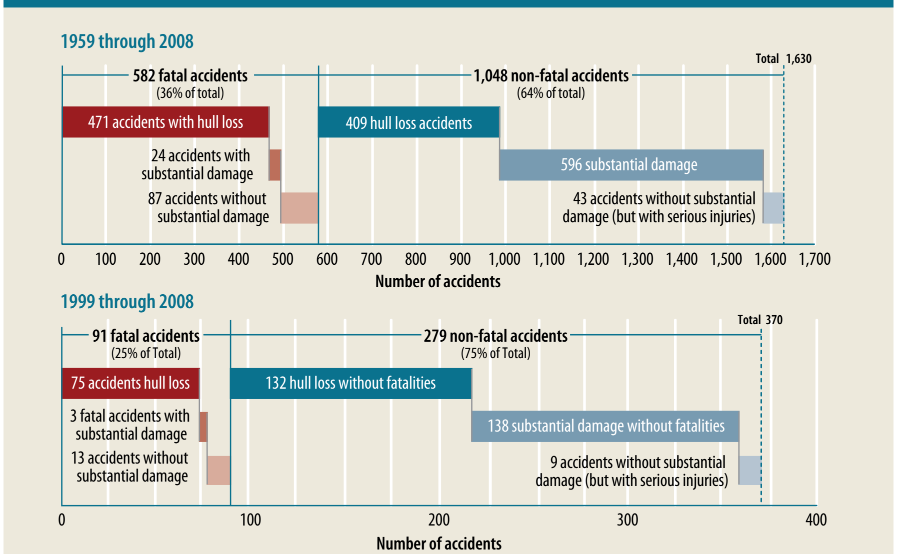
10 accidents with onboard fatalities, or 30 percent, were runway excursions. Six excursions were classified as major accidents, a category that partially overlaps the fatal accident category.[3]

Thirty-one accidents, 58 percent of the total, occurred in the initial approach, final approach or landing phase. The accidents included six fatal and six major accidents.

In the most recent 10-year period, fatal accidents accounted for 25 percent of the total (Figure 1). The fatal-accident proportion of all accidents was 36 percent for the 1959–2008 span. The number of fatal accidents without substantial airplane damage was 14 percent and 15 percent of the total of fatal accidents in the past 10 years and from 1959 onward, respectively.

Among nonfatal accidents, those involving substantial damage represented

Accidents, by Injury and Damage, Worldwide Commercial Jet Fleet



Note: Airplanes manufactured in the Commonwealth of Independent States or the Soviet Union are excluded because of lack of operational data. Commercial airplanes used in military service are also excluded.

Source: Boeing Commercial Airplanes

Figure 1

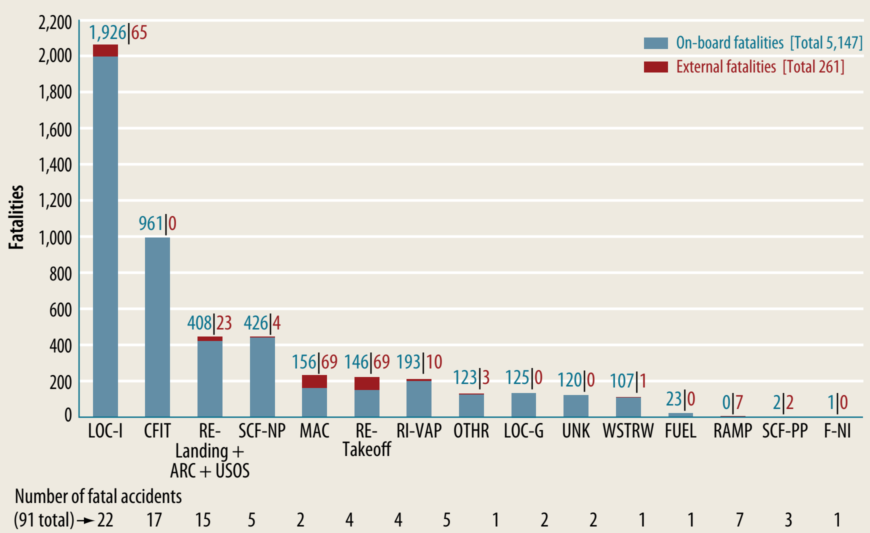
49 percent in 1999–2008 and 57 percent in 1959–2008. Thirteen fatal accidents in the most recent 10-year period, 14 percent of the fatal-accident total, were not accompanied by substantial damage. Nine nonfatal accidents with serious injuries, but no substantial damage, represented 3 percent of the nonfatal-accident total for this period.

For the 10 years ending in 2008, the fatal accident rate for scheduled commercial passenger operations worldwide was 0.45 per million departures. All other operations — charter passenger and cargo, scheduled cargo, maintenance test, ferry, positioning, training and demonstration flights — had a fatal accident rate of 0.63 per million departures.

Tabulating fatal accidents by the U.S. Commercial Aviation Safety Team (CAST)/International Civil Aviation Organization (ICAO) taxonomy, "loss of control in flight" was the dominant category in 2008 and the trailing nine years (Figure 2).[4] Loss of control accidents resulted in 1,926 on-board fatalities, more than double the 961 for "controlled flight into terrain" (CFIT). The difference widened since the 1998–2007 report, when the numbers were 1,984 and 1,137 respectively. The CFIT data for the 1998–2007 period were also an improvement on 1997–2006, when on-board CFIT fatalities totaled 1,655. It appears that industry efforts to reduce CFIT can claim a degree of success.

The number of on-board fatalities in the next-largest category for 1998–2007, "system/component failure or malfunction (non-powerplant)," was also reduced from 655 to 426 in the latest 10-year period.

Fatalities by CAST/ICAO Taxonomy Accident Category, Worldwide Commercial Jet Fleet, 1998–2007



CAST = U.S. Commercial Aviation Safety Team; ICAO = International Civil Aviation Organization; ARC = abnormal runway contact; CFIT = controlled flight into terrain; F-NI = fire/smoke (non-impact); FUEL = fuel related; LOC-G = loss of control – ground; LOC-I = loss of control – in flight; MAC = midair/near midair collision; OTHR = other; RAMP = ground handling; RE = runway excursion; RI-VAP = runway incursion – vehicle, aircraft or person; SCF-NP = system/component failure or malfunction (non-powerplant); SCF-PP = system/component failure or malfunction (powerplant); UNK = unknown or undetermined; USOS = undershoot/overshoot; WSTRW = wind shear or thunderstorm.

No accidents were noted in the following principal categories: aerodrome, abrupt maneuver, air traffic management/communications, navigation, surveillance, cabin safety events, evacuation, fire/smoke (post-impact), ground collision, icing, low altitude operations, runway incursion – animal, security related, turbulence encounter.

Note: Principal categories are as assigned by CAST. Airplanes manufactured in the Russian Federation or the Soviet Union are excluded because of lack of operational data. Commercial airplanes used in military service are also excluded.

Source: Boeing Commercial Airplanes

Figure 2

Notes

1. Boeing Commercial Airplanes. *Statistical Summary of Commercial Jet Airplane Accidents: Worldwide Operations 1959–2008.* Available via the Internet at <www.boeing.com/news/techissues>.

2. An airplane *accident* is defined as "an occurrence associated with the operation of an airplane that takes place between the time any person boards the airplane with the intention of flight and such time as all such persons have disembarked, in which death or serious injury results from being in the airplane; direct contact with the airplane or anything attached thereto; or direct exposure to jet blast; the airplane sustains substantial damage; or the airplane is missing or completely inaccessible." Occurrences involving test flights or resulting from hostile action such as sabotage or hijacking are excluded.

3. Boeing defines a *major* accident as one in which any of three conditions is met: the airplane was destroyed, or there were multiple fatalities, or there was one fatality and the airplane was substantially damaged. Flight Safety Foundation supports the use of this term to designate the most severe accident category, in place of the traditional term *hull loss*, which the Foundation believes is more significant for insurance actuarial purposes than as a measure of risk.

   Substantial damage is "damage or failure which adversely affects the structural strength, performance or flight characteristics of the airplane, and which would normally require major repair or replacement of the affected component."

4. The taxonomy is described at <www.intlaviationstandards.org>.

More Accidents, Less Oversight

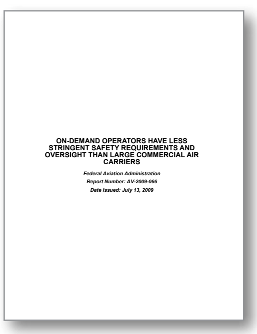
U.S. on-demand operations, with a far higher accident rate than scheduled commercial carriers, receive less attention from the FAA.

REPORTS

Counting Seats Is Not What Counts

On-Demand Operators Have Less Stringent Safety Requirements and Oversight Than Large Commercial Air Carriers

U.S. Department of Transportation, Office of Inspector General. AV-2009-066. July 13, 2009. 25 pp. Available via the Internet at <www.oig.dot.gov/item.jsp?id=2511>.



ON-DEMAND OPERATORS HAVE LESS STRINGENT SAFETY REQUIREMENTS AND OVERSIGHT THAN LARGE COMMERCIAL AIR CARRIERS

Federal Aviation Administration

Report Number: AV-2009-066

Date Issued: July 13, 2009

In the United States, on-demand — also called for-hire, air taxi, chartered and unscheduled — flights are conducted by more than 2,300 operators, compared with about 120 commercial air carriers. On-demand operators' aircraft, estimated at more than 9,000 total, are configured for 30 passengers or fewer or less than 7,500 lb of payload under U.S. Federal Aviation Regulations (FARs) Part 135. On-demand includes unscheduled passenger flights, cargo operations, commercial sightseeing, and air medical missions such as emergency medical services.

"The operators comprising the on-demand industry segment can range from a company with one pilot and one aircraft to a company with over 600 aircraft," the report says. "On-demand aircraft range from small, two-seat piston engine aircraft to helicopters to turboprops and jets with 10 or more seats."

As an example of the leaner oversight given to on-demand companies, the report cited an operator that offered "dozens of flights daily during the summer" for glacier viewing, in the course of which the aircraft landed and took off on skis. "This operator flies 17 aircraft and was inspected eight times by FAA [the U.S. Federal Aviation Administration] in 2008," the report says. "In contrast, a [FARs] Part 121 operator with 10 aircraft, overseen by the same FAA oversight office, received 199 inspections in 2008."

The report's findings are summarized under three major headings.

First, "On-demand operators have less stringent safety regulations than commercial operators." The report says that the on-demand industry has changed, while regulations have not: "Many of the Part 135 provisions [which apply to on-demand operations] have not been updated since 1978." Today, the use of jet aircraft is far more common, and operators fly internationally more frequently, than was the case decades ago.

"Current requirements for maintenance focus on the number of passenger seats [as a criterion for safety inspection] rather than the risk factors in an aircraft's operating environment," the report says. For example, unlike Part 121 carriers, on-demand carriers are not required to have a maintenance program that includes required inspection items and a continuous analysis and surveillance system.

Crew resource management (CRM) training is not required for on-demand operators. "CRM for on-demand operators is one of the NTSB's [U.S. National Transportation Safety Board's] six most wanted aviation safety improvements," the report says.

The FAA has issued a notice of proposed rule making that would expand CRM training requirements to Part 135 operators (*ASW*, 6/09, p. 45).

Other areas noted by the report under this heading are the lack of required safety training for cabin attendants if the aircraft carries 19 or fewer passengers; the lack of a requirement for dispatchers who follow the flight and can inform the flight crew of conditions that might affect safety, such as adverse weather; no required aging-related aircraft inspections in on-demand service, although according to an FAA study, 60 percent of the on-demand passenger and cargo fleet is over 20 years old; that maintenance requirements for on-demand aircraft seating nine or fewer passengers are less demanding than those for larger aircraft; and that recommendations to strengthen Part 135 oversight, submitted in 2005 by the FAA Aviation Rulemaking Committee (ARC), have not resulted in any final rule making by the agency.

"We found that 16 NTSB recommendations resulting from on-demand operator accident investigations issued since June 2002 also remain open," the report says. "For example, the NTSB has been concerned about the safety effects of fatigue on flight crews since 1989, and has recommended that operators set working-hour limits for flight crews based on fatigue research. … Another key NTSB concern is reducing dangers to aircraft flying in icing conditions; this has been on the NTSB's most wanted aviation safety improvements list since 1997. FAA's response to this has been classified as 'unacceptable' by the NTSB."

"FAA lacks a risk-based oversight strategy for on-demand operators."

The FAA has recently amended the airworthiness standards applicable to transport category airplanes certificated for flight in icing conditions. The rule, effective Sept. 2, 2009, requires either that ice protection systems be automatically activated or that a means be provided to tell pilots when they should be activated.

The second major heading for the report's findings is "on-demand operators have more inherent risks in their operations and more fatal accidents than commercial operators."

The report says that on-demand operators have more takeoffs and landings per aircraft; fly to many airports lacking control towers; use pilots who may be unfamiliar with routes; and have smaller aircraft than airlines. "Because they fly at lower altitudes, on-demand aircraft are more vulnerable to sudden weather changes or other obstacles," the report says. "We note that the high-end jet aircraft flown by some on-demand operators have the same advanced electronics as commercial aircraft. Many of the smaller operators, however, still have very basic equipment in their cockpits."

On-demand operators have more fatal accidents as a result of the higher risks involved, the report says: "Between 2000 and 2008, the fatal accident rate for on-demand operators was 50 times higher than that of commercial carriers. Since January 2003, on-demand operators have been involved in 95 fatal accidents, which resulted in 249 deaths. … The most fatalities for the period 2003 through 2008 occurred in the states of Alaska and Hawaii and in the Gulf of Mexico. In both Alaska and Hawaii, air tours are common, and small planes are a major source of transportation for people and cargo. In addition, there are numerous helicopter operations in the Gulf of Mexico delivering crews and supplies to oil rigs [platforms]."

The report lists other problems under the heading "FAA lacks a risk-based oversight strategy for on-demand operators."

The FAA Air Transportation Oversight System, based on data-driven risk assessment, is the agency's primary tool for overseeing commercial carriers. But, the report says, "oversight of on-demand operators is primarily based on required, pre-determined inspection items assigned to inspectors on a nationwide basis. These items are focused on compliance with regulations rather than where risk dictates."

Required inspections, called "R-items," for on-demand operators are based on the National Program Guidelines (NPG), assigned nationally without regard to specific operator factors. "Inspectors must complete all R-items and may add other inspections to their work plan (planned or P-items) for operators that they feel need additional oversight," the report says. "However, some of the inspectors we spoke with did not complete P-items because they only had time to complete the R-items on their programs."

Inspections are spread thinly, the report says: "Operations inspectors must conduct a ramp inspection on a minimum of 10 percent — a minimum of 25 percent for the Alaska region — of all on-demand operators that are certificated within their region. Surveillance of these operators must be rotated from year to year, meaning an operator could receive a ramp inspection from an operations inspector as seldom as once every 10 years."

The operators flying the smallest aircraft get less attention. The report says, "We found that 78 percent of all fatal on-demand accidents between 2003 and 2008 involved aircraft seating nine or fewer passengers. Yet, the NPG require inspections for aircraft seating 10 or more passengers that are not required for aircraft seating nine or less. Single-engine aircraft and single-pilot operations have even fewer required inspections than operators categorized as [having] nine or fewer seats."

A new, risk-based oversight method, the System Approach for Safety Oversight (SASO), is under development. But the FAA plans to wait until SASO is up and running — not expected before 2013 — rather than implement any interim prioritization process for on-demand aviation, the report says.

The report recommends that FAA revise its regulations and practices by:

- "Establishing milestones to track the implementation of recommendations made by the ARC and the NTSB that would enhance the safety and oversight of on-demand operators and reporting annually on progress toward those milestones to the Office of Inspector General;
- "Implementing an interim risk assessment oversight process for on-demand operators until the risk-based SASO approach is implemented; [and,]
- "Considering the inherent operational risk factors in on-demand operations in developing risk indicators for the new risk-based Part 135 oversight system."

— Rick Darby

Handle With Care

Musculoskeletal Ill-Health Risks for Airport Baggage Handlers: Report on a Stakeholder Project at East Midlands Airport

Oxley, Laraine; Riley, David; Tapley, Sarah. Health and Safety Executive (HSE), United Kingdom. RR675. 106 pp. Available via the Internet at <www.hse.gov.uk/research/rrhtm/rr675.htm>.

According to the results of an HSE questionnaire, 73 percent of airport baggage handlers reported having lower back trouble, 51 percent reported knee problems and 43 percent reported shoulder trouble in the previous three months. "Compared to other data from physically demanding tasks, baggage handling produced the highest prevalence rates for trouble experienced in the last three months/year," the report says.

The report describes work undertaken to better understand musculoskeletal risks of baggage handling and to appraise the efficacy of new extending belt loader (EBL) technology. Data were collected on site visits to East Midlands Airport, Bristol Airport and Stansted Airport, England.

Loading baggage onto aircraft is performed according to two basic methods: direct-to-hold, where the baggage is transferred manually from a cart to the hold door, and mechanically assisted, using some form of equipment, mainly belt loaders. Unloading uses similar methods in reverse.

In its recommendations, the report says that "EBL-type technology significantly reduces musculoskeletal risks through the mechanization of the transfer of bags down the hold and improvements in posture and lifting." It adds, "For the external on- and off-load of bags, the vertical level and lift distance of the bags is more favorable when using a belt loader … compared to direct-to-hold loading from the ramp."

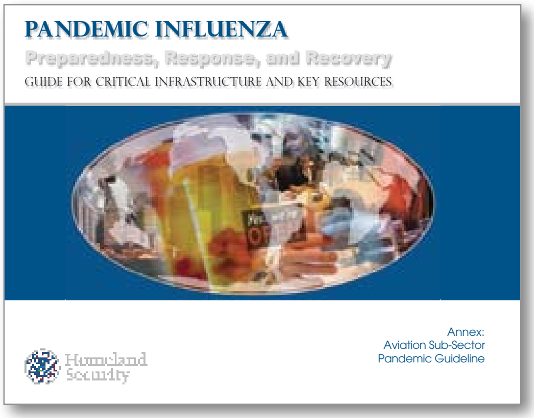
— Rick Darby

WEB SITES

Flu Planning

Pandemic Influenza: Preparedness, Response, and Recovery Guide for Critical Infrastructure and Key Resources. Annex: Aviation Sub-Sector Pandemic Influenza Planning Guidelines, <www.dot.gov/pandemicflu/pdf/aviation.pdf>

One would have to be living under a rock to be unaware of news reports of the latest threat of pandemic influenza virus. Most



governments provide information and guidance to individuals and businesses about planning and operations in anticipation of, and during, an outbreak. The U.S. Department of Homeland Security (DHS) issued an 84-page guide in 2006 saying, "Eighty-five percent of critical infrastructure resources reside in the private sector, which generally lacks individual and systemwide business continuity plans specifically for catastrophic health emergencies such as pandemic influenza." DHS said that most existing contingency plans for businesses are tailored for diverse natural and manmade disasters that "do not account for the extreme health impact assumptions and containment strategies projected for a severe pandemic influenza."

In March 2008, DHS issued a 16-page annex to the initial report, tailored specifically to aviation. "Organizations that fail to prepare for such a prolonged and potentially catastrophic event may find themselves without the staff, equipment or supplies necessary to continue providing essential transportation services for their customers and the nation," the annex says.

The annex is a non-prescriptive reference to help owners, operators and planners evaluate and augment their emergency response plans to include pandemic health events. DHS identified seven key areas of vulnerability with related questions and actions to consider. Noting that individual airports, airlines and other aviation businesses will be affected differently in a pandemic environment and act or react differently, the annex says guidelines "are designed simply to represent a starting point to stimulate thinking about further actions and options."

Seven key action areas and examples of questions to consider are these:

Identify and assess essential services, supporting functions and processes. How can your business adapt to support a community or the nation?

Review assets and equipment critical to support essential functions. Unlike a natural disaster, a health pandemic will not directly damage physical assets and infrastructure, but could recurring maintenance requirements be met during a pandemic lasting three months?

Review materials and supplies to sustain functions and equipment for up to 12 weeks. How would critical materials such as parts and fuel be affected? How vulnerable are contractors and suppliers?

Identify types and numbers of workers needed to sustain essential functions; policies and procedures that ensure safe workplaces and minimize disease transmission; and actions to protect and sustain essential workers. "A severe pandemic influenza scenario may result in absentee rates as high as 40 percent among all worker groups," says the DHS.

Identify interdependent relationships and actions to sustain mutual support. Which businesses does your organization most depend upon (such as communications, food, power generation or trucking), inside or outside of aviation?

Identify regulatory and government policy issues that may affect business operations. What issues might arise for your business if temporary regulatory waivers or new government restrictions are imposed?

Identify and assess consequences resulting from community mitigation strategies. How will local community quarantines and nonessential travel restrictions affect your business?

The annex and the initial report contain numerous references and links to other resources, documents and Web sites with information on influenza; occupational health and safety; public and media relations; internal communications; and other aspects of response planning, preparation and recovery. The initial report may be accessed directly at <www.flu.gov/plan/pdf/cikrpandemicinfluenzaguide.pdf>.

— *Patricia Setze*

Question of Command

In the absence of SOPs, authority for a land/go-around decision was uncertain.

BY MARK LACAGNINA

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

JETS

Captains Did Not Designate a PIC

Israel Aircraft Industries Astra SPX. Substantial damage. One minor injury.

Both pilots conducting the business flight from Coatesville, Pennsylvania, U.S., to Atlanta the evening of Sept. 14, 2007, were qualified as captains in the Astra. They routinely took turns flying the airplane from the left seat; however, they did not formally decide who had authority as pilot-in-command (PIC) for each flight, said the report by the U.S. National Transportation Safety Board (NTSB).

The right-seat pilot, the pilot monitoring (PM), was the aviation department's chief pilot. He held type ratings in several business jets and had 10,800 flight hours, including 2,200 hours in the Astra (now called the Gulfstream G100). The left-seat pilot, the pilot flying (PF), also held several business jet type ratings and had 16,042 flight hours, including 1,500 hours in the Astra.

As the airplane neared Atlanta's DeKalb-Peachtree Airport, the pilots were cleared to conduct the instrument landing system (ILS) approach to Runway 20L, which is 6,001 ft (1,829 m) long and 100 ft (30 m) wide. "The threshold was displaced 1,000 ft [305 m] due to obstructions," the report said. "The runway had precision markings that were in good condition. It was equipped with a precision approach path indicator [and] a medium-intensity approach lighting system with sequenced flashers."

Weather conditions included surface winds from 270 degrees at 7 kt, scattered clouds at 1,800 ft, broken clouds at 2,500 ft and an overcast ceiling at 3,800 ft. Reported visibility was 1 1/4 mi (2,000 m) in light rain and mist. However, the visibility decreased to 1/2 mi (800 m) in heavy rain and fog as the pilots conducted the ILS approach.

The Astra was descending on the glideslope when the PM announced that he had the approach lights in sight. The PF replied that he also had the lights in sight and disengaged the autopilot. "The [PF] then attempted to continue and land visually, though they were flying in moderate to heavy rain," the report said.

The PF told investigators that he initially had "good visual contact" with the approach lights but lost sight of the lights shortly after activating his windshield wiper. The PF said that he announced this to the PM and considered initiating a missed approach but did not go around because the PM replied that he still had the approach lights in sight. (The Astra has two windshields, each with its own wiper.)

Cockpit voice recorder (CVR) data indicated that the PM then began to direct the PF, saying, "Just follow the glideslope … little bit to the right, little to the right. … There it is. You got it?" The PF replied, "Yep, I got it." Seconds later, however, the PM again began providing directions, saying "Okay, to the left, left, left, left." The

PF asked, "I'm on the runway now, right?" The PM replied, "Yeah. … I got it."

The PM took control of the airplane, but both pilots realized that there was only about 1,000 ft of runway remaining. "We're not going to make it," said the chief pilot, now the PF. The other pilot said, "I don't know what to do."

The Astra was substantially damaged when it overran the runway, struck the localizer antenna complex and traveled several hundred feet before coming to a stop near the airport fence. The chief pilot sustained minor injuries; the left-seat pilot and the two passengers were not hurt.

Both pilots realized that there was only about 1,000 ft of runway remaining.

Investigators found that the Astra's windshields had not been maintained in accordance with the manufacturer's recommendations to preserve their water-shedding coating. The report said that this contributed to the left-seat pilot's loss of visual references after activating his windshield wiper.

The report said that during post-accident interviews, when queried about who was in command, "the [chief pilot] stated that he was confused as to who was the PIC and that he and the [left-seat pilot] were 'co-captains.' When asked about standard operating procedures (SOPs), the [chief pilot] advised that they [i.e., the aviation department] did not have any. They had started out with one pilot and one airplane, and they now had five pilots and two airplanes.

"The [chief pilot] later stated that they probably should have gone around when the flying pilot could not see out the window."

Short Circuit Breaches Oxygen Hose

Boeing 767-200. Substantial damage. No injuries.

The freighter had been loaded, and the pilots were preparing to start the engines for departure from San Francisco International Airport the night of June 28, 2008, when they heard a loud pop and hissing sounds. The first officer said, "Hey, there's something going on in the back." He opened the cockpit door and saw black smoke and flames near the ceiling of the entrance/service compartment, which is between the cockpit and the main deck cargo compartment. He told the captain, "We've got a fire … a big fire."

The CVR then recorded the sounds of the lavatory smoke detector and the fire warning bell. The first officer reported the fire to air traffic control (ATC) and requested aircraft rescue and fire fighting (ARFF) service. Unable to use the main door or service door because of the proximity of the intensifying smoke and flames, the pilots evacuated through their cockpit window exits.

The NTSB report said that ARFF personnel arrived about four minutes after the first officer reported the fire. They were unable to open the airplane's doors because of fire damage and initially used skin-penetrating nozzles to fight the fire. The fire was contained within about 25 minutes and extinguished about 18 minutes later.

Examination of the airplane revealed extensive thermal damage to the cockpit, the entrance/service compartment and the two forward cargo containers in the main deck cargo compartment. "[The operator] reported that the substantial damage to the airplane resulted in a hull loss," the report said.

Investigators determined that the fire most likely began when a short circuit in adjacent electrical wiring penetrated the hose for one of the three supplemental oxygen masks stowed in the entrance/service compartment and ignited a metal spring inside the hose. The oxygen and the polyvinyl chloride hose material, a plastic that chemically decomposes when exposed to heat, fueled the fire.

NTSB concluded that the probable causes of the accident were the design of the supplemental oxygen system hose and "the lack of positive separation between electrical wiring and electrically conductive oxygen system components." The investigation generated several recommendations regarding aging oxygen hoses, the proximity of oxygen system components to electrical wiring, smoke detection systems in cargo aircraft, and other issues (*ASW*, 7/09, p. 10).

Wind Shear Strikes on Short Final

Boeing 747-400. Substantial damage. No injuries.

Visual meteorological conditions (VMC) prevailed at Manchester (England) Airport the night of March 1, 2008, but the surface winds were strong and gusty. The flight crew of the 747, inbound on a cargo flight from Dubai, was cleared to conduct the ILS approach to Runway 23R. The automatic terminal information system reported winds from 280 degrees at 25 kt, gusting to 42 kt, and moderate to severe turbulence on approach to Runway 23R.

The aircraft did not encounter significant turbulence during the approach, but the enhanced ground-proximity warning system (EGPWS) generated a wind shear warning when the aircraft was 500 ft above ground level (AGL). The crew conducted a go-around and requested and received ATC radar vectors for another ILS approach. "The second approach was described as smoother but still with a strong wind from the northwest, resulting in a crosswind from the right which was close to the operator's limit for landing this aircraft," said the report by the U.K. Air Accidents Investigation Branch (AAIB).

The report said that the second approach was stable until the commander disengaged the autopilot and autothrottle system at 220 ft AGL. The aircraft drifted above the glideslope and right of the localizer. The commander was correcting when the wind shifted to a direct right crosswind and increased in velocity. "The aircraft started yawing right and rolling right," the report said. "Left control wheel and rudder inputs were made, slowing the rate of roll to the right but not stopping it before touchdown."

Meanwhile, airspeed had decreased 20 kt within one second and then increased 23 kt within the next four seconds before touchdown. Rate of descent increased from 700 fpm to 1,400 fpm but was reduced to 300 fpm before touchdown.

The aircraft was drifting left of the runway centerline and was banked nearly 10 degrees right when it touched down on the right main landing gear. The no. 4 engine nacelle struck the runway and was substantially damaged. The 747 then rolled left, and the no. 1 and no. 2 engine nacelles scraped the runway. A tire on the left main landing gear burst as the crew stabilized the rollout and brought the aircraft to a stop on the runway. Investigators traced the tire failure to a malfunction of an anti-skid control valve that had prevented the wheel brake from releasing.

"There were no abnormal indications on the engine instruments, and after an external check by the airport fire fighting and rescue service, the aircraft taxied on to a stand," the report said.

Engine Cowling Separates, Strikes Tail

Canadair CRJ200. Substantial damage. No injuries.

While holding for takeoff from Capital City Airport in Lansing, Michigan, U.S., the night of April 7, 2007, the flight crew received indications that the left thrust reverser was unlocked. "The captain cycled the reverser and had decided to return to the gate when the messages cleared," the NTSB report said. "With the issue apparently resolved, he elected to take off."

The crew felt a slight vibration during climb-out and suspected that it was caused by the thrust reverser. Later, during cruise flight at 16,000 ft, the crew heard a loud bang, and the airplane pitched up and rolled left. "The autopilot disengaged and the left thrust lever moved to idle during the event," the report said. "The first officer ran the checklist to stow the reverser. The captain decided to continue to the intended destination because the thrust reverser messages had cleared and the vibrations had stopped." The airplane was landed at Chicago O'Hare International Airport without further incident.

The crew heard a loud bang, and the airplane pitched up and rolled left.

Examination of the CRJ revealed that the translating cowling for the thrust reverser system on the left engine had separated and struck the empennage, causing the loud bang heard by the crew. "The inboard leading edge of the left horizontal stabilizer was dented and crushed aft, consistent with impact damage," the report said. "The left side skin of the vertical stabilizer was punctured immediately forward of the center spar."

The report said that inadequate maintenance by the operator had contributed to the accident. "Damage to the thrust reverser components was consistent with prior operation with the reverser out of alignment and jamming of the translating structure," the report said. "Review of the aircraft's maintenance records revealed a history of anomalies related to the left engine thrust reverser."

SOPs Neglected in Taxiway Collision

Airbus A321, Boeing 777. Substantial damage. No injuries.

After landing at London Heathrow Airport on July 27, 2007, the A321 flight crew was taxiing the aircraft to the assigned stand when they noticed that the electronic stand entry guidance system had not been activated. "The Airbus commander stopped his aircraft about 50 m [164 ft] short of the intended parking position," the AAIB report said. "It was aligned with the stand centerline but with about half the aircraft protruding into the taxiway behind."

The A321 commander attempted to establish radio communication with the airport ground traffic controller, but the frequency was congested and his call was not acknowledged. Meanwhile, the controller had approved the 777 flight crew's request for pushback from an adjacent stand.

The 777 pushback crew consisted of a tug driver and a headset operator, both of whom were in the tug's cab when the collision occurred. The tug driver initially did not see that the A321 was partially obstructing the taxiway behind the 777. "The tug driver reported that he … applied the vehicle's brakes but was too late to prevent the collision," the report said. The collision damaged the 777's left aileron and wing panel, and the A321's vertical fin and fairing.

The tug driver had been on duty for nearly 14 hours.

"The accident occurred primarily because the Boeing 777 pushback was not conducted in accordance with the aircraft operator's normal operating procedures and safe practices," the report said. The tug had a radio capable of receiving and transmitting messages on the ground controller's frequency, but the radio had not been turned on. Although it was standard practice for the headset operator to walk alongside an aircraft during pushback, he remained in the tug's cab; he was not aware of the collision until the 777 commander asked what had happened.

The tug driver was working a double shift and had been on duty for nearly 14 hours when the collision occurred. The headset operator had worked a 16-hour night shift and had about 12 hours off before reporting back on duty less than an hour before the collision. "The pushback crew's working-time records for the preceding four weeks showed that working-hours rules had not always been adhered to," the report said. "Both crewmen had worked in excess of the permitted 72 hours per week for at least part of the four-week period. … The possibility that fatigue played some part in the ground crew's performance cannot be discounted."

Attention Diverted During Close Call

Boeing 737-700, Airbus A330-200. No damage. No injuries.

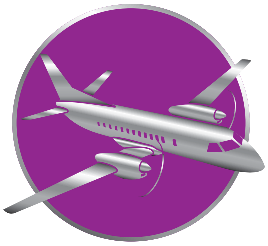
Night VMC prevailed on July 2, 2008, when the airport traffic controller cleared the A330 flight crew for takeoff on Runway 34R at Seattle–Tacoma International Airport and shortly thereafter told the flight crew of the 737, which had been landed on Runway 34C, to exit on high-speed Taxiway F, which is near the end of the runway, and to hold short of Runway 34R. The 737 captain, the PM, acknowledged the instruction.

"The first officer steered the airplane onto the taxiway, gave control to the captain, ran the 'After Landing' checklist and shut down the right engine," the report said. "During this time, the captain was consulting his airport diagram while taxiing."

The controller asked the 737 crew to verify their hold-short clearance, and the first officer acknowledged. "The hold-short markings, in-pavement lights and elevated guard lights were visible and illuminated, but the flight crew of the Boeing 737 did not notice them," the report said.

The airport surface detection equipment generated aural and visual warnings when the 737 was taxied onto Runway 34R at a groundspeed of about 12 kt. The A330 flew over the 737 at 425 ft AGL. There were 314 people aboard the two airplanes.

The report said that the probable cause of the incident was the 737 flight crew's "diverted attention during taxi."



TURBOPROPS

Elevator Trim Rigged in Reverse

Convair 580. Destroyed. Three fatalities.

The flight crew was conducting the first flight in the cargo airplane following maintenance that included rigging of the flight controls. The captain, a check airman for the company, had more than 16,000 flight hours. The post-maintenance test flight from Columbus, Ohio, U.S., to Mansfield, Ohio, the afternoon of Sept. 1, 2008, also was intended as a training flight for two newly hired pilots: the first officer, who had more than 19,000 flight hours, and the observer, who had about 500 hours.

VMC prevailed when the airplane departed from Runway 05L at Rickenbacker International Airport. CVR data indicated that neither the captain nor the first officer called for the landing gear or flaps to be retracted, or for the power to be reduced from the takeoff setting. About a minute after takeoff, the first officer requested and received clearance to return to the airport.

The NTSB report said that during the 2-minute 40-second flight, the captain repeated the instruction "pull" 27 times. At one point, the observer said, "Come back on the trim?" The CVR then recorded the sound of the elevator trim wheel in motion and the captain replying, "There's nothing anymore on the trim."

Recorded ATC radar data indicated that the airplane entered a downwind leg for Runway 05L at 900 ft AGL and turned to a base leg at about 187 ft AGL. The Convair then descended steeply to the ground about a mile southwest of the airport.

The report said that the probable causes of the accident were "the improper (reverse) rigging of the elevator trim cables by company maintenance personnel and their subsequent failure to discover the misrigging during required post-maintenance checks." A contributing factor was "the captain's inadequate post-maintenance preflight check."

Skydiving Flight Encounters Icing

Antonov An-28. Substantial damage. Two minor injuries.

The aircraft, a turboprop version of the An-14, was being used for skydiving flights from an airstrip in Osterdalen, Norway, on July 16, 2004. After conducting six drops, the aircraft was refueled in preparation for the next flight with 20 parachutists who were to jump in two groups, said the report issued recently by the Accident Investigation Board of Norway.

The flight crew flew the aircraft to 15,000 ft and maintained a southerly course over the drop zone — the airstrip — where the first 10 parachutists jumped. "The aircraft continued on that course for a short time before turning through 180 degrees and getting ready for the next drop at the same location on a northerly course," the report said.

VMC prevailed, but a large cumulonimbus cloud was nearing the drop zone from the north. "To reach the drop zone above the runway, the aircraft had to fly close to this cloud," the report said. "[A videotape] showed that the parachutists became covered in a layer of white ice within 2–3 seconds of leaving the aircraft. The ice on the parachutists only thawed once they had descended to lower altitudes where the air temperature was above zero."

As the commander made a turn away from the cloud, still maintaining the low power setting and airspeed used for the drop, the first officer saw that ice had formed on the windshield. He engaged the anti-icing system without informing the commander of his action. The anti-icing system uses engine bleed air, and the An-28 manual warns that fuel flow to the engines will be shut off automatically if the anti-ice system is selected when engine compressor speed is low.

Both engines flamed out when the first officer engaged the anti-ice system, and the propellers were feathered automatically. The first officer made several unsuccessful attempts to restart the engines using a checklist that did not specify that if the autofeather system had engaged, the propeller-feathering levers had to be moved fully aft and then fully forward to recycle the system; the engines cannot be started unless the autofeather system is armed.

With no hydraulic pressure to extend the flaps, the commander had to maintain a relatively high airspeed on approach to the 600-m (1,969-ft) runway. "The final approach was further complicated because the [commander] had to avoid the last 10 parachutists who were still in the air and who were steering toward a landing area just beside the airstrip," the report said.

The An-28 touched down about halfway down the runway. The commander realized that he would not be able to stop the aircraft on the runway and lifted off to clear a 2.5-m (8.2-ft) embankment about 60 m (197 ft) beyond the end of the runway. The aircraft cleared the embankment but struck a ditch and flipped over while rolling out in a marshy area.

Noting that the crew had not used supplemental oxygen while flying the unpressurized aircraft at 15,000 ft, the report said that their performance might have been affected by hypoxia. "The fact that the first officer switched on the anti-icing system without asking the commander first indicates that crew collaboration was not functioning at its best," the report said.

Instrument Takeoff Goes Awry

Beech King Air E90. Destroyed. Two fatalities.

Visibility was 1/4 mi (400 m) in fog when the King Air departed from Runway 24 at McClellan/Palomar Airport in Carlsbad, California, U.S., for a business flight to Tucson, Arizona, the morning of July 3, 2007. The airport is on a plateau surrounded by lower terrain, according to the NTSB report.

The pilot apparently did not achieve a positive rate of climb or track the extended centerline of the runway. The King Air struck a power line about 90 ft (27 m) below field elevation and 2,500 ft (762 m) beyond the end of the runway. The airplane then struck a transmission tower, crashed on a golf course and burned. "The debris path was along a magnetic bearing of 270 degrees," the report said, noting that both engines were producing power on impact.

The pilot had a private license and 1,177 flight hours, including 286 hours in the E90 and 268 hours of instrument flight time.

PISTON AIRPLANES

Fuel Quantity Indications Neglected

Piper Navajo. Destroyed. One serious injury.

The pilot had flown five passengers from Mount Isa to Century Mine, both in Queensland, Australia, the morning of July 27, 2008, and was returning alone to Mount Isa. He had conducted the takeoff and climb to cruise altitude with the inboard wing fuel tanks selected, as required by the aircraft operating manual, and had selected the outboard fuel tanks prior to leveling off at cruise altitude. However, the pilot did not monitor fuel quantity during the flight and neglected to switch from the outboard tanks to the inboard tanks during descent, said the report by the Australian Transport Safety Bureau (ATSB).

The Navajo was descending through 3,000 ft about 33 km (18 nm) from Mount Isa when the left engine lost power. The right engine lost power shortly thereafter. The pilot, who had 470 flight hours, including 30 hours in type, mistakenly believed that the engines were still producing power and did not feather the propellers or switch fuel tanks.

The aircraft descended rapidly at a low airspeed. "The aircraft impacted the ground at an angle of approximately 30 degrees left-wing-down and 30 degrees nose-down," the report said. Investigators found signs that the flaps were retracted and the landing gear was partially extended during the forced landing on sparsely wooded terrain.

ATSB concluded that the engines had lost power because of fuel starvation and that power could have been restored if the pilot had selected the inboard tanks, which contained sufficient fuel to complete the flight. Alternatively, if the pilot had feathered the propellers after losing power and maintained control of the aircraft, he might have been able to land the Navajo on a highway 4 km (2 nm) from the accident site, the report said.

Control Lost During Split-Flap Takeoff

Beech Duke. Destroyed. One fatality.

A flight instructor who saw the Duke in the run-up area near Runway 27 at New Castle (Delaware, U.S.) Airport the morning of Dec. 4, 2007, said that the run-up appeared normal, except that it was performed with the flaps extended. Before takeoff, the pilot of the Duke requested and received clearance from ATC for a right-turn departure. During initial climb, however, the airplane banked left at about 50 ft AGL. The left bank steepened, and the airplane stalled at about 300 ft AGL and spun to the ground.

The NTSB report said that when the pilot attempted to retract the flaps before takeoff, the left flap retracted but the right flap remained fully extended. Examination of the wreckage revealed that a component in the right-flap drive mechanism had fractured in overload. "The pilot could have identified this condition prior to takeoff, either visually or by means of the flap indicator, which received its input from the right flap actuator," the report said.

A study performed by the manufacturer said that control of the airplane in the split-flap configuration and with full power could have been maintained, "though marginally," at airspeeds as low as 70 kt.

HELICOPTERS

Overheated Heater Fills Cabin With Smoke

Sikorsky S-76B. Minor damage. No injuries.

The flight crew was conducting a positioning flight from Denham, England, to Coventry the night of Nov. 22, 2007, when they detected an unusual odor. "The crew began to troubleshoot the problem and switched off the heating system as a possible source," the AAIB report said.

The helicopter was about 15 nm (28 km) from Coventry when the cockpit began to fill with smoke and the copilot felt heat begin to build near his seat. "Given the increasing levels of smoke in the aircraft, the crew considered making an emergency landing but decided it was safer to reach the airfield, where full fire cover had been placed on standby," the report said.

The smoke and heat intensified significantly. The crew landed the helicopter near the fire crew and evacuated quickly. "Eventually, the smoke and heat dissipated, and the aircraft was declared safe," the report said.

Examination of the S-76 revealed that the auxiliary electric heater had overheated and had melted the plastic ducting between the cabin and the cockpit. "The electronic control box for the heater was removed and subsequently confirmed to have failed, probably disabling the overheat protection and cockpit controls for the system," the report said.

Brownout Causes Spatial Disorientation

Eurocopter AS 350B-3. Substantial damage. Three serious injuries.

Dark night VMC prevailed when the pilot, flight nurse and paramedic were dispatched to the site of a motorcycle accident near Ash Fork, Arizona, U.S., on June 27, 2008. The pilot, who was using night vision goggles, conducted an approach to the landing zone over a sparsely vegetated dirt field, the NTSB report said.

"Halfway through the approach, the flight encountered brownout conditions, and the pilot began to perform a go-around," the report said. "He reported being confident that he had initiated a climb, but shortly thereafter the helicopter impacted the ground."

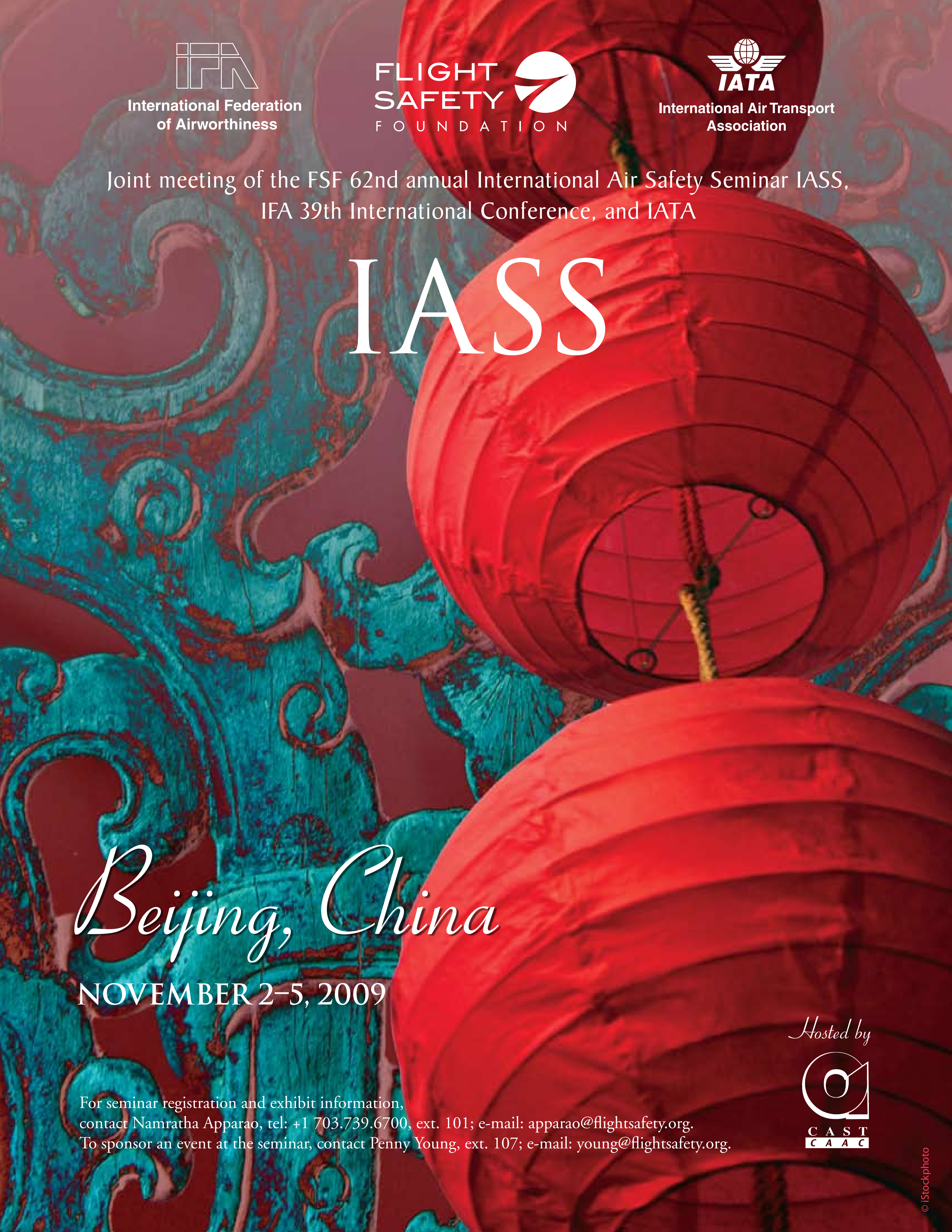
NTSB determined that the probable cause of the accident was "the pilot's spatial disorientation resulting in his failure to detect and compensate for an unintentional descent during a go-around." The report said, "Contributing to the accident were the pilot's inadequate choice of landing approach, reduced visibility from brownout conditions and the dark night."

Preliminary Reports, June 2009

Date	Location	Aircraft Type	Aircraft Damage	Injuries
June 2	Halavelhi Resort, Maldives	de Havilland DHC-6	destroyed	7 minor
The float-equipped Twin Otter flipped over while landing on a lagoon during a charter photography flight.				
June 3	Santa María de Caparo, Venezuela	Bell 407	destroyed	5 fatal
The helicopter crashed in mountainous terrain.				
June 6	Sittwe, Myanmar	Fokker F28-4000	substantial	NA
Three of the 68 occupants sustained unspecified injuries during a runway-excursion accident on landing.				
June 7	Port Hope Simpson, Labrador, Canada	Britten-Norman Islander	destroyed	1 fatal
Visibility was limited by fog when the airplane struck a hill on approach during an emergency medical services (EMS) positioning flight.				
June 7	Anchorage, Alaska, U.S.	de Havilland DHC-2	destroyed	4 minor
The float-equipped Beaver struck a fence during takeoff from Lake Hood and crashed in a garden.				
June 9	near Santa Fe, New Mexico, U.S.	Agusta A109E	destroyed	2 fatal, 1 serious
The police helicopter was on a search-and-rescue mission when it struck a ridge in night instrument meteorological conditions (IMC).				
June 10	Coomera, Queensland, Australia	Bell 206B-II	destroyed	2 serious, 3 none
The JetRanger struck the ground and rolled over after the engine failed on final approach.				
June 12	Bridgeport, Connecticut, U.S.	Pilatus PC-12/47	substantial	7 none
IMC prevailed when the airplane touched down about halfway down the 4,677-ft (1,426-m) runway and struck a blast fence.				
June 13	Orange, Virginia, U.S.	de Havilland DHC-6	none	1 serious
The Twin Otter was making a low pass over a landing area when it shredded a skydiver's parachute canopy. The skydiver was seriously injured.				
June 14	Tanah Merah, Indonesia	Dornier 328	substantial	33 none
After landing, the airplane veered off the right side of the 950-m (3,117-ft) gravel runway.				
June 15	Rapid City, South Dakota, U.S.	Beech King Air B100	none	1 serious, 4 minor
The patient was seriously injured when the airplane encountered clear air turbulence on descent during an EMS flight.				
June 18	Newark, New Jersey, U.S.	Boeing 777-200	none	1 fatal, 237 none
The first officer took control when the captain became incapacitated during a flight from Brussels, Belgium, and landed the 777 without further incident in Newark.				
June 18	Fort Worth, Texas, U.S.	Learjet 45	substantial	2 none
The airplane was being taxied to a run-up area following engine maintenance when it struck an embankment and a hangar.				
June 22	Mollet del Vallès, Spain	Aerospatiale AS 350-B3	destroyed	2 fatal
The helicopter crashed after dropping water on a forest fire.				
June 23	Barcelona, Spain	Partenavia P-68	destroyed	2 fatal
The airplane crashed in a garden after an engine failed during a training flight.				
June 24	Holbrook, Arizona, U.S.	Beech Travel Air	destroyed	4 fatal
Witnesses said that the pilot appeared to be ill before departure and that the airplane appeared to be turning back to the airport when it banked steeply and descended to the ground.				
June 25	Maryland Heights, Missouri, U.S.	Piper Cheyenne	substantial	2 none
The airplane was on a positioning flight when it overran the runway while landing at Creve Coeur Airport, traveled down a ravine and came to a stop in a cornfield.				
June 25	Caticlan, Philippines	Xian MA60	substantial	55 none
The twin-turboprop airplane had a tail wind when it was landed long, overran the runway and came to a stop in a drainage ditch.				
June 29	Wamena, Indonesia	de Havilland DHC-6	destroyed	3 fatal
The Twin Otter was on a cargo flight from Dekai when it struck a mountain at 9,600 ft during approach to Wamena.				
June 30	Moroni, Comoros	Airbus A310-300	destroyed	152 fatal, 1 serious
Strong winds prevailed when the flight crew of the A310, inbound from Yemen, conducted a go-around during a night approach to the island airport. The airplane subsequently stalled while turning base and crashed in the sea.				

NA = not available

This information, gathered from various government and media sources, is subject to change as the investigations of the accidents and incidents are completed.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