AeroSafety WORLD

HEMS FATAL MIDAIR
Procedures not followed

ADS-B DRAWS NEAR
Investment needed for benefits

ATR 72 FUEL EXHAUSTION
Wrong gauge installed

ANAFRONTS
Cold, nasty surprises

PILOT COGNITION
CONSIDERING THE THINKING PROCESS

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

JULY 2009

AUTOMATION Expectations

So far, 2009 does not look like a great year for safety. As we hit the halfway mark, the world already has had as many airline accidents as the recent norm for a whole year. If things continue at this pace, we could have a year as bad as 1999, an accident spike. Of course, recent high-profile crashes of Airbus aircraft have thrown the debate about automation and envelope protection into the spotlight. In the public forum, that discussion gets boiled down to some overly basic questions: Is automation good or bad? Is one manufacturer's approach better than the other? Those are the wrong questions.

First, it is impossible to turn back the hands of time on the issue of flight deck automation. Current aircraft are highly automated, and the next generation of aircraft will be more so. I don't think this is bad. But I do think that we all have done a lousy job — or at least a superficial job — adapting to the reality of automation. Airplanes come with nice checklists to deal with some problems that automation presents, but we generally have fallen victim to the unconscious assumption that automation will not fail. Of course it fails. Sometimes technicians don't seat a circuit board properly. Sometimes a sensor goes bad, like a pitot tube (maybe the case in the crash of Air France Flight 447) or a radar altimeter fails (certainly the case in the Turkish Airways accident in Amsterdam). Other times, pilots input the wrong weight (e.g., the Emirates tail strike in Melbourne, Australia) or even type in the wrong route.

And when automation does fail to protect us, we appear to expect that other automated systems will step in to save the day. Is that how we treat engine failures? I think most of us started thinking about engine failures at an early stage of our aviation consciousness. I remember being 15 years old, dreaming of the day I'd have a handful of throttles and deal brilliantly with an engine exploding at rotation. Even then I knew the sequence of events, starting with "dead foot, dead engine." This sort of thing is just part of a pilot's DNA. The "trouble" is, engines just don't quit much anymore. Most of us will retire without being a party to an engine failure at any time, much less on takeoff. What every pilot *will* experience, however, is some sort of confusion regarding the automation. Whether it is due to a system error or a human error doesn't matter. It is a threat that has to be acknowledged and has to be managed because it can take down an aircraft.

When a pilot flew a DC-6 or a Connie, the biggest worry was an engine failure on takeoff. Now the biggest threat is the possibility of being handed an aircraft with ambiguous indications, and maybe a stick shaker in the middle of the night. It is time for young pilots to go to bed thinking about that threat, and to come up with the equivalent of "dead foot, dead engine" for that scenario. Just look at the accidents lately; it is time to stop debating the role of automation and really start to deal with it.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

contents

July2009 Vol 4 Issue 7

features

13 FlightOps | **Extreme Weather Makers**

16 CoverStory | **Thinking Things Through**

22 SafetyOversight | **Dangerous Goods**

26 CausalFactors | **ATR 72 Ditching**

32 HelicopterSafety | **Procedural Disregard**

37 InfraStructure | **Practical Necessity of ADS-B**

42 AircraftRescue | **In the Drink**

departments

1 President'sMessage | **Automation Expectations**

5 EditorialPage | **Failed Justice**

6 AirMail | **Letters From Our Readers**

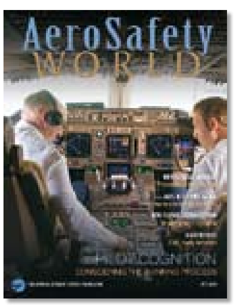
8 SafetyCalendar | **Industry Events**

9 InBrief | **Safety News**

47 **Data**Link | **Route Causes**

52 **Info**Scan | **Erring on the Safe Side**

57 On**Record** | **Bangs and Flames**



About the Cover
Thinking processes in the cockpit.
© Chris Sorensen Photography

We Encourage Reprints (For permissions, go to <www.flightsafety.org/asw_home.html>)

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.

Sales Contacts

Europe, Central USA, Latin America
Joan Daly, joan@dalyllc.com, tel. +1.703.983.5907

Northeast USA and Canada
Tony Calamaro, tcalamaro@comcast.net, tel. +1.610.449.3490

Asia Pacific, Western USA
Pat Walker, walkercom1@aol.com, tel. +1.415.387.7593

Regional Advertising Manager
Arlene Braithwaite, arlenetbg@comcast.net, tel. +1.410.772.0820

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.

AeroSafetyWORLD
telephone: +1 703.739.6700

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

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

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

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

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

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

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

Ann L. Mullikin, art director and designer
mullikin@flightsafety.org, ext. 120

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

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

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

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

www.flightsafety.org

Member enrollment **Ahlam Wahdan**, membership services coordinator	ext. 102 wahdan@flightsafety.org
Seminar registration **Namratha Apparao**, seminar and exhibit coordinator	ext. 101 apparao@flightsafety.org
Seminar sponsorships **Penny Young**, chief financial officer	ext. 107 young@flightsafety.org
Exhibitor opportunities **Namratha Apparao**, seminar and exhibit coordinator	ext. 101 apparao@flightsafety.org
FSF awards programs **Linda Horger**, manager support services	ext. 100 horger@flightsafety.org
Technical product orders **Namratha Apparao**, seminar and exhibit coordinator	ext. 101 apparao@flightsafety.org
Library services/seminar proceedings **Patricia Setze**, librarian	ext. 103 setze@flightsafety.org
Web site **Karen Ehrlich**, web and print production coordinator	ext. 117 ehrlich@flightsafety.org

Regional Office: GPO Box 3026 • Melbourne, Victoria 3001 Australia
Telephone: +61 1300.557.162 • Fax +61 1300.557.182

Paul Fox, regional director	fox@flightsafety.org
Amy Beveridge, event manager	beveridge@flightsafety.org

FAILED Justice

The Italian judicial system totally failed the cause of aviation safety during the investigation of the Tuninter ATR 72 ditching accident in 2005 (see story, p. 26). This failure, documented in the report of the Agenzia Nazionale per la Sicurezza del Volo (ANSV) aviation safety investigative authority, was not, for the most part, due to capricious decisions of any individual, but tragically was in line with what is called for by Italian law.

The report, released nearly four years after the accident, states that the ANSV's ability to conduct its inquiry in accordance with Annex 13 of the Convention on International Civil Aviation "was found to be limited in the light of that envisaged by the criminal procedures system in force."

The obstructions of the ANSV's duties were many. ANSV was not allowed to directly inspect the aircraft wreckage, which was impounded by the judicial authority. ANSV personnel could only observe.

Prevented from sampling or testing fuel and oil samples from the fuel tanks and engines, ANSV had to rely on the judicial authority's collecting and testing. ANSV could only observe.

The judicial authority did not pass along to the ANSV documentation of its findings until the ANSV filed legal applications, and even then did not release all of the documents "until ANSV repeatedly pressed for them," the report said.

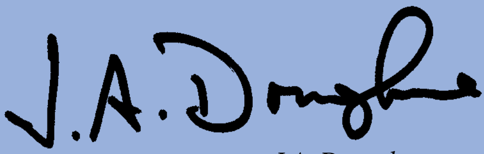
Access to the flight data recorder (FDR) and cockpit voice recorder (CVR) was delayed until 10 days after they were recovered. The data that ANSV laboratories then extracted from the FDR and CVR were immediately sequestered by the authorities, along with the original tapes. The ANSV did get a copy of the raw FDR data for decoding; the CVR material was given to the ANSV a few days later.

As little cooperation as ANSV got, accredited representatives of the interested parties to this accident — including those from Tunisia, where the aircraft was registered and the airline is based; France, where the aircraft was built; Canada, where the engines were built; and the United States, where the propellers were built — were more broadly excluded from the process, even to the point of not being allowed to receive FDR and CVR data. The inability to share FDR data meant the ANSV was unable to mount simulations of the event until more than 15 months after the accident. Sadly, on the day that data were released, the general news media somehow received the CVR recording in both audio and transcript form.

Most of the judicial authority's behavior, the ANSV took pains to note, "was in accordance with applicable Italian criminal laws."

Highlighting the safety threats involved in being unable to quickly obtain information and access to all available help to discover how to prevent future such accidents, the ANSV included in its report recommendations that Italian law be changed to allow ANSV "immediate and unconditional access to all elements … necessary for the technical investigation," to ensure the rights of accredited international parties to the investigation and to prevent any recordings or transcripts pertaining to the investigation from being improperly used.

There are more outrageous elements to this sad tale than space here can accommodate, but this colossal cluster of obstructions to the safety process mounted by government prosecutors is yet another strong argument for the decriminalization of the accident investigation process, a cause Flight Safety Foundation is dedicated to advance.



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

CENIPA Replies

*This letter is a response to "Midair Over the Amazon" (*ASW*, 2/09, p. 11), concerning the collision of the Gol Boeing 737-800 and the ExcelAire Embraer Legacy 600 in Brazilian airspace.*

When the International Federation of Air Traffic Controllers' Associations (IFATCA) criticized the final report by the Aeronautical Accident Prevention and Investigation Center (CENIPA) and used the expression "missed opportunity," we did not make any comments, although disagreeing with their standpoint. We understood that they were exercising their right to defend a class or group of people; they were just playing their role, and we will always defend their right to do so.

However, when a respected organization such as the Flight Safety Foundation, echoing the words used by the IFATCA, decides to lend support to this latter organization and criticizes the serious job done by the Brazilian state, it is time for the chief of the CENIPA to reply to the person who wrote the article, and to the Foundation, on account of the aforementioned support.

Unfortunately, the Foundation's article, despite being totally based on the final report made available to the world through the Internet, was not able to make a single positive comment regarding the investigation conducted by the Brazilian state, which had the participation of other international organizations, and preferred to depreciate the two-year-long work done by a team composed of more than 50 people.

Take, for example, the very subtitle that includes the words "controversial Brazilian report": Who classified the final report as controversial? What are the bases for such a classification? Apart from the IFATCA, who considered the report controversial?

To affirm that the U.S. National Transportation Safety Board (NTSB) questioned the findings and conclusions of the final report is, to say the least, inappropriate, and the few points that were not incorporated in the report, on account of differences of investigation methodology, were included in an appendix of the report.

At one point, the article refers to the "probable cause" (which the NTSB, by legislation requirements, is obliged to report), failing to comment (due to lack of information?) that in Brazil the investigators work with contributing factors without establishing precedence between them.

It is worth pointing out that, once more, the influence of the footrest is mentioned as one of the hypotheses considered by the Brazilian investigators, but nothing is said about the fact that such a hypothesis was discarded after a full demonstration in the final report, by means of a detailed ergonometric study, corroborated by the fact that the pilot himself affirmed that he had not utilized it.

When the article refers to the "bad system design," it mentions the NTSB, thus inducing the reader to conclude that such classification had been made by the renowned American investigating organization, and only many lines later does it credit the classification to its real source: the IFATCA. When the article comments on the symbol "=" which is placed between the flight levels, it again induces a reader less familiar with air traffic control to logically conclude that 370 cannot be equal to 360 ("370 = 360"). For the trained eye, however, the interpretation is different: the aircraft is at Flight Level (FL) 370 — neither climbing nor descending — and the new flight level requested is FL 360. This does not mean that the system has a faulty design. Since its creation, it was taught and operated like that for many years without any problems. We know the system is not perfect, and we know that a perfect system is something everyone is looking for in the world. Can it be improved? Of course, it can. That's why (and, again, this is not commented on in the article) the final report established more than 30 safety recommendations forwarded to the Airspace Control Department.

At another point, the article says that the investigators were not able to learn how the transponder changed to standby (STBY). The final report, however, shows that the pieces of equipment were tested in the laboratories of the manufacturer, in the presence of NTSB representatives, and they functioned faultlessly. They operated normally from the departure until after the aircraft passed over the Brasília VOR, and resumed transmitting after the collision. Therefore, the most probable hypothesis is that the equipment was inadvertently set to STBY. Thus, the investigator and the aviation authority, contrary to what is said in the article written by the IFATCA (reprinted in the FSF article), do not blame A or B for the accident, simply because, in accordance with the prescriptions of the International Civil Aviation Organization — of which Brazil is a group 1 contracting state — it is not the objective of the aeronautical accident investigation to establish blame or liability, but solely to prevent the occurrence of further accidents.

Last, I would like to comment on the ill-intentioned question of the subhead "Misplaced Blame?" It is not the purpose of the investigation to blame or acquit any individual or organization that has played a role in the event; the author, however, tries to mislead the reader by making illogical comparisons. The final report clarifies the findings related to the controllers involved, to the air traffic control and to the flight crew. Thus, it is not wise to compare the preparedness and performance of the controllers to the preparedness and performance of the pilots. There is no doubt that the events related to the moments following the change of the transponder to the STBY mode were exhaustively analyzed in relation to the performance of everyone involved. However, I am not willing to rewrite a report of almost 300 pages or refute all the improprieties of an article that reduced them to five.

In concluding, I think it is proper to praise the author of the article for informing readers that it was based on the CENIPA report, available on the Internet.

As chief of the CENIPA, I expect that the Foundation will treat this reply with the same consideration given to the article in *AeroSafety World*.

Brig. Gen. Jorge Kersul Filho
Chief of the CENIPA
Brasília, Brazil

The editor replies: *The topic of the story was the accident, not the quality of CENIPA's investigation of the accident. The report is indeed controversial because its findings have been questioned by several organizations, including IFATCA and NTSB. Thus, the inclusion of other points of view in the story to present a balanced view of what might have happened is not, in our judgment, a flaw.*

Regarding the footrest issue, the story stated, "Investigators were unable to determine conclusively how the transponder had been switched to the standby mode," continuing to say the "most likely explanation" was that it was an inadvertent result of the use of the radio management unit for other purposes. Only then did the story note that CENIPA identified the footrest as "another possibility," a conclusion the NTSB reached as well, and the NTSB report was quoted, too.

The source of the term "Bad System Design" in the subhead was clearly noted as being IFATCA, not NTSB.

The story's presentation of the radar display symbol "370=360" is exactly what the report stated and was fully explained. No attempt was made to portray this as a formula. It was the ease with which changes in the display might not be identified — given the moderate visual difference between "370 =370" and "370 =360" — when the change is made automatically, that led to the IFATCA's critical comments.

The story states the finding that the transponder likely was inadvertently set to standby and does not state that the equipment was faulty, and neither does IFATCA.

Finally, your statement that "it is not wise to compare the preparedness of the controllers to the preparedness and performance of the pilots" in our opinion is not supported by the factual information included in the report.

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>.

JULY 7–9 ➤ Deicing Conference. Airports Council International–North America and Air Transport Association of America. Cincinnati. <meetings@aci-na.org>, <www.aci-na.org/conferences/detail?eventId=142>, +1 202.293.8500.

JULY 8–9 ➤ Safety Management System Overview Workshop. ATC Vantage. San Francisco. <registrations@atcvantage.com>, <www.atcvantage.com>, +1 727.410.4759.

JULY 13–17 ➤ Safety Management System Principles Course. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Page McCanless, <mpthomps@mitre.org>, <mai.mitrecaasd.org>, +1 703.983.6799.

JULY 13–22 ➤ Safety Management System Theory and Application Course. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Page McCanless, <mpthomps@mitre.org>, <mai.mitrecaasd.org>, +1 703.983.6799.

JULY 16–17 ➤ Implementing LOSA and TEM Into Your Organization Course. Morning Star Aviation Consulting. Denver. David Bair, <DLBair@comcast.net>, <www.regonline.com/builder/site/Default.aspx?eventid=127619>, +1 720.981.1802.

JULY 20–21 ➤ Flight Operations Manual Workshop. National Business Aviation Association. Alexandria, Virginia, U.S. Jay Evans, <jevans@nbaa.org>, <www.nbaa.org/events/pdp/operations-manual/20090720.php>, +1 202.783.9353.

AUG. 3–6 ➤ Air Safety and Security Week. Air Line Pilots Association, International. Washington. <crewroom.alpa.org/safety/?tabid=2427>, +1 703.689.2270.

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.

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. 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. 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. 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. 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. 7–8 ➤ International Winter Operations Conference. Air Canada Pilots Association and Canadian Society of Air Safety Investigators. Toronto. Capt. Barry F. Wiszniowski, <bwiszniowski@acpa.ca>, <www.winterops.ca>, 800.634.0944, +1 905.678.9008.

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.

Safety News

Blacklist Expansion?

The European Commission (EC) has revised its blacklist of airlines banned in the European Union, accompanying issuance of the new list with a proposal to develop a worldwide blacklist (*ASW*, 4/09, p. 42).

"Citizens have the right to fly safely everywhere in the world," said Antonio Tajani, EC vice president in charge of transport policy. "We will not accept that airlines fly at different standards when they operate inside and outside Europe. It is high time that the international community rethinks its safety policy; those airlines which are unsafe should not be allowed to fly anywhere."

Roberto Kobeh González, president of the Council of the International Civil Aviation Organization (ICAO), said he does not believe that an international blacklist is the answer.

"Lists that discourage passengers [from using a specific] airline would not necessarily reduce accidents," Kobeh said. "But I fully agree with … the need of working together in order to address deficiencies affecting air transport security."

The revised list — made public in mid-July — lifted the ban on European operations that previously had been imposed on four Indonesian airlines "because their [civil aviation] authority ensures that they respect the international safety standards," the EC said. Other Indonesian air carriers remain on the blacklist.

The previously blacklisted One Two Go, based in Thailand, is no longer on the list because Thai authorities have revoked its operating certificate, the EC said.

In addition, TAAG Angola Airlines is now permitted to operate into Portugal but only with specific aircraft and under specific conditions. Six other carriers also may operate only under specific conditions.

The list bans 255 air carriers from operations in the European Union,

Susan Reed

including all carriers from 12 countries — Angola, Benin, Democratic Republic of Congo, Equatorial Guinea, Gabon (with exceptions for three carriers that operate under restrictions), Indonesia (except for the four carriers that have been removed from the list), Kazakhstan (except for one carrier operating under restrictions), Kyrgyz Republic, Liberia, Sierra Leone, Swaziland and Zambia.

Color Vision Recommendations

Revised color vision requirements and testing could lead to the acceptance of 35 percent of color-deficient pilots who apply for medical certification, according to a report by researchers from the U.K. Civil Aviation Authority (CAA) and the U.S. Federal Aviation Administration (FAA).

Research by color vision specialists from the two agencies resulted in joint recommendations for new color vision standards (*ASW*, 12/08, p. 38). The research was needed because of a "lack of reliable, standardized tests and the absence of information on the specific color vision needs of professional flight crew," the CAA researchers said in the foreword to CAA Paper 2009/04, which discussed the work. The report also was published as FAA Office of Aerospace Medicine report 09/11.

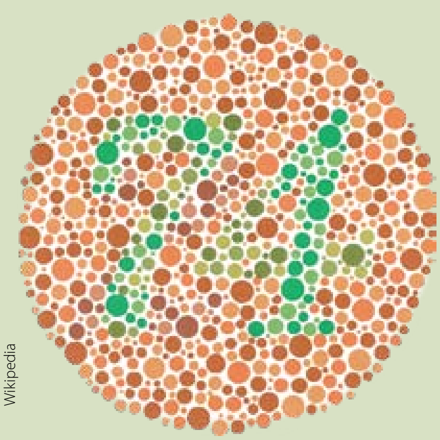
In their studies, the researchers evaluated "the level of color vision loss above which subjects with color deficiency no longer perform the most safety-critical, color-related tasks within the aviation environment with the same accuracy as [people with normal color vision]," the joint report said.

The result was a new test that accurately assesses a pilot applicant's color vision and identifies the type and severity of color vision loss.

"The results of the test also indicate whether the applicant's color vision meets the minimum requirements for safe performance that have emerged as necessary from this investigation," the report said.

The report noted that color has long been important in aviation in the coding of signals and other information and that, as a result, color vision requirements are necessary "to ensure that flight crew are able to discriminate and recognize different colors, both on the flight deck and externally."

In recent years, the requirements adopted by some civil aviation authorities have been criticized as inappropriate; critics say the tests have been devised so that pilot applicants with minimal color deficiencies often fail, even though many of them might be able to "perform safety-critical tasks as well as [pilots with normal color vision]."



Wikipedia

NSTB Seeks to Replace Oxygen Hoses

Operators should be required to replace electrically conductive combustible oxygen hoses in their aircraft, and use of the hoses should be prohibited, unless conductivity is an intentional — and approved — element of the hoses' design, the U.S. National Transportation Safety Board (NTSB) says.

The recommendations follow the NTSB investigation of a June 28, 2008, fire in an ABX Air Boeing 767-200 before engine startup at San Francisco International Airport. The captain and first officer — the only people in the airplane — evacuated through the cockpit windows and were not injured in the fire, which caused substantial damage to the airplane.

The crew said that they had heard loud popping and hissing sounds as they conducted the engine start checklist and that the first officer opened the cockpit door and saw "black smoke in the supernumerary compartment … [and] fire near the ceiling," the NTSB said. About one minute earlier, the first officer had been in the supernumerary compartment, and there had been no smoke or fire at that time.

The NTSB said that the probable cause of the accident was "the design of the supplemental oxygen system hoses and the lack of positive separation between electrical wiring and electrically conductive oxygen system components." This lack of positive separation "allowed a short circuit to breach a combustible oxygen hose, release oxygen and initiate a fire," the NTSB said.

As a result of the investigation, the NTSB issued 11 safety recommendations to the U.S. Federal Aviation Administration, including several that concerned requirements for oxygen system tubing and other components. Another recommendation said that operators of transport category cargo airplanes should be required to install smoke detectors in supernumerary compartments in their aircraft.


U.S. National Transportation Safety Board

The NTSB also recommended that ABX Air "modify [its] continuing analysis and surveillance program so that all identified chronic discrepancies, such as those affecting the oxygen system on the accident airplane, are effectively resolved."

Record Review

Pilots seeking jobs with U.S. airlines will undergo increased scrutiny by potential employers, who have agreed to review not only records from past employers but also all records maintained by the U.S. Federal Aviation Administration (FAA) involving pilot applicants.

The pilot record checks will be conducted in accordance with an agreement between the airlines, pilot unions and the FAA. The agreement, which was accepted during a meeting of all three parties, is part of an effort to strengthen "pilot hiring, training and testing practices at airlines that provide regional service, as well as at the country's major air carriers," the FAA said.


© Ad Doward/iStockphoto

The airlines and labor unions also agreed to review and strengthen pilot training programs. Representatives of both sides recommended developing mentoring programs to "expose less experienced pilots to the safety culture and professional standards practiced by more senior pilots," the FAA said. "The programs could pair experienced pilots from the major airlines with pilots from their regional airline partners."

FAA Administrator Randy Babbitt said all airlines will be asked to adopt safety reporting systems such as flight operational quality assurance (FOQA) and the aviation safety action program to generate more useful data on safety issues.

EASA Safety Review

Only 5.5 percent of fatal commercial air transport accidents worldwide involved airplanes registered in a member state (MS) of the European Aviation Safety Agency (EASA), the agency says in its *Annual Safety Review* for 2008.

Three fatal commercial air transport accidents were recorded in Europe in 2008 — the same number that occurred in 2007 and comparable to the lowest annual totals from the previous 10-year period of 1997 through 2006, the report said (see table). The average for the 10-year period was six fatal accidents per year.

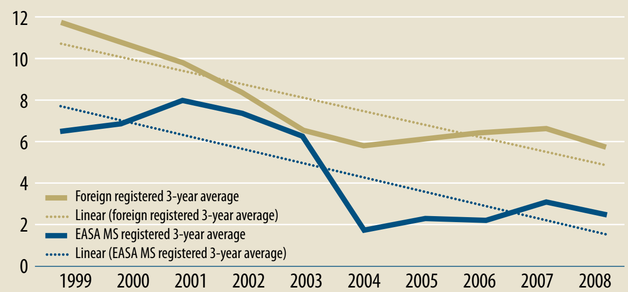
Overview of Total Number of Accidents and Fatal Accidents for EASA MS Registered Airplanes

Period	Total Number of Accidents	Fatal Accidents	Fatalities on Board	Ground Fatalities
1997–2006 (average)	32	6	105	1
2007 (total)	37	3	25	1
2008 (total)	35	3	160	2

The number of on-board fatalities in 2008 was 160 — compared with the 1997–2006 annual average of 105 — and 154 of the 160 resulted from the Aug. 20, 2008, crash of a Spanair McDonnell Douglas MD-82 during takeoff from Madrid.

The 2008 fatal accident rate was just over three per 10 million scheduled passenger flights averaged over a three-year period, the report said (see figure). "During the past decade," the report added, "the rate of accidents decreased from an average of four to three accidents per 10 million flights for EASA [member states]."

Fatal Accidents in Commercial Air Transport — EASA MS and Foreign Registered Airplanes



When accidents were assigned to categories, the highest accident rates were those associated with "abnormal runway contact," "non-powerplant component failure," "runway excursion" and "ground handling."

"In many cases, runway excursions are consequential events in accidents, and therefore a large number of accidents are assigned this category," the report said. "There has been an increase in the rate of accidents associated with 'flight preparation, loading or ground servicing' (all categorized under 'ramp'). Although this rate has increased to an average of almost eight accidents per 10 million flights, it remains relatively low. 'System or component failures not associated with the engines' (SCF-NP) also appear to be ever more present in accidents of EASA [member states'] aircraft. Accidents attributed as 'controlled flight into terrain (CFIT)' appear to have an overall decreasing rate."

Window Check

The European Aviation Safety Agency (EASA), citing a recent event in which a side glass window of an ATR 72 blew out during a ground pressure test, is requiring operators of some ATR 42s and 72s to inspect the windows for indications of damage or past repairs.

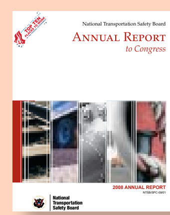
The investigation of the incident revealed anomalies in the windows that are considered indications of structural deterioration, the EASA said. "Air or water leakages between the Z-bar and the outer glass ply, or between the inner retainer and inner glass ply indicate the presence of deteriorating structural components in the window," the agency said.

Attempted repairs could lead to the same type of window failure that occurred in the recent event, the EASA said.

An EASA emergency airworthiness directive cautioned that an in-flight failure of a forward side window "could have catastrophic consequences for the airplane and/or cause injuries to people on the ground. The loss of the forward side window while the airplane is on the ground with a positive differential cabin pressure could also cause injuries to people inside or around the airplane."

© Roberto Benetti/Wikimedia

Annual Report



The U.S. National Transportation Safety Board (NTSB) has delivered its annual report to Congress, summarizing the 19 major accident investigations — including seven involving aviation accidents — that began in 2008. The NTSB also investigates highway, marine, pipeline and railroad accidents.

The report noted that the NTSB also initiated 221 other accident investigations, including 206 that involved aviation, and provided support in 18 international aviation accident investigations. Of 129 safety recommendations issued in 2008, 86 involved aviation, the report said.

Safety Culture

Administrator Randy Babbitt of the U.S. Federal Aviation Administration (FAA) says the agency is "moving away from a culture of blame and punishment" by reducing the emphasis on blame when errors by air traffic controllers are reported.

"Controllers remain accountable for their actions, but we're moving toward a new era that focuses on why these events occur and what can be done to prevent them," Babbitt said.

Under the revised procedure, controllers' names no longer will be included in reports sent to FAA headquarters about operational errors; removal of names will "allow investigators to focus on what happened rather than who was at fault," the FAA said. Training and disciplinary action will continue to be administered as needed, and these actions will be included in the controller's record.

"We need quality information in order to identify problems and learn from incidents before they become accidents," Babbitt said "The best sources of that information are our front line employees. Our success depends on their willingness to identify safety concerns."

Another procedural change, intended to avoid disruptions of operations, will keep controllers in their positions after operational errors "unless it is deemed necessary to remove them," the FAA said.

The FAA said the changes are part of a transition to a nonpunitive reporting system for air traffic controllers known as the Air Traffic Safety Action Program (ATSAP), already in place for controllers in about one-third of the United States. Under ATSAP, controllers and other employees can report safety problems "without fear of punishment unless the incident is deliberate or criminal," the FAA said.

© Jennifer Walz/Dreamstime

Manslaughter Probe

France is conducting a judicial inquiry into the June 1 crash of an Air France Airbus A330 to determine responsibility for the accident, published reports say.

The Paris prosecutor's office said it was conducting the inquiry against "unnamed persons on charges of manslaughter."

All 228 people in the A330 were killed when the airplane plunged into the Atlantic Ocean during a flight from Rio de Janeiro to Paris. A preliminary French accident report said that the flight crew had been in contact with Brazilian air traffic controllers and that, more than two hours after departure, a position message and aircraft maintenance messages were transmitted automatically by the aircraft communications addressing and reporting system (ACARS). There were no further communications from the airplane.

Wreckage and bodies were found several days later by searchers from the French and Brazilian navies.

© Christopher Weyer/Wikimedia

In Other News …

The United Arab Emirates **General Civil Aviation Authority** (GCAA) has signed an agreement with Flight Safety Foundation to establish a partnership aimed at expanding the GCAA's access to best practices in applying high safety standards. … Maintenance performance at **Qantas** has improved in the wake of reviews in 2008 in which the Civil Aviation Safety Authority of Australia found "emerging problems" with the airline's maintenance. … Acting Chairman Mark V. Rosenker and Member Kathryn O'Leary Higgins have announced their resignations from the U.S. **National Transportation Safety Board** (NTSB). Both Rosenker, a former NTSB chairman and member since 2003, and Higgins, a member since January 2006, say they are leaving the NTSB for opportunities in the private sector.

Compiled and edited by Linda Werfelman.

EXTREME *Weather* MAKERS

Hard-to-forecast anafronts generate unusual combinations of threats.

BY ED BROTAK

Sudden, drastic weather changes at Dallas/Fort Worth International Airport during two days in November 2006 seemed to defy the usual explanations. At 1800 the first day, the temperature was 72° F (22° C), winds were from the south-southeast at 20 kt gusting to 26 kt, skies were broken at 3,000 ft, and the visibility was greater than 10 mi (16 km). Within minutes, the wind shifted abruptly to the north-northwest at 20 kt gusting to 27 kt, the temperature fell precipitously into the 40s (4.4° to 9.4° C), and the skies became overcast. Soon, rain began to fall, becoming heavy. Ceilings lowered to below 1,000 ft and visibility dropped to 4 mi (6.4 km).

During the night, a thunderstorm moved over the airport. The temperature continued to fall, by morning going below 32° F (0° C). The rain started to freeze, causing icing conditions. Flight crews descending through 4,000 ft above ground level (AGL) encountered an air temperature of 49° F (9.4° C) and wind from the southwest at 26 kt. At 2,800 ft AGL, the temperature was 22° F (minus 5.6° C) with icing conditions, and the wind was from the north-northwest at 26 kt. It was a classic example of an *anafront,* an exceptional type of cold front.

All fronts — the boundary layer between two types of air masses — have denser, relatively cold air near the ground and lighter, relatively warm air aloft. Their passage poses familiar problems in aviation. Low clouds producing low ceilings; precipitation resulting in poor visibilities; strong winds that quickly change direction; and dramatic changes in temperature, humidity and air density are all common.

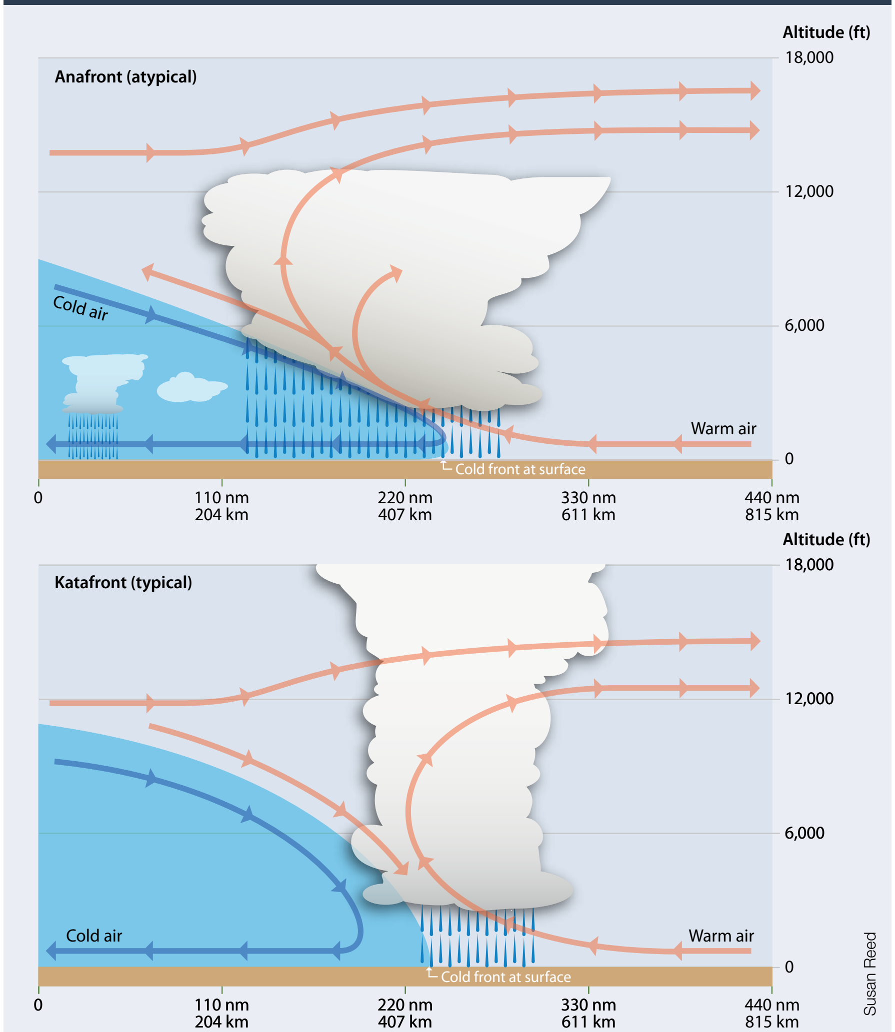
Although such weather conditions often are associated with cold fronts, the situation usually improves rapidly after the cold front passes.[1] When an anafront passes, the conditions initially seem similar to other cold fronts, just more extreme. The apparent similarities quickly end, however, and the challenges for flight crews begin.

The profile view of the common cold front, called a *katafront,* shows air sinking along a steeply sloping frontal surface that sits on top of a fairly deep layer of cold air, and then lifting right along or even ahead of the surface front. This is where the clouds and precipitation occur. For the anafront, air rises along a shallow sloped front that caps a shallow layer of cold air (Figure 1, p. 14). This is similar to a warm front except, in this case, the cold air moves forward, undercutting the warm air.

With the warm air rising along the full length of the frontal surface, precipitation occurs well behind the surface cold front in a process meteorologists call *overrunning.* If the overlying warm air is unstable, thunderstorms can develop by a process called *elevated convection* even though the surface air may be cold and stable. Such thunderstorms can be difficult to forecast because the convection is not surface-based as usual.

During the anafront passage, the surface wind direction changes

Atypical vs. Typical Cold Front Weather



ft = feet; nm = nautical miles; km = kilometers

Note: The direction of frontal movement is left to right in both profile illustrations. Behind an anafront, persistent conditions may include cumulus clouds and thunderstorms; behind a katafront, conditions typically improve quickly. Altitudes and distances shown only provide a rough approximation of the scale.

Source: Ed Brotak

Figure 1

dramatically, often clockwise by 180 degrees. Drops in temperature also can be spectacular, sometimes 30° F (16.7° C) in a short time.

Typically, there is no precipitation ahead of or with the actual passage of the anafront. But the low clouds persist well behind the front, so there is no clearing. This is also where precipitation occurs. In winter, freezing rain often is observed. Despite Fahrenheit temperatures in the single digits, rain falls. This liquid precipitation can be very heavy and a major factor in icing risk. Strangely enough, thunderstorms can occur even with temperatures that low.

With the anafront, if the very shallow cold air layer near the surface has temperatures below freezing, freezing rain is common because the temperatures aloft can be warm. Any frozen precipitation that forms in or falls through this warmer layer aloft quickly turns to rain. The cold air layer below again cools the water to the freezing temperature but is so shallow that the rain does not have a chance to re-freeze into sleet or ice pellets. Instead, it remains liquid until it encounters a cold surface. Then it freezes on contact, producing glaze conditions.

This may occur within several thousand feet of the surface, so icing becomes a low-level hazard. For aircraft in the descent phase, flight conditions may be normal until the airplane flight path penetrates the cold layer of air at the anafront. The flight crew then may encounter unexpectedly severe icing conditions.

The vertical wind structure through the frontal zone also can be problematic. Near the surface, north to northeast winds in the Northern Hemisphere strongly change direction counterclockwise with increasing altitude to become winds from the southwest or even the south as the airplane climbs.[2] Besides directional shear, velocity shear can be a problem with strong north winds or even a low-level jet occurring in the cold air.[3] The practical effect is that during takeoff and landing, pilots could encounter rapid changes in wind direction and speed.

The bad weather conditions experienced behind the anafront can last for many hours — or many days — because anafronts are slow-moving. The front itself is usually parallel to the upper air flow so there is little energy to push the front.

Unlike common cold fronts, the supporting upper-level trough for an anafront is well displaced to the north, often hundreds of miles away. Computer forecast models, which handle upper-level features better than low-level features, therefore don't predict anafronts as well as other cold fronts.

U.S. anafronts most commonly occur in the central part of the lower 48 states, between the Rocky Mountains and the Appalachian Mountains. The Plains and Midwest regions of the country are devoid of the topographic barriers that impede the southward flow of the shallow, dense and cold air from Canada that can generate anafronts. Cold fronts that cross mountain ranges, even those at the relatively low height of the Appalachians, have the familiar steep slope because the cold air from Canada behind the fronts banks up and becomes deeper.

The following case study illustrates how meteorologists can identify anafronts from upper-level charts, surface weather maps, radar summary charts and/or satellite imagery: The surface weather map for 1200 coordinated universal time (UTC) on Dec. 9, 2007, showed a cold front moving from the north into southern Texas. The front had pushed through Oklahoma the previous day. A strong, arctic high pressure system was to the north. A nose of higher pressure extended southward from the high pressure area into Texas. This cold air had banked up along the Rocky Mountains and had been driven well south.

The 500-millibar (mb) chart, approximately 18,500 ft above sea level (ASL), showed quite a different pattern.[4] A deep trough and a closed low pressure area off the Southern California coast were producing a strong southwest flow over the southern Plains states. The 850-mb chart (approximately 5,000 ft ASL) showed that the flow was even more southerly and moisture-laden than on the 500-mb chart. This was the warm, moist air overriding the frontal surface.

Freezing rain began in eastern Oklahoma during the morning of Dec. 9 and lasted well into the next day. Thunderstorms were numerous and widespread. Meteorologists recorded these conditions as one of the worst ice storms in Oklahoma history, and they were a nightmare for aviation. The major air carrier airports at Oklahoma City and Tulsa, Oklahoma, reported almost continuous freezing rain or drizzle for 36 hours with thunderstorms occasionally reported, too.

The charts for the morning of Dec. 9 at Oklahoma City showed other conditions significant for aviation. At the surface, the temperature was 27° F (minus 2.2° C), and the winds were from the north at 19 kt. The cold air near the ground was only a few thousand feet thick. Continuing up through this air mass, the temperature exceeded 50° F (10° C) at 4,000 ft.

This meant there was no chance for snow even though the surface temperatures were well below freezing. The wind sharply changed direction counterclockwise with height: north-northeast near the surface and southwest just above that. Thunder was reported at the airport during the day. Surface-based air mass stability indexes like the lifted index showed extremely stable conditions. However, the Showalter Index using conditions at approximately 5,000 ft ASL was minus 1.5, indicating possible convection.[5]

Although these examples come from the United States, anafronts can occur anywhere in the world where a source of very cold air exists. They often, but not exclusively, form on the lee side of mountain ranges for this reason.

Anafronts generate a difficult set of problems for aviation interests. They also are more difficult to forecast accurately than common cold fronts. Meteorologists have resources, such as upper-level soundings, and expertise to explain the whole situation. They enable the industry to anticipate when and where anafronts are likely to occur.

For short-term purposes, a few hours in advance of flight operations, the best option for non-meteorologists is to look at the latest surface analysis chart. Real-time radar depictions also are a good option to see if the precipitation is behind the surface front. For a longer-term perspective, surface forecast maps are good. Anytime a cold front has thunderstorms or freezing rain behind it, an anafront — and all that it entails — can be suspected.

Edward Brotak, Ph.D., retired in May 2007 after 25 years as a professor and program director in the Department of Atmospheric Sciences at the University of North Carolina Asheville.

Notes

1. Common cold fronts occur when a mass of cold, dense and stable air advances and replaces a warmer air mass. Distinguishing characteristics may include the length of the front; frontal surface slope; speed of movement; and precipitation decrease after frontal passage.
2. In the Southern Hemisphere, with cold air to the south, anafronts have southerly winds at low levels that change direction clockwise to a northerly component aloft.
3. A low-level jet is a wind speed maximum of at least 30 kt below 10,000 ft with wind speeds decreasing both above and below that altitude.
4. Upper-level charts, such as the 500-mb chart, graphically represent a compilation of data from radiosonde soundings, observations transmitted from sensors aboard aircraft and satellite data.
5. Any positive number for the Showalter Index — used by meteorologists to assess the potential for thunderstorms to develop — indicates stable air. Values from zero to minus 4 signify marginal instability, values from minus 4 to minus 7 signify large instability, and values of minus 8 or less signify extreme instability, the greatest probability of thunderstorms.

© Chris Sorensen Photography

Thinking First of Things Two Parts Through

BY CLARENCE E. RASH AND SHARON D. MANNING

A pilot's cognitive processes — thinking and decision-making skills — often are the key to successfully overcoming in-flight safety risks.

On the chilly afternoon of Jan. 15, 2009, having lost power from both engines of their Airbus A320 minutes after takeoff from New York's LaGuardia Airport, the crew of US Airways Flight 1549 landed the aircraft in the Hudson River.[1] Although the A320 was destroyed, all 155 people inside survived.

There is little doubt as to the role that the training and experience of the flight crew played in the successful emergency landing, but ultimately, it was their decision-making skill that turned a potential tragedy into a triumph.

When faced with a challenging situation, pilots must use their skills, abilities and knowledge to overcome the immediate circumstances. Cognitive psychologists consider decision making as the interaction between a *problem* needing to be solved and a *person* who wishes to solve it within a specific environment and set of circumstances.[2] Although making the right decisions does not always lead to success, making the wrong decisions makes success considerably less likely.

When the crew is faced with a threatening situation in the cockpit, the outcome is largely determined by three groups of factors:

- External factors, such as weather, runway conditions, takeoff weight and presence of birds;
- Aircraft and flight deck design factors, such as the structural limits of the aircraft and the human factors engineering design of flight deck displays and input controls that affect the workload; and,
- Factors related to human capabilities, such as those that influence a pilot's level of cognitive processing and his or her decision-making capability.

The first two groups are largely predetermined and beyond the immediate control of the pilots. However, the third group of factors centers around the human performance of the pilots and is within their direct control.[3] This group includes high-profile factors that are recognized as important enough to be regulated, such as the amount of rest time provided and alcohol consumed within a specified preceding time period, as well as factors that frequently are overlooked, such as nutrition state, hydration level, smoking rate and ambient noise level. These and other seemingly unimportant factors can significantly degrade pilot performance by impairing cognition, and, as a result, problem-solving and decision-making capabilities.

Cognitive Capacity

Although philosophers have been interested in human thought for thousands of years, the field of cognitive science — the scientific study of the human mind or of intelligence — is barely more than 100 years old. Despite tremendous advances in the understanding of how the mind works, it remains difficult, even for cognitive specialists, to predict the cognitive capabilities of an individual in most sets of circumstances.

When cognitive demands exceed an individual's capacity — a condition referred to as cognitive saturation — newly presented information may not be perceived or understood.[4] This implies that individuals have a set amount of cognitive resources — a term that refers to information-processing capabilities and knowledge that can be used to perform mental tasks. Different cognitive tasks appear to involve different information-processing systems, and the resources and limits of these systems determine the cognitive capability to perform a given set of tasks. One of the main goals of cognitive science is to identify the properties of these systems and characterize their limits.

Scientists have explored human cognition by studying its fundamental processes and how they are affected by internal and external factors called stressors.

Cognitive Processes

To make decisions that lead to doing the "right thing" at the "right time" requires pilots to acquire, process and act on information available within the immediate situation. This information is acquired through the five basic human senses — sight, hearing, smell, taste and touch — and the so-called sixth sense of proprioception, or the ability to sense the position and movement of the body and its parts (see "How Humans Obtain Information").

On the flight deck, there is an unusually broad unitization of the senses to continually update pilot information. For example, vision is used to monitor panel displays and to detect airspace and runway incursions. Hearing is used to detect aural warning signals and in communication. Smell — and in some cases, taste — can help detect the presence of fire, fuel leaks or chemicals. Proprioception supplies not only the sensations associated with "seat of the pants" flying but also a range of other signals from sensors in the skin, muscles, tendons and joints that aid in establishing awareness of the position of the body relative to the Earth.

As information is provided by the senses, it is interpreted by the respective cognitive processes of perception, attention, memory, knowledge, problem solving and decision making, after which a course of action is implemented. This defines just one cycle in the decision-action sequence, which is a continuous feedback loop of acquisition, processing, decision and action.

Perception

Perception is a series of conscious sensory experiences. It is a combination of the information from the stimuli, or sources of information, in the world around us producing sensations in the sense organs — via sensory receptors — and cognitive processes that interpret those sensations. Perception deals with the psychological awareness of objects in the world, based

© Chris Sorensen Photography

on the effect of those objects on the sensory systems. It often is defined as the mental organization and interpretation of the visual sensory information with the intent of attaining awareness and understanding of the objects and events in the immediate environment.

Because perception is an interpretation by the cognitive processes of the information obtained by the senses, it is possible for an interpretation to be wrong. These misperceptions are called "illusions" and are attributed to all of the senses. The flight environment is known for inducing a host of sensory illusions in pilots. When not recognized as incorrect interpretations of the current state of the aircraft, these illusions impair situational awareness and frequently lead to incorrect decisions and courses of action, often with disastrous consequences.

How Humans Obtain Information

Humans obtain information via a number of senses. Although most cognitive scientists have moved away from the historical concepts of physiological senses and their resultant sensations and toward the psychological concept of perception — the understanding of sensory information — these older concepts are useful in understanding how we obtain information to make decisions.

Our senses acquire information using specialized receptors (Table 1). The most basic sense modes are sight, hearing, touch, taste and smell.

Along with the sense of balance (equilibrioception, or vestibular sense), these senses sometimes are referred to as exteroceptive senses, because they relate to our perceptions of the world around us. However, scientists have identified a second group of senses called interoceptive senses that pertain to our sense of self. This group includes thermoception, or temperature; nociception, or pain; and proprioception, the sense of the orientation and position of oneself in space. Proprioception does not result from any specific sense organ but from the nervous system as a whole.

— CER, SDM

Human Senses

Human Sense	Receptors	Sensations/Perceptions
Sight (Vision)	Photoreceptors (Cones and rods)	Brightness and color
Hearing (Audition)	Hair cells (Vibration receptors)	Sound
Touch (Tactility)	Touch receptors (Mechanoreceptors)	Touch and pressure
Smell (Olfaction)	Chemoreceptors (Odor receptors)	Smell (Odor)
Taste	Taste buds	Salty, sour, sweet, bitter and umami[1]
Thermoception (Temperature)	Thermoceptors (Heat receptors in the skin)	Temperature (Heat and cold)
Proprioception	Muscle spindles, Golgi tendon organs, and joint receptors	Self orientation and position
Nociception (Pain)	Nocioptors (Pain receptors)	Pain
Equilibrioception (Vestibular sense)	Otolith organs	Balance (Direction of gravity)

Note:

1. Umami, the lesser-known "fifth taste," is described as savory or "meaty."

Source: Clarence E. Rash and Sharon D. Manning

Table 1

Attention

Because humans have limited cognitive processing capability, there is a distinction between the total information provided by the real world and the amount of this information that actually is processed. The mental process that is involved in producing this distinction is referred to as "attention." A stimulus can be processed very differently when attended to, compared with when it is unattended. For example, if someone is asked a question while he is busy attending to something else, he may not even hear the question.

Generally, attention involves a voluntary or intended focusing of concentration. It is believed that attention can be directed to different aspects of the environment. In reality, attention is not based on a single mechanism but involves the properties of many different cognitive systems.

Cognitive scientists distinguish between voluntary and involuntary attention.[5] Voluntary attention occurs when a person makes an obvious cognitive effort to remain focused on a particular task. Involuntary attention often is related to environmental stimuli, such as warning signals, that seem to automatically draw attention.

One attention condition that has been the subject of considerable interest in aviation is "cognitive tunneling." Cognitive tunneling refers to a difficulty in dividing attention between two superimposed fields of information — for example, head-up display (HUD) symbology as one field and see-through images as another field. It sometimes is referred to as "attentional tunneling" or "cognitive capture." In the aviation environment, such difficulty can lead to serious problems. Studies have found that pilots sometimes have failed to detect an airplane on a runway when they are landing while using a HUD system.[6,7] Cognitive tunneling is an extreme form of a trade-off between attending to displays and attending to the outside world. Several studies have shown that a HUD improves monitoring of altitude information in a simulated flight but at the expense of maintaining the flight path.[8,9]

Memory

Memory interacts with attention and perception. Indeed, many failures of attention are described as breakdowns in memory of recent events. Cognitive scientists have identified various components of memory, such as short-term memory, working memory and long-term memory.[10]

Short-term memory deals with memory of items for several seconds and generally has a relatively small capacity, holding only a few items before forgetting takes place. Working memory, which typically involves the manipulation of a piece of information — such as the mental comparison of two remembered airspeeds — is broken down into subsystems that process information in a variety of ways.[11]

Long-term memory refers to the important memories that are stored for long-term use. For example, training information, information about rules for behavior in specific situations and other developed forms of knowledge are stored in long-term memory. Closely related to this type of knowledge is a sort of mental model, a cognitive structure called a "schema," that helps interpret information about how particular situations typically play out; for example, of how a specific aircraft will behave under stall conditions. Schemas allow people to adapt to new situations by using knowledge about other similar situations.

The cognitive process of problem solving refers to an immediate distinction between the present state of circumstances and a goal for which there is no immediately obvious path to attainment.[12] The ability to solve a problem is interrelated with the previously discussed cognitive processes. Some problems are difficult because their solution requires retaining more information than can be held by working memory, and others are difficult because individuals lack the appropriate schemas to characterize and analyze the important issues of a problem.

One important aspect of problem solving is to identify the differences between expert and novice problem solvers. Pilots are specially trained for their duties and are thus experts at solving some aviation-related problems. As a result of their training, experts in a particular field solve problems faster and with a higher success rate than novices. The primary difference between expert and novice problem solvers seems to be that experts have more specific schemas for solving problems.

Experts also generally have more knowledge about their field of specialization than novices. Their knowledge is organized differently than novices' knowledge. In particular, experts often organize their knowledge in a way that reflects the fundamental aspects of solving a class of problems.

Decision Making

The culmination of the other cognitive processes is the decision-making process.

The major elements of decision making are: outcome selection, certainty and uncertainty, and risk. An outcome is what will happen if a particular course of action is selected. Training helps identify the list of possible outcomes and the courses of action that may lead to each outcome. Knowledge of possible outcomes is important when multiple courses of action are available. Certainty implies that decision makers have complete and accurate knowledge of the possible outcomes for each possible course of action, and that there is only one outcome for each course of action. This last condition is not always met.

Risk becomes a factor when there are multiple outcomes for one or more courses of action. Risk can be managed if a probability can be assigned to each outcome when a specific course of action is taken. Uncertainty is present when the probabilities cannot be assigned; such a decision situation is referred to as "decision under uncertainty."

Researchers at the U.S. National Aeronautics and Space Administration (NASA) Ames Research Center examined decision-making errors in aviation[13] and found most errors to be intentional — that is, they resulted from a positive selection of an incorrect course of action (a mistake) and not from a failure to take action (a lapse) or because an intended action was carried out incorrectly (a slip).[14]

However, as has been described, the decision-making process is the culmination of the other cognitive processes; if the other processes are degraded or go awry, then the decision-making process and the resulting selected course of action will be incorrect. The consequences can be disastrous.

To assist pilots with their decision-making skills, the U.S. Federal Aviation Administration (FAA) developed a six-step model for use in teaching the elements of decision making. Known by the acronym "DECIDE," the six elements are:[15,16]

- *Detect* that a change has occurred;
- *Estimate* the need to counter or react to the change;
- *Choose* a desirable outcome;
- *Identify* actions that could successfully control the change;
- *Do* take the necessary action to adapt to the change; and,
- *Evaluate* the effect(s) of the action.

Decision making is a skill. Pilots, like other professionals, must learn to become better decision makers. The DECIDE model — one of many human factors approaches to teaching decision-making skills — has proved to be a successful resource for learning the crucial components of making more effective decisions.

Developing good decision-making skills is not just an academic exercise for pilots; it is a necessity. With lives at stake, making the right decision at the right time is imperative. From 1990 through 2002, decision errors were identified as a contributing factor in 30 to 40 percent of commercial and general aviation accidents.[17,18]

Clarence E. Rash is a research physicist with 30 years experience in military aviation research and development and the author of more than 200 papers on aviation display, human factors and protection topics. His latest book is Helmet-Mounted Displays: Sensation, Perception and Cognition Issues*, U.S. Army Aeromedical Research Laboratory, 2009.*

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

Notes

1. U.S. National Transportation Safety Board. Preliminary accident report DCA09MA026. NTSB news releases, Feb. 19, 2009; June 4, 2009. Preliminary reports from the NTSB attributed the loss of engine thrust to multiple bird strikes on each of the A320's engines during initial climb. Five people in the airplane received serious injuries. The investigation is continuing.

2. Narayan, S.M.; Corcoran-Perry, S. "Line of Reasoning as a Representation of Nurses' Clinical Decision Making." *Research in Nursing & Health* Volume 20 (1997): 353–364.

3. Research has shown that several personal factors not in the direct control of an individual, such as gender and age, can affect decision making. Sanz de Acedo Lizárraga, María L.; Sanz de Acedo Baquedano, María T.; Cardelle-Elawar, María. "Factors That Affect Decision Making: Gender and Age Differences." *International Journal of Psychology and Psychological Therapy* Volume 7 (2007): 381–391.

4. Dean, Allan; Pruchnicki, Shawn. "Deadly Omission." *AeroSafety World* Volume 3 (December 2008): 10–16.
5. Pashler, H.E. *The Psychology of Attention*. Cambridge, Massachusetts, U.S.: MIT Press, 1997.
6. Fischer, E.; Haines, R.F.; Price, T.A. "Cognitive Issues in Head-Up Displays." NASA Technical Paper 1711, NASA Ames Research Center, Moffett Field, California, U.S., 1980.
7. Wickens, C.D.; Long, J. "Object Versus Space-Based Models of Visual Attention: Implications for the Design of Head-Up Displays." *Journal of Experimental Psychology: Applied* Volume 1 (1995): 179–193.
8. Foyle, D.C.; Sanford, B.D.; McCann, R.S. "Attentional Issues in Superimposed Flight Symbology." In *Proceedings of the Sixth International Symposium on Aviation Psychology*, edited by Jensen, R.S. Columbus, Ohio, U.S.: Ohio State University, 1991.
9. Neath, I.; Surprenant, A.M. *Human Memory: An Introduction to Research, Data, and Theory* (2nd edition). Belmont, California, U.S.: Wadsworth, 2003.
10. Ibid.
11. Baddeley, A.D. "Working Memory: Looking Back and Looking Forward." *Nature Reviews Neuroscience* Volume 4 (Sept. 30, 2003): 829–839.
12. Lovett, M.C. "Problem Solving." In *Steven's Handbook of Experimental Psychology,* 3rd edition (Medin, D.L., editor): 317–362. New York: Wiley, 2002.
13. Orasanu, Judith; Martin, Lynne. "Errors in Aviation Decision Making: A Factor in Accidents and Incidents." Workshop on Human Error, Safety, and System Development (HESSD): 100–107, 1998.
14. Wickens, Christopher; Hollands, Justin. "Stress and Human Error." In *Engineering Psychology and Human Performance*, 3rd edition. London: Prentice Hall, 1999.
15. Jenson, R.S.; Adrion, J.; Lawton, R.S. *Aeronautical Decision Making for Instrument Pilots*, DOT/FAA/PM-86/43, 1987.
16. FAA. Advisory Circular 60-22, *Aeronautical Decision Making*, 1991.
17. Shappell, S.A.; Wiegmann, D.A. *Human Error and General Aviation Accidents: A Comprehensive Fine-Grained Analysis Using HFACS*. 2005. <www.hf.faa.gov/docs/508/docs/gaFY04HFACSrpt.pdf>.
18. Shappell, S.A.; Detwiler, C.A.; Holcomb, K.A.; Hackworth, C.A.; Boquet, A.J.; Wiegmann, D.A. *Human Error and Commercial Aviation Accidents: A Comprehensive Fine-Grained Analysis Using HFACS*. Washington, D.C.: FAA Office of Aviation Medicine, 2006.

HIGH STAKES

ICAO auditors' findings on Australian and U.S. dangerous goods oversight reflect challenges of achieving global consistency.

BY WAYNE ROSENKRANS

© Chris Sorensen Photography

Two countries with high overall scores on effective implementation of critical elements of a safety oversight system[1] lost points when teams of international auditors looked at how they regulate the transport of dangerous goods by air.[2] Australia and the United States hosted auditors representing the International Civil Aviation Organization (ICAO) in February 2008 and November 2007, respectively, under ICAO's Universal Safety Oversight Audit Program (USOAP).[3,4] The results were released to the public this year.[5]

The audits were the first for each state conducted under the comprehensive systems approach in the 2005–2010 cycle of audits (*ASW*, 2/07, p. 39). ICAO agreed that each country's resultant action plan fully addressed most of the findings and recommendations. Most corrective actions in response to dangerous goods–related findings had been completed by mid-2009; others were scheduled to be completed by the end of 2010, the states said in the final reports.

Around the time of the previous visits by USOAP auditors to Australia and the United States under the program's initial approach, a passenger airliner was destroyed in Malaysia. According to accident information compiled by the Aviation Safety Network, citing news media accounts in China and other sources, Malaysia Airlines Flight 085, an Airbus A330, arrived at Kuala Lumpur International Airport after a flight from Beijing on March 15, 2000. At about 2340, five of 20 cargo handlers suddenly became ill when they encountered fumes while unloading 80 canisters weighing 2,000 kg (4,409 lb) from the cargo hold of the aircraft. None of the 252 passengers and 14 crewmembers was injured.[6]

Aircraft rescue and fire fighting personnel identified the source of the fumes emitted by the canisters as oxalyl chloride, a liquid used in laboratory chemical analysis that may be fatal if swallowed or inhaled, and releases toxic and corrosive fumes in contact with water or moist air.

Several canisters had leaked inside the hold, causing fuselage damage so severe that the insurer judged the five-year-old airplane to be damaged beyond economic repair. A Chinese court found that the shipper had misidentified the canisters as a safe powder-type chemical.

© Chris Sorensen Photography

Australian Improvements

USOAP auditors found that regulations of the Civil Aviation Safety Authority (CASA) had prescribed Australian

International Civil Aviation Organization requirements for the consignment and carriage of dangerous goods by air and addressed training, documentation, record keeping, incident reporting, packaging, marking, labeling and loading. "However, the regulations are not up to date with the latest amendments of ICAO's Annex 18, *The Safe Transport of Dangerous Goods by Air,* and its *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284)," ICAO said.

The government agreed to conduct "a thorough review of the provisions of Annex 18 … to determine if Australian legislation requires amendment. … CASA will also develop and implement processes to ensure future Annex 18 amendments are considered and either appropriately incorporated into the Australian safety system or differences are lodged with ICAO."

The auditors found that CASA had two dangerous goods inspectors at the time of the audit. "This number is not sufficient for the level of activity in Australia as to ensure effective safety oversight," ICAO said. "In addition, the dangerous goods inspectors have not been provided with adequate dangerous goods training or technical guidance materials." The auditors noted that this contrasted with CASA's practice of issuing advisory circulars to inform the aviation industry about the regulatory requirements for dangerous goods.

The government agreed with the finding and responded that a new dangerous goods project, called DG Vision 2010, would develop new approaches to ensure that adequate numbers of trained inspectors are available. The government also agreed to establish clear standards and processes, including a program for surveillance and enforcement; develop systems for reporting, capturing and analyzing dangerous goods data; and revise and update CASA's dangerous goods training course.

Another finding was that CASA did not have a finalized and approved "process for granting specific authorizations related to the transport of dangerous goods by air, including review of the air operator's acceptance checklists, loading procedures, in-flight emergency response procedures, and approval of dangerous goods training programs."

© Alexander Kueh/Airliners.net

A prohibited corrosive liquid spilled in cargo left this Airbus A330 a constructive total loss.

The government said that CASA would introduce a layered approach to dangerous goods inspection, beginning with surveillance and audit training of existing flight operations inspectors, cabin safety inspectors, air transport inspectors and airport inspectors. "Once trained, these inspectors will provide initial safety oversight in conjunction with their other duties," CASA said. "Recruitment and development of specialists will be undertaken as necessary. … A core team of dangerous goods specialists will be supported by the other inspectors (up to two per office) [who] have received enhanced dangerous goods oversight training. … Australia will examine and consider instituting specific authorizations to carry dangerous goods … make any necessary legislative amendments and update supporting documentation including the advisory circular."

The auditors found that CASA did not have "a comprehensive surveillance program of regular and random inspections of activities pertaining to the safe transport of dangerous goods by air." The government said, "Currently, inspections by the dangerous goods inspectors are being undertaken on a risk-management basis with a particular focus on both random and scheduled audits occurring in areas that are of higher risk or have not been closely scrutinized in recent times. However, a specific surveillance program is not yet in place."

U.S. Improvements

In the United States, the USOAP audit team cited difficulty identifying lines of accountability because of the ways that oversight has been divided among the U.S. Federal Aviation Administration (FAA) and other agencies. Essentially, the Department of Transportation has authority to issue dangerous goods–related regulations but delegates overall rulemaking authority to another of its agencies — the Pipeline and Hazardous Material Safety Administration (PHMSA) — while delegating to the FAA the enforcement of hazardous material regulations (HMRs) for the aviation sector, and involving the FAA in dangerous goods rulemaking related to ICAO Annex 6, *Operation of Aircraft*.

The auditors found a system of exemptions from regulatory requirements that did not comply with ICAO standards and an unclear division of responsibilities. "Although the [federal law] in general permits compliance with ICAO's *Technical Instructions* [TI], subsidiary regulations applicable to the transport of dangerous goods are not in full compliance with ICAO Annex 18 … and the [TI]," ICAO said.

The exemption-related discrepancy was between ICAO's basis for granting exemptions from dangerous goods regulations to aircraft operators and findings that PHMSA had issued exemptions without these conditions being met. The TI essentially says that states may issue exemptions to dangerous goods regulations "in cases of extreme urgency, or when other forms of transport are inappropriate, or full compliance with the prescribed requirements is contrary to public interest … provided that in such cases, every effort is made to achieve an overall level of safety in transport, which is equivalent to the level of safety provided by [the TI]."

The U.S. government replied, "PHMSA concurs that we may issue a variance to the ICAO TI only provided [that] an equivalent level of safety is demonstrated, or is necessary to protect life or property. Such authorizations for the use of an alternative means of compliance support medical necessities, [and] allow shippers and [air] carriers to quickly implement new technologies and to evaluate new operational techniques that enhance safety and increase productivity in support of U.S. interests. Individual technical safety evaluations are conducted, and more stringent safety provisions than the standard applicable provisions of the TI are often required as a condition of the [exemption]." Nevertheless, the United States agreed to provide ICAO with a written description of the procedures followed by PHMSA for accepting, reviewing, approving or denying applications for exemptions from dangerous goods regulations.

The auditors found that, except for the FAA, agencies on the U.S. Interagency Group on International Aviation (IGIA) — including PHMSA — lacked formal procedures to amend U.S. regulations in concert with updates to ICAO standards and recommended practices or to identify national differences and notify ICAO accordingly. They also found a lack of formal coordination on dangerous goods issues among the rulemaking departments of the Department of Transportation, the FAA and PHMSA, and no procedure or practice for them to consult with each other on harmonization of proposed U.S. amendments and ICAO standards and recommended practices.

The government responded, "We will establish standard operating procedures for IGIA members and include provisions for coordination with the appropriate rulemaking departments in the U.S. government. … FAA and PHMSA are addressing the coordination concerns raised in this finding in a new memorandum of understanding between the two agencies. … We believe that [a written FAA process already] satisfies the recommendation to develop coordination procedures among the various rulemaking departments."

The government's action plan also included commitments to "identify all incorrect ICAO references and standards [in U.S. regulations]; take action to update all incorrect ICAO references and standards; identify and file any differences as appropriate; initiate action to consider requiring mandatory compliance with the provisions of the ICAO TI, in addition to specifically identified more restrictive requirements of the U.S. HMRs, for hazardous material shipments by air from the United States; [and] identify the specific differences between the ICAO TI and the U.S. HMRs and consider the appropriate means to address each difference."

Notes

1. Australia scored 83.38 percent effective implementation of ICAO's critical elements of a safety oversight system compared with a global average of 58.48 percent for 115 audited states in 2008. The United States scored 91.13 percent compared with a global average of 57.77 percent for 108 audited states in 2007.
2. U.S. regulations and guidance material use the term *hazardous materials*.
3. ICAO. "Final Report on the Safety Oversight Audit of the Civil Aviation System of the United States of America: 5 to 19 November 2007." Universal Safety Oversight Audit Program. August 2008.
4. ICAO. "Final Report on the Safety Oversight Audit of the Civil Aviation System of Australia: 5 to 19 November 2007." Universal Safety Oversight Audit Program. January 2009.
5. Both governments — in the interest of public confidence in air travel through transparency of safety information (*ASW*, 8/08, p. 30) — exceeded the typical practice of the 190 states by authorizing public posting of the final reports on the ICAO Flight Safety Information Exchange Web site, <www.icao.int/fsix>.
6. Among the sources cited was "Chinese Chemical Firm Ordered to Pay Insurers $65 Million in Plane Damage Case." *People's Daily Online*, June 12, 2007.

FALSE POSITIVE

Eric Gaba/Wikimedia Commons

The gauges showed 'fat on fuel' when the tanks ran dry.

BY MARK LACAGNINA

The fuel quantity indicator (FQI) showed that there was plenty of fuel aboard the ATR 72 when both engines flamed out high above the Mediterranean Sea. Accordingly, the flight crew spent precious minutes trying to restart the previously faultless engines rather than coaxing the maximum glide performance from the aircraft for a possible landing at a coastal airport — a theoretical possibility.

The restart attempts were futile because there actually was no fuel remaining in the tanks. The problem was not that the FQI was malfunctioning, the problem was that it was designed to be used in an ATR 42, not in the larger ATR 72 in which it had been installed before the flight.

The aircraft broke into three pieces when it was ditched in rough seas off the northern coast of Sicily. Fifteen passengers and the senior flight attendant were killed; 13 passengers, the captain, the copilot and the assistant flight attendant were seriously injured; and seven passengers sustained minor injuries.

In its recent report on the Aug. 6, 2005, accident, the Agenzia Nazionale per la Sicurezza del Volo (ANSV, the Italian Air Safety Board) said, "The ditching was primarily due to the [flameout of] both engines because of fuel exhaustion. The incorrect replacement of the [FQI] was one of the contributing factors which led irremediably to the accident."

Not Interchangeable

The accident aircraft was operated by the Tunisian airline Tuninter, which had two ATR 72s and one ATR 42 in its fleet. Based in Tunis, the airline conducted "domestic and international scheduled service and charter flights, the latter chiefly to and from Italy," the report said.

The day before the accident, the aircraft had been used for five flights, of which four were conducted by the accident captain. He had noticed that the FQI display was difficult to read because of the failure of several light-emitting diodes. The captain recorded the fault in the aircraft's logbook after completing his last flight, which terminated in Tunis.

The captain also recorded that 790 kg (1,742 lb) of fuel remained in the aircraft after shutdown.

The FQIs in the ATR models compute the weight of fuel in the wing tanks based on measurements of the electrical capacitance of metallic probes inside the tanks. "The FQI is an instrument processing the signal from the capacitive sensors installed in the wing fuel tanks, based on an algorithm which is specific to each type of aircraft, depending on the shape of the tanks, their sizes and the number of probes," the report said. "The wing fuel tanks of ATR 42 and ATR 72 aircraft are different in terms of maximum capacity, shape, [and the] number and positioning of the capacitive probes. Therefore, ATR 42 and ATR 72 type FQIs use different algorithms and cannot be interchanged."

The FQIs for the two ATR models are almost identical in appearance, the only difference being the inscriptions on the gauge faces showing the maximum fuel quantity for each wing tank: 2,500 kg (5,512 lb) for the ATR 72 and 2,250 kg (4,960 lb) for the ATR 42. The installation procedure is the same.

Search for a Spare

Following up on the captain's malfunction report, a maintenance technician in Tunis had used a video terminal to search the manufacturer's illustrated parts catalog (IPC) for the correct part numbers for a replacement FQI. He found three: 748-681-2 (the same part number as that of the faulty FQI that required replacement), 749-160 and 749-759.

The ATR 72 broke into three pieces when it was ditched in rough seas. Some survivors climbed atop the center section to await rescue.

Agencia Nazionale per la Sicurezza del Volo

Though it looks almost identical and fits perfectly, this ATR 42 fuel quantity indicator will read high when installed in the larger ATR 72.

The technician then searched Tuninter's spare parts management system for FQIs bearing those part numbers but found none shown as either in stock or installed in one of the airline's ATR 72s. "As this result was rather strange, considering that at least the FQIs already installed on the aircraft of the carrier should have shown on the information system, the technician tried to look for FQIs recorded with a PN [part number] different from the one listed in the IPC," the report said.

(FQIs suitable for the ATR 72 actually were available in stock at Tunis, but their part numbers had not been entered in the spare parts management system's database exactly as they appeared in the IPC; the dashes in 748-681-2, for example, had been omitted. Thus, when the technician entered the part numbers that he had derived from his search of the IPC, the spare parts management system did not recognize them.)

The technician continued his search by entering "748-" in the spare parts management system. The system erroneously showed that PN 748-465-5AB was applicable for installation in both the ATR 72 and the ATR 42, and was interchangeable with FQIs of two different part numbers, one of them being 749-158. "The information relating to the applicability was wrong, as PN 748-465-5AB identifies an FQI only applicable to ATR 42 aircraft and not also to [the] ATR 72," the report said.

The spare parts management system showed that a PN 749-158 FQI was in stock. The technician's shift was nearly over when he retrieved the FQI from stock, so he prepared the gauge for installation and left it for the maintenance technician assigned to the next shift.

The maintenance technician on the next shift replaced the FQI in the accident aircraft. "The technician replacing the part did not complete, however, an IPC check for the applicability of PN 749-158 to the ATR 72 aircraft either before or after the replacement," the report said.

After it was installed, the FQI showed a total fuel quantity of 3,100 kg (6,834 lb), rather than 790 kg. No checks of the accuracy of this indication were performed or were required to be performed. "The replacement procedure did not require any manual checks, using the so-called dripsticks, of the actual quantity of fuel present in each tank or the subsequent comparison with the value shown by the FQI," the report said.[1] The job instruction card required only a check that the displays were illuminating properly.

Shuffled Schedule

The schedule for the accident aircraft, registration TS-LBB, the morning of Aug. 6 began with a round-trip flight between Tunis and Djerba, a resort island off the southeast coast of Tunisia. The flight crew assigned to these flights requested an initial fuel load that was about half the 3,100 kg shown on the centralized refueling panel, which simply repeats the quantity shown on the cockpit FQI.

It was decided that TS-LBB would have to be partially defueled. However, the defueling tanker would not be available for two hours. Rather than delaying the flight, the assigned crew agreed to conduct the flight in the other ATR 72 operated by Tuninter.

That aircraft, TS-LBC, had been scheduled for a flight to Palermo later that morning. However, when the dispatcher told the crew assigned to that flight that TS-LBC had been rescheduled and that they would have to take

TS-LBB instead, the captain refused. “He took this decision because, during previous flights using the same aircraft, a malfunctioning of the nosewheel steering [system] had repeatedly been notified,” the report said. “It was his opinion that this fault had not been correctly handled and resolved.” (The fault was excessive vibration and a loud noise when the nosewheel was fully deflected.) The dispatcher then offered the ATR 42 for the Palermo flight, and the captain accepted it.

‘Missing’ Fuel Slip

The captain who had reported the malfunctioning FQI in TS-LBB the previous day had been scheduled to conduct subsequent flights in the aircraft on Aug. 6, beginning with a positioning flight to Bari, which is on the southeastern coast of the Italian peninsula, and a charter flight to Djerba (ultimately, the accident flight).

The captain and the copilot assigned to the flights were Tunisian nationals. The captain, 45, had 7,182 flight hours, including 5,582 hours in type. He had been on duty more than nine hours the previous day and had a rest period of nearly 18 hours. The copilot, 28, had 2,431 flight hours, including 2,130 hours in type.

The dispatcher asked the pilots if the indicated fuel quantity, 3,100 kg, would be sufficient to complete the flights to Bari and Djerba without refueling in Bari. The copilot told the captain that he had calculated a departure fuel load of 4,200 kg (9,259 lb) as sufficient to avoid refueling in Bari. “The flight captain, responsible for the final decision, decided to request a block fuel value of 3,800 kg [8,377 lb],” the report said. “During [post-accident] interviews, the flight captain justified this decision with possible route shortenings, which are often allowed due to low volumes of traffic.”

Accordingly, the aircraft was refueled to an indicated quantity of 3,800 kg. Because of the FQI’s erroneously high readings, however, only 465 kg (1,025 lb) of fuel, rather than 700 kg (1,543 lb), was required to bring the indicated quantity from 3,100 to 3,800 kg. No one noticed the discrepancy.

Meanwhile, while reviewing the aircraft documents, the captain had noticed that there was no fuel slip showing that the aircraft had been refueled from the 790 kg he had recorded after his last flight the previous day to the 3,100 kg indicated before the refueling that morning. The fuel slip could not be found; indeed, it did not exist because the aircraft had not been refueled from 790 kg to 3,100 kg.

However, the dispatcher told the captain that “it was highly likely that one of the crews planning to complete the previous routes, subsequently cancelled, might have mistakenly kept the copy of this refueling slip,” the report said. The dispatcher said that he would find the slip and give it to the captain when he returned to Tunis later that day.

The captain “trusted in the assurances given by the flight dispatcher” and agreed to depart without the fuel slip, the report said. “A diligent search for the aforementioned slip … making enquiries of the refueling company as well, would undoubtedly have led the crew to suspect that the fuel reading was not entirely reliable and, hence, to investigate further.”

The fuel slip could not be found; indeed, it did not exist because the aircraft had not been refueled.

‘Technical Problem’

The ATR 72’s tanks actually contained a total of 1,255 kg (2,767 lb) of fuel — about one-third of the quantity indicated — when the engines were started (Figure 1, p. 30). The aircraft departed from Tunis at 1005 coordinated universal time (UTC; 1205 local time) and landed in Bari at 1146 UTC.

The crew had planned to have 2,700 kg (5,952 lb) of fuel aboard for the flight from Bari to Djerba, but the FQI indicated 2,300 kg (5,071 lb). The captain therefore decided to upload fuel. Again, no one noticed the discrepancy when the addition of 265 kg (584 lb) of fuel was sufficient to increase the indicated fuel quantity from 2,300 kg to 2,700 kg.

The tanks actually held 570 kg (1,257 lb) of fuel when the ATR 72 departed from Bari at 1232 UTC as Flight TUI 1153.

The aircraft was cruising at Flight Level (FL) 230 (approximately 23,000 ft) at 1320 UTC when the right engine flamed out. The copilot reported a "technical problem" to the Rome Area Control Center and requested clearance to descend to FL 170. "The [copilot] did not specify to air traffic control the type of problem occurring," the report said.

Recorded flight data indicated that the left engine flamed out about 100 seconds later. The copilot told the center controller that they wanted to land in Palermo, which is on the northern coast of Sicily. This radio transmission, however, was partially blocked by the controller's transmission of a clearance to descend to FL 170 and a question about the need for special assistance. Shortly thereafter, the copilot declared an emergency, repeated the request to proceed directly to Palermo and said, "We lose both engines."

The center controller decided to hand off the flight to Palermo Approach Control, which could provide greater assistance to the crew.

'Send Us Helicopters'

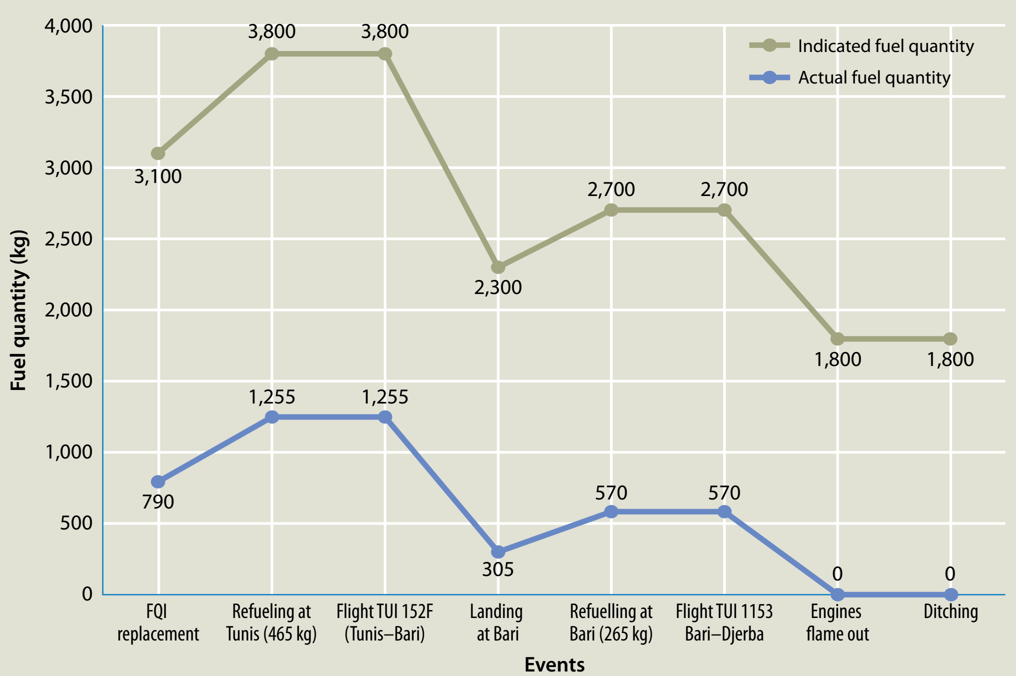
After establishing radio communication with the approach controller at 1325, the crew confirmed that they had lost both engines and asked three times in English for the distance to Palermo. The report said that the requests were "not sufficiently clear" and that the controller "had not perfectly understood" them but "finally replied that the current distance [to] Palermo was 48 nm [89 km]." At this point, the aircraft was descending through 15,000 ft.

The crew asked twice if there was a closer airport: "Any nearest airport where we can land?" The controller did not understand the question until it was repeated by the crew of another aircraft. The controller confirmed that Palermo was the closest airport.

At 1333 — after a series of radio communications in which the crew requested vectors direct to Palermo and the controller requested information about passengers, fuel and dangerous goods aboard the aircraft — the controller told the crew that they were 20 nm (37 km) from Palermo. The crew replied that they were at 4,000 ft and would not be able to reach the coast. "They also requested that emergency services be dispatched ('Can you send us helicopters or something like that?')," the report said.

The aircraft was at 2,200 ft when the crew radioed that they were turning to a heading of 180 degrees to ditch the aircraft as close as possible to two "big boats" they had spotted. The crew asked

Indicated vs. Actual Fuel Quantity



FQI = fuel quantity indicator

Source: Agencia Nazionale per la Sicurezza del Volo

Figure 1

the controller to advise the boats of the situation shortly before radio communication ended at 1337.

'Unable to Understand'

When the right engine flamed out, the pilots had noticed a low fuel pressure warning and had initiated the associated checklist. However, when the left engine flamed out, the captain told the copilot to stop reading the checklist. "For about a minute, the pilots tried to interpret the indications of the cockpit instrument warnings and identify the reasons for the failure of both engines, but unsuccessfully," the report said.

The pilots did not conduct the checklist related to flameout of both engines and, thus, did not feather the propellers. They focused on trying to restart the engines. The FQI showed 1,800 kg (3,968 lb) of fuel remaining. The low-fuel warning never appeared because the indicated quantity had not fallen below the requisite 320 kg (705 lb). Among the recommendations generated by the ANSV's investigation was that all public transport aircraft have a low-fuel-quantity warning system that is independent of the FQI system.

The aircraft was descending through 12,000 ft when the captain told the senior flight attendant to prepare the passengers for a possible ditching. The senior flight attendant used a megaphone to brief the passengers about donning their life vests; he also assisted some passengers who were having difficulty doing so. The assistant flight attendant was "greatly in distress," and "deficiencies have been found in her behavior," the report said.

"Before ditching, all passengers [and] the flight attendants were sitting with their seat belts fastened and ready for collision," the report said. Despite their instructions, however, some passengers inflated their life vests inside the aircraft.

Meanwhile, the pilots had continued trying to restart the engines, and the captain had summoned the maintenance technician assigned to the flight to assist. "Both the flight crew and the engineer were unable to understand what type of fault had occurred to the two engines," the report said. The last restart attempt was made shortly before the aircraft descended through 4,000 ft.

The captain flew the aircraft and also handled radio communication while the copilot began to conduct the ditching checklist. "The flight captain, in view of the imminence of the ditching, asked the copilot to assist him in the steering of the aircraft and to get ready for the impact," the report said. "The ditching checklist was not completed."

Violent Impact

The sky was clear and visibility was good, but the sea conditions were described by the report as "rough to very rough." The aircraft struck the water tail-first. The impact was described as violent and as having caused most of the fatalities.

"Although broken in three main parts, the aircraft remained floating for about 20 to 30 minutes after ditching," the report said. The center fuselage section, with the wings and engines attached, remained floating after the front and rear sections sank in nearly 5,000 ft of water.

"Almost all [the surviving] passengers remember that they found themselves outside the aircraft after the impact or that they immediately exited the aircraft from the openings in the fuselage," the report said. Rescue operations by helicopters and patrol boats began about 30 minutes after the ditching.

Recovered wreckage and the flight data and voice recorders were sequestered by Italian judicial authorities. The report said that the criminal investigation impeded the technical investigation of the accident by the ANSV and accredited parties to the investigation (see editorial, p. 5).

Calculations and two flight simulator tests performed by the ANSV indicated that if the pilots had configured the ATR 72 for optimum glide performance after the second flameout occurred at 21,800 ft and about 60 nm (111 km) from Palermo, and if they had maintained the appropriate drift-down speed, they *theoretically* could have reached the airport.

However, the report noted that maintaining drift-down speed while dealing with distractions and while flying with reference to standby instruments providing no distance readout would have been very difficult. One of the two experienced ATR crews that participated in the simulator tests was able to reach the runway; the other landed in the sea, about 1 nm (2 km) from the runway threshold.

This article is based on the ANSV's "Final Report: Accident Involving ATR 72 Aircraft, Registration Marks TS-LBB," available online at <ansv.it/EN/Detail.asp?ID=1083>.

Note

1. *Dripstick* is an outdated term that is still used to describe a modern fuel quantity measuring stick that, when manually unlocked, extends from a sealed tube in the wing tank through the bottom of the wing until a magnet at the top of the stick aligns with a magnetic float in the tank. The stick has calibration marks showing fuel quantity.

Procedural Disregard

Failure to comply with recommended arrival and communication procedures played a big part in the fatal midair collision of two EMS helicopters, the NTSB says.

BY LINDA WERFELMAN

Pilots of two emergency medical services helicopters failed to see and avoid each other's aircraft before the two Bell 407s collided as they approached the Flagstaff (Arizona, U.S.) Medical Center helipad, each to drop off a patient, the U.S. National Transportation Safety Board (NTSB) said.

In its final report on the accident, the NTSB cited each pilot's failure to see and avoid the other helicopter as the probable cause of the June 29, 2008, crash that killed all seven people in the two aircraft — one operated by Air Methods Corp. of Englewood, Colorado, and the other,

U.S. National Transportation Safety Board

by Classic Helicopter Services of Page, Arizona. Contributing factors were "the failure of [the Air Methods] pilot to follow arrival and noise abatement guidelines and the failure of [the Classic] pilot to follow communications guidelines."

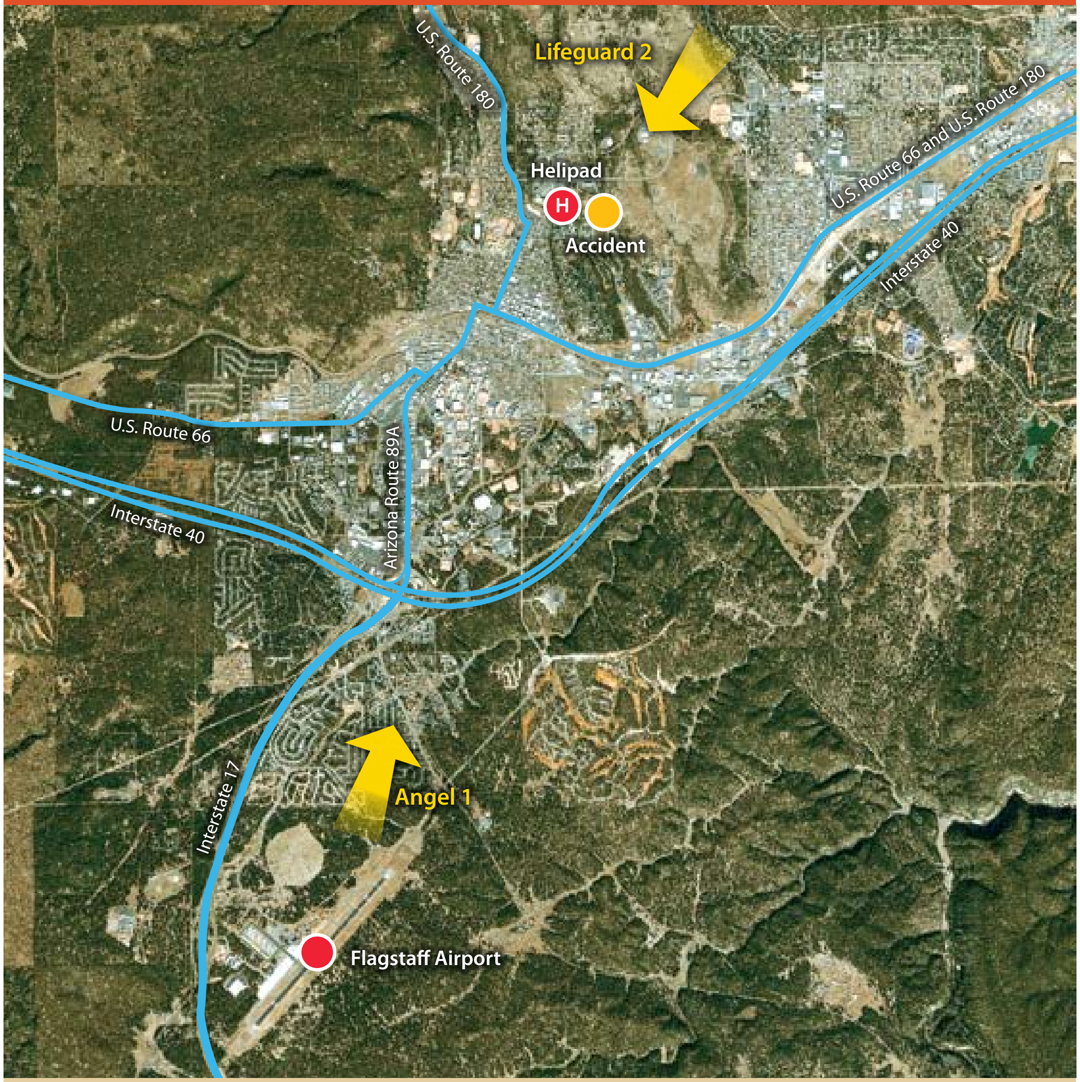
Both helicopters were destroyed in the crash, which occurred at 1547 local time in visual meteorological conditions that included clear skies and at least 10 mi (16 km) visibility.

The Air Methods pilot, operating under the call sign Angel 1, had contacted Guardian Control, the operator's communications center, at 1516, saying that he was departing from Winslow, Arizona, with two flight nurses and a patient and that he might land at Flagstaff Pulliam Airport (FLG) if he calculated that the helicopter would be too heavy for a safe out-of-ground-effect hover at the hospital helipad (FMC). He estimated his flight would take 25 minutes.

At 1517, he again contacted Guardian Control to request FLG weather conditions; within the next two minutes Guardian Control's transportation coordinator contacted FMC to report that the helicopter would arrive at the helipad in about 23 minutes. About 1518, the pilot told Guardian Control he would first fly to FLG to allow one of the flight nurses to disembark before proceeding to FMC.

The Classic helicopter pilot, with the call sign Lifeguard 2, contacted Classic Control

Accident Flight Paths



Source: U..S. National Transportation Safety Board

Figure 1

at 1517 to report having departed from the South Rim of the Grand Canyon and estimating that the flight to FMC would take 32 minutes. In addition to the pilot, the Classic helicopter carried a flight nurse, a flight paramedic and a patient.

At 1523, the Classic Control dispatcher contacted Guardian Control to say that Lifeguard 2 was en route to FMC and would arrive from the north. Guardian Control responded that Angel 1 also was en route and expected to land in 20 minutes.

The Classic dispatcher replied, "Oh, okay, I'll let them know when I talk to them next, and I'll tell them to be sure and get ahold of you."

Guardian Control then called the FMC emergency department and said that Classic's Lifeguard 2 would land at the hospital helipad "in about 28 minutes … and they know about mine coming in." The person who had answered the FMC telephone said, "All right," and Guardian Control then contacted the Angel 1 pilot with the same information.

The crash … occurred at 1547 local time in visual meteorological conditions that included clear skies.

Bell 407

The Bell 407 is a single-engine light helicopter developed in the mid-1990s as a replacement for the JetRanger and LongRanger. The 407 has a four-blade main rotor, a wider cabin than the LongRanger and a larger cabin window area. Designed for a pilot and six passengers, it also can be modified for emergency medical services use.

The 407 has an Allison 250-C47 turboshaft engine rated at 813 shp (606 kW) for takeoff and 701 shp (523 kW) for continuous operation. Standard usable fuel capacity is 126 gal (477 L). Empty weight is 2,598 lb (1,178 kg), and maximum takeoff weight with an internal load is 5,000 lb (2,268 kg).

Maximum cruising speed at sea level is 115 kt. Maximum range is 312 nm (577 km).

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

The Angel 1 pilot replied, "Roger, will be looking for 'em, thanks."

At 1532, the Lifeguard 2 pilot, in his last recorded communication, gave Classic Control a position report and said he planned to land at FMC in 15 minutes.

About the same time, the Angel 1 pilot told Guardian Control he would land at FLG in 10 minutes to drop off the flight nurse. Two minutes later, he asked Guardian Control to contact FMC for help in moving the patient from the helicopter.

At 1543, having landed and dropped off the flight nurse, Angel 1 departed from FLG. One minute later, he told Guardian Control in his last recorded communication, "If you haven't figured it out, we've, uh, landed at the … airport, departed and we're about two minutes out of the hospital."

At 1550, the Classic dispatcher telephoned Guardian Control and asked if Guardian had had contact with "my ship." The Classic dispatcher said, "Negative."

Medical crewmembers on both helicopters had spoken with different personnel at the hospital. The Classic crewmember said that Lifeguard 2 was expected to arrive at the hospital helipad about 1546; the Air Methods crewmember estimated a 1549 arrival time for Angel 1. The hospital medical personnel said that neither conversation mentioned that another helicopter also was en route to the helipad. Hospital personnel were not required to provide this information.

Video recorded on a hospital surveillance camera showed one of the helicopters approaching the helipad from the north, the other approaching from the south and both descending.

Witnesses said that Angel 1 approached the helipad on a "usual landing pattern," from the southwest. The report quoted one witness as saying that she heard one helicopter approaching from the north and a second, from the south and "looked up just as the northbound helicopter apparently clipped the rotor of the southbound [helicopter]. At that time, they both were in a turn to the hospital."

The wreckage was found about 0.25 nm (0.50 km) east of the helipad, in a wooded area. The Classic helicopter, which showed no signs

At the time of the crash, Classic Helicopter Service operated three aircraft, including this Bell 407.

RotorImage/Airliners.net

of fire damage, was about 300 ft (91m) west of the Air Methods 407, which exploded in flames after striking the ground.

Full-Time EMS Pilots

The Air Methods pilot, who had 5,241 flight hours, including 4,500 hours in helicopters, held a U.S. Federal Aviation Administration (FAA) commercial pilot certificate for single-engine land airplanes and helicopters and instrument ratings for both categories of aircraft. He also held a first-class medical certificate.

He was hired by Air Methods in October 2003 to fly Bell 407s from the operator's Flagstaff base. He worked full-time as an EMS pilot and was qualified to fly with night vision goggles (NVGs). He satisfactorily completed all company initial, recurrent and NVG training courses, the operator said. He was the Air Methods safety officer and safety coordinator.

The Classic pilot had 14,500 flight hours, including 9,780 hours in helicopters. He held a commercial pilot certificate for single-engine land airplanes and helicopters and instrument ratings for both categories, and he was NVG-qualified. He also held a second-class medical certificate.

He was hired by Classic in May 2007 as a full-time EMS pilot to fly Bell 407s from the Classic base in Page, and he satisfactorily completed U.S. Federal Aviation Regulations Part 135 requalification training. He had worked for Classic previously, flying Bell 206Ls and 407s and serving as the EMS safety officer between 1998 and 2005, when he left to work for TriState CareFlight in Bullhead City, Arizona, where he flew Agusta A119s in EMS operations. He was that operator's safety and training manager.

He also had "extensive" experience in helicopter operations in the Grand Canyon and had been a U.S. Army and Army Reserve pilot.

Helipad Guidelines

The FMC helipad, at an elevation of 7,016 ft, is on the roof of the hospital emergency department, at the southeast corner of the hospital. In 1999, the hospital implemented its *Guidelines of Practice* for helipad operations.

RotorImage/Airliners.net

The pilot of Air Method's Angel 1 stopped at nearby Flagstaff Pulliam Airport before continuing to the hospital helipad.

"The guidance states that helicopters operating at FMC are advised to establish communications with Guardian Control at the earliest opportunity," the report said. "It is required that all inbound aircraft will notify Guardian Control at the earliest convenience but not less than … 5 miles out. The guidance stated, 'Timely communication with Guardian Air Control is especially paramount when multiple helicopters are inbound to the facility.'"

Classic said that, during approaches from the northwest, the Guardian Control signal is obscured by mountain peaks but becomes clear within 10 mi (19 km) of the helipad. The signal problems do not prevent pilots from contacting Guardian Control, however.

The guidelines also instruct pilots to avoid noise abatement areas when possible during their approaches to the helipad and to maintain an altitude of 8,000 ft mean sea level over Flagstaff. The guidelines specify that simultaneous operations are not conducted, and that, if two helicopters are approaching at about the same time, the first should land on the southern side of the helipad and move to the parking area on the north side to make room for the second. Alternative guidelines call for the first helicopter to "hot drop" its patient — unload the patient without shutting off the engine — and then fly to FLG to allow the second helicopter to land.

The First Time

The transportation coordinator (TC) at Guardian Control said that the accident flight marked the first time in her 1 ½ years in that job that a Classic pilot failed to notify her that he was approaching FMC.

The Classic Control dispatcher, who had worked for Classic since September 1997 and had been a supervisor since 1999, told investigators that all three Classic aircraft had been dispatched on the day of the accident and that he had handled all three flights.

"At 1532, the pilot of Lifeguard 2 gave a … position report via the on-board radio," the report said. "The dispatcher acknowledged the call but did not inform the pilot of the inbound Air Methods helicopter. He said, 'We normally would notify our aircraft about another helicopter that was inbound at the same time.' At that time, he said he was unconcerned because the Guardian Control TC had told him that she would notify the pilot of Lifeguard 2 of the other inbound helicopter. In addition, he knew the Lifeguard 2 pilot was 'so anal' about contacting Guardian Control prior to landing at FMC."

"If the pilot had known to expect another aircraft in the area, he would have been more likely to look for the other aircraft."

Investigators had the Classic dispatcher listen to a recording of his 1523 telephone conversation with the Guardian Control TC. Afterward, the Classic dispatcher said that he was "amazed" not only that he had not remembered the Air Methods helicopter's correct arrival time at FMC but also that he had "incorrectly remembered his conversation with the Guardian Control TC about who was supposed to advise Lifeguard 2" about the presence of the Air Methods helicopter.

The Classic 407 had a global positioning system that included a terrain awareness and warning system (TAWS), the report said. The Air Methods 407 was not equipped with TAWS, and TAWS was not required.

Neither helicopter had a traffic-alert and collision avoidance system (TCAS). Although TCAS was not required, the report said, "had such a system been on board, it likely would have alerted the pilots to the traffic conflict so they could take evasive action before collision."

No Contact

In addition, the report said, if the Classic pilot had contacted the FMC communications center, the FMC transportation coordinator "likely would have told him directly that another aircraft was expected at the helipad. If the pilot had known to expect another aircraft in the area, he would have been more likely to look for the other aircraft."

The Classic pilot, approaching the helipad from the northeast, likely was visually scanning the typical flight paths described in the FMC approach and noise abatement guidelines and did not see the Guardian helicopter, which was approaching from the south — and not on a typical path.

"At the time of the collision, both pilots were at a point in the approach where their visual attention typically would have been more focused on the helipad in preparation for landing, rather than on scanning the surrounding area for other traffic," the report said. "Nevertheless, the pilots were responsible for maintaining vigilance and to see and avoid other aircraft at all times."

The report reiterated four NTSB safety recommendations issued to the FAA in 2006, including one that called on the agency to require operators to install TAWS in all EMS aircraft and ensure that crews are adequately trained in its use.

The three other recommendations involved actions that had been in place for the accident flights: requiring EMS operators to comply with Part 135 requirements — instead of the more lenient weather minimums for Part 91, "General Operating and Flight Rules"; to implement flight risk evaluation programs; and to use formal dispatch and flight-following procedures.

The NTSB has placed four related safety recommendations, all dealing with EMS operations at night, on its "Most Wanted List of Safety Improvements."

This article is based on NTSB accident report DEN08MA116A and supporting documents.

BY DAVID BJELLOS

Early adopters — including corporate operators — take an optimistic view of the near-term benefits of ADS-B.

Practical Necessity

The next decade will bring profound changes in the way corporate aircraft operators begin to share a more scheduled and predictable U.S. National Airspace System (NAS) with air carriers, and all flight crews take on new responsibilities. Although many operators have yet to be persuaded that the time has come to invest in automatic dependent surveillance–broadcast (ADS-B) technology, the U.S. Federal Aviation Administration (FAA) and many industry leaders see voluntary aircraft equipage as a major step to be accomplished as soon as possible. As part of a worldwide move to a new air traffic management paradigm, ADS-B can deliver near-term safety benefits, and often cost savings, in each phase of flight.

In the United States, a major push is under way for the ADS-B-based Next Generation Air Transportation System (NextGen) to be fast-tracked, much like the country's Interstate Highway System in the 1950s. Urgency about ADS-B equipage among operators would help make the transition to NextGen's aircraft performance-based navigation infrastructure as seamless as possible. The global context includes early adopter civil aviation authorities in countries and regions including Australia, China, Europe, Fiji, India and Russia.[1]

In about 12 months, 340 ADS-B ground stations — about half of the eventual U.S. system — will be in place, FAA Administrator Randy Babbitt said in June, emphasizing that NextGen must be accelerated through many successful flight demonstrations of ADS-B to build user confidence that major investments in avionics and training will have tangible returns for corporate operators and other industry stakeholders. Data from flight operations with ADS-B and required navigation

© Chris Sorensen Photography

performance (RNP) area navigation (RNAV) will help make the NextGen results measurable.[2]

As of mid-July, the latest proposal to fund the FAA's activities during fiscal year 2010 included significant directives on ADS-B. If the bill is enacted in its present form, Congress would require the FAA to develop a plan to provide runway incursion information directly to pilots in the cockpit and accelerate implementation of NextGen technologies — specifically, integration of *ADS-B Out* on all aircraft by 2015 and *ADS-B In* on all aircraft by 2018, and of RNP RNAV at the 35 busiest U.S. airports by 2014 and throughout the NAS by 2018.[3]

Corporate aircraft could adapt quickly to ADS-B and assimilate into NextGen airspace — and its Single European Sky Air Traffic Management Research (SESAR) counterpart — but fewer than 100 aircraft currently are equipped to do so. The corporate fleet lags behind commercial carriers in ADS-B equipage; cost of retrofit, implementation methods and airline demand for avionics are key issues for corporate aviation.

Several ADS-B-equipped corporate jet aircraft already are operating, with more U.S. corporate operators adding ADS-B this year. By comparison, operators of Boeing Commercial Airplanes and Airbus types have installed ADS-B on roughly 40 to 50 percent of the U.S. airline fleet, and some data show the percentages for non-U.S.-registered airliners to be higher.

Avionics manufacturers have made major investments developing equipment with fleet-type commonality that provides airlines a reasonable return on investment from fuel savings and reduced block times. The largest corporate-aircraft manufacturers also currently see operators beginning to specify ADS-B for their new aircraft and to retrofit existing aircraft.

Seeing Like ATC

Essentially, ADS-B takes flight crew confidence to a higher level by providing unprecedented positioning accuracy in congested airspace, enabling clear and immediate recognition that a conflicting aircraft is maintaining its flight path, turning, climbing/descending or accelerating/decelerating. The value of this information will become evident, especially for those operating in today's most challenging U.S. environments — such as those in the Northeast, Los Angeles basin and Dallas/Fort Worth metropolitan areas — and will continue while further increases in air traffic density occur as projected.

By 2020, adoption of NextGen technologies will support safe ground and airborne separation despite the traffic growth in the United States and many other countries. Even before the FAA's 2010–2013 completion of the ADS-B ground station infrastructure, early adopters can expect significant risk reduction in parts of the NAS.

Enhanced safety on airport surfaces ranks as the most compelling argument for rapid adoption. With ADS-B and cockpit display of traffic information (CDTI), flight crews track the movement of the own-ship, other aircraft and vehicles, and electronic flight bag (EFB) software alerts the flight crew to potential conflicts with traffic, imminent runway incursions and runway/taxiway misidentifications.

If a runway is occupied and a flight crew approaches a taxiway hold line, for example, the runway area on the EFB display turns yellow. If they proceed past the hold line, the runway display turns red, accompanied by an aural warning. The 2009 edition of the U.S. National Transportation Safety Board's "most wanted" safety improvements says, among measures to improve runway safety, that aircraft systems should "give immediate warnings of probable collisions/incursions directly to cockpit flight crews."

UPS Airlines flight crews arriving at the company's Louisville, Kentucky, U.S., hub routinely adhere to accurate and predictable separation criteria based on Mode S transponders upgraded to add ADS-B. Using merging and spacing software functions on Class 3 EFBs, the crews track, capture and maintain precise in-trail spacing with other company aircraft in all weather conditions (*ASW,* 11/07, p. 44).

Separation responsibility shifts during these arrivals from FAA controllers to the UPS flight crews. When instructed by air traffic control (ATC) to merge with another aircraft, the flight crew enters on the EFB the number of minutes or seconds to follow in-trail. Once the target ship has been acquired, the own-ship speed command continuously indicates the fast/slow trailing speed trend for pilot monitoring. The functions work in conjunction with an RNP RNAV continuous descent arrival, and with a cockpit moving map display.

As of mid-2009, another of several NextGen test programs was under way. US Airways began using Aviation Communications and Surveillance Systems' SafeRoute software applications for merging and spacing, surface area movement management, CDTI, CDTI-assisted visual separation and continuous descent arrivals. Under a two-year contract, the airline will install ADS-B Out and ADS-B In upgrades/new avionics and Class 2 EFBs on as many as 20 Airbus A330s, develop standards and prototypes, conduct flight demonstrations at Philadelphia International

Airport (PHL) and provide data from line operations to the FAA. ATC facilities at PHL are scheduled to add ADS-B in February 2010.[4]

ADS-B in the United States emerged from validation trials in 2001–2007 during the FAA's two-phase Capstone Project in Alaska and other research. The project confirmed for U.S. and European regulators that pilots safely could maintain 3 nm to 5 nm (5.6 km to 9.3 km) separation. In August 2007, the FAA agreed to accelerate the installation of 38 ADS-B ground stations if the government of Alaska and industry associations independently raised funds to help equip 4,091 Alaskan aircraft over a five-year period.[5]

Benefit Package

Stand-alone ADS-B avionics, or an ADS-B Out upgrade to almost any Mode S transponder made in the past 17 years, *squitters* data — that is, broadcasts messages without interrogation — to other aircraft and ADS-B ground stations within 200 nm (370 km). This gives an ADS-B–equipped flight crew an accurate, near-real-time view of potential aircraft and vehicle conflicts — and more time to perceive them and respond — before they are detected by a traffic-alert and collision avoidance system (TCAS II).

Some corporate operators question what they stand to gain from ADS-B compared with existing avionics — especially TCAS II (*ASW*, 4/09, p. 34). A key point is that ADS-B Out using 1090 MHz extended squitter (1090ES) — used above Flight Level 240 (approximately 24,000 ft) — is about 10 times more accurate than the transponder data used by TCAS II.

The FAA has yet to propose a requirement for ADS-B In, but operators that voluntarily install a transmitter/receiver or transceiver to receive ADS-B messages gain optimal situational awareness. Unlike TCAS II, no recommended avoidance maneuvers are provided or authorized as a direct result of an ADS-B display or an ADS-B alert. ADS-B In does provide two advisory aids to visual acquisition. The primary aid is once-per-second CDTI updates, based on the data received directly from other ADS-B–equipped aircraft. The second — traffic information system–broadcast (TIS-B) — is a free FAA service providing a more complete traffic picture in situations where some nearby aircraft lack ADS-B Out. TIS-B enables the display, nominally every three to 13 seconds, of any aircraft with an operating Mode S or Mode A/C transponder that is also within ATC radar or multilateration coverage.

Achieving ADS-B In capability using a 1090ES transceiver for the data link may involve spending $55,000 to $100,000 more per aircraft than ADS-B Out equipage, typically to retrofit the 1090 MHz receiver of an existing TCAS II. Operators of these aircraft will begin receiving TIS-B data at a later stage of the FAA's ADS-B implementation.

Similarly, an operator that meets FAA criteria to use the lower-cost 978-MHz universal access transceiver (UAT) technology for ADS-B Out voluntarily can install a UAT transceiver and multi-function display to provide ADS-B In. This allows flight crews to receive the messages from other ADS-B–equipped aircraft, TIS-B service and the flight information system–broadcast (FIS-B) service. The FIS-B service — comprising aviation routine weather reports, special aviation reports, terminal area forecasts

© Ian Schofield/Airliners.net

Among major FAA demonstration projects, Airbus A330s at US Airways are being equipped with ADS-B avionics.

and next-generation radar (NEXRAD) precipitation maps — also operates at the nominal 200 nm line-of-sight distance from any ground-based transceiver in the FAA's ADS-B network. Eleven ADS-B ground-based transceivers in Florida currently broadcast TIS-B and FIS-B data, for example.

Electronic flight bags or multi-function displays typically are used for ADS-B–based cockpit display of traffic information.

Flying With ADS-B

Consistent with safe practices and assimilation into the NAS, the FAA plans to provide air traffic services on a "best equipped, best served" basis during ADS-B implementation.[6] A look at benefits by phase of flight during hypothetical future operations at a major airport gives a sense of what is in store.[7]


© Chris Sorensen Photography

At the flight planning stage, the algorithms built into NextGen and SESAR will be capable of customizing departure routes and downloading them directly to a flight management system based on the flight crew's pre-departure clearance request, and communicating operator flight path intent.

For airport surface movement, from engine start to takeoff, airport surface detection equipment, model X (ASDE-X), will remain the critical infrastructure for ATC to reduce risk while controlling aircraft and ground vehicles. Small Mode S transponders on all ground vehicles will identify them for ready observation by flight crews and ATC. Tracking will be accomplished partly by surface radar and ADS-B backed up by multilateration systems using a network of ground sensors.[8]

Before the taxi phase, the flight crew typically will receive electronically the entire ATC clearance for taxi, takeoff, a precise departure flight path and the assigned route, called the flight path trajectory route. The flight crew also will select the transponder "ON" to reply to Mode S interrogations and broadcast ADS-B messages during taxi, with those settings retained until engine shutdown at the destination airport. Just before takeoff, the ATC terminal flow management system will assign a calculated takeoff time for the most efficient spacing.

During the en route phase, the flight crew will fly the RNP RNAV departure route that — based on the preflight departure clearance request — typically will have been tailored specifically to their preferred route and initial heading. The EFB also will tap NextGen's four-dimensional weather data cube system to display the latest available weather data, including continuous monitoring of physical dimensions and predicted times of weather activity.

Also during en route operation, the FAA's enhanced integrated traffic management adviser software automatically will help controllers reroute the flight crew around significant weather using ADS-B Out messages from each aircraft and controller-pilot data link communications. The newly assigned course, often an offset to a published route, will turn the single airway into a "multi-lane highway" onto which multiple aircraft simultaneously can be routed with 5 nm (9.3 km) in-trail spacing.

If the en route phase involves oceanic operation, the future air navigation system (FANS) 1/A+ or FANS 2/B–equipped airliner or corporate aircraft will fly optimized trajectories.[9] Aircraft equipped with ADS-B In and Out also will be able to conduct trans-oceanic flights on heavily used routes, such as New York–London routes, with safe and more efficient in-trail spacing.

Worldwide Solution

ADS-B in NextGen parallels transformations about to occur elsewhere in the world. As NextGen and SESAR integrate, in roughly the 2015–2020 timeframe, a gradual but crucial shift will occur: air traffic *control* will give way to air traffic *management.*

U.S. and non-U.S. airlines have recognized an urgent need to overhaul the underlying infrastructure that creates extremely congested airports and terminal areas such as London Heathrow Airport, Amsterdam Airport Schiphol and New York John F. Kennedy International Airport. ADS-B promises to help reduce cockpit mistakes, mitigate fatigue-related events through better situational awareness and increase pilot confidence during high rates of low-visibility approach procedures.

From today's mostly non-equipped aircraft to full ADS-B conformity, the NextGen transformation will take years. Early CDTI equipage, however, also prepares operators to take full advantage of various local ATC technologies such as multilateration, whether used as a runway incursion countermeasure or for accurate ATC surveillance and vectoring in mountainous airspace and airspace not covered by radar, whether it be over the vast Australian outback, Hudson Bay in northeastern Canada or mountains in the Czech Republic.

For example, Air Navigation Services of the Czech Republic since 2002 has provided local and wide-area multilateration systems to improve safety in the mountainous terrain of Ostrava and in other areas that lack radar coverage. Civil aviation authorities in the Netherlands and Taiwan also have the technology, which the FAA has applied to upgrade selected U.S. airports from radar-only ASDE-X to multilateration-based ASDE-X (*ASW*, 9/08, p. 46).[10]

David M. Bjellos is aviation manager of Florida Crystals and president of Daedalus Aviation Services.

Notes

1. Proceedings of the Hearing of the Aviation Operations, Safety and Security Subcommittee. U.S. Senate Committee on Commerce, Science and Transportation. May 13, 2009.
2. Babbitt, Randy. "The Secret to Success." Speech to RTCA, June 10, 2009. Testimony before the U.S. House Appropriations Subcommittee on Transportation hearing on reauthorization of FAA for fiscal year 2010. June 16, 2009. Babbitt became FAA administrator on June 1.
3. U.S. Senate Committee on Commerce, Science and Transportation. "Rockefeller, Hutchison, Dorgan, DeMint Introduce Bipartisan Aviation Bill: Key Focus on Increasing Safety and Modernization." News release, July 14, 2009. ADS-B Out refers to the aircraft capability to broadcast messages; ADS-B In means its capability to receive messages.
4. Schofield, Adrian. "US Airways' A330s Slated to Test ADS-B." *Aviation Week & Space Technology.* Jan. 25, 2009. ACSS. "SafeRoute: ADS-B Solutions for Approach and Taxi." <www.acssonboard.com/products/Pages/SafeRoute.aspx>.
5. Alaska Air Carriers Association; Alaska Airmen's Association; Alaskan Aviation Safety Foundation. Letter to federal officials and legislators, and the governor of Alaska, Jan. 27, 2009. Under Alaska's five-year Surveillance and Broadcast Services Capstone Statewide Plan, the state's commitment of grants and loans is intended to help this many operators to equip their aircraft by October 2012. The associations said that some members were reluctant to acquire the new technology because of doubts as to whether the avionics specified would comply with future FAA requirements.
6. FAA. "NextGen Governing Principles for Avionics Equipage." Feb. 27, 2009.
7. The FAA has published scenarios for 2018 that preview other avionics uses by phase of flight at <www.faa.gov/about/initiatives/nextgen/2018>.
8. Era Systems Corp. "Improving Aircraft Tracking in the Air and on the Ground" and "Multilateration and ADS-B Surveillance System." <www.sra.com/era/era.php> May 2009. Multilateration systems enable ATC to receive, process and integrate transmissions of Mode A/C/S transponder data from civil aircraft or vehicles, ADS-B (1090ES or UAT) messages from civil aircraft and data from military aircraft.
9. FANS technology supports separation of aircraft in oceanic airspace and on polar routes using controller-pilot data link communications by satellite when out of VHF radio range, including automated reports of aircraft position, and RNP RNAV. First-generation standards comprise FANS 1 on Boeing airplanes and FANS A on Airbus airplanes; FANS 2/B is the second generation of flight management system software solutions.
10. Beechener, Jenny. "ANS CR Chief Jan Klas Is Spearheading Regional Cooperation." *Jane's Airport Review.* April 10, 2008. Reproduced on the Web site of Air Navigation Services of the Czech Republic, <www.ans.cz>.

in the Drink

Thorough ditching training is not mandated for U.S. civilian airplane crews, but some specialists envision benefits from simulator exercises.

© Condor Airlines

BY ROBERT W. MOORMAN

Ditching is the short term for an intentional and controlled emergency landing on water. Interest in what the flight crew and cabin crew of an airliner should do before and after ditching resurfaced at the U.S. National Transportation Safety Board (NTSB) June 9–10 public hearing on the widely reported mid-January 2009 ditching of US Airways Flight 1549, in which all occupants of the Airbus A320 survived.

It remains to be seen whether NTSB will recommend that the U.S. Federal Aviation Administration (FAA) mandate specific ditching training beyond what is now required by U.S. Federal Aviation Regulations (FARs). Basically, pilots of all large and turbine-powered multi-engine airplanes currently must only be familiar with the emergency equipment aboard the airplane such as life vests and life rafts; no specific ditching training is required. For crewmembers engaged in fractional ownership, on-demand, commuter and air carrier operations, there must be instruction on the use of ditching equipment and in the performance of ditching procedures, as well as ditching drills or demonstrations.[1]

Several training organizations provide post-ditching training, but pre-ditching simulator training for U.S. commercial airline pilots appears to be nonexistent. Several air carriers contacted said they practice elements of a ditching scenario but not the ditching maneuver itself. "There are several reasons for this, the most relevant being that there is no commercial simulation available for a realistic sea surface, particularly the swells and the firmness of the water surface," said Bill Johnson, director of flight training for Alaska Airlines. "In other words, simulators simulate ground contact, not water

[contact], and any training to touchdown would actually be negative training."

CAE, a provider of simulators and training solutions, offers "theoretical procedures" for ditching large commercial jets, but the simulation software available only takes the flight crew to the "point of contact with the water," said CAE spokesman Chris Stellwag.

Alteon, a unit of The Boeing Co., does not offer specific ditching training for pilots but provides emergency procedures training, the company said.

Johnson said that Alaska Airlines trains its pilots for specific emergencies that might force them to ditch. For example, the airline's recurrent training updates for 2010, introduced in January, involve losing thrust from both engines because of volcanic ash and obtaining maximum glide performance while attempting to relight the engines.

Some airlines review ditching procedures and the related flying techniques and principles in the classroom. "Basically, it comes down to a few things pilots need to remember," said Tom Hull, Alaska's flight operations instructor, "such as 10-degree to 12-degree nose-up attitude before touchdown, notifying the cabin crew of what's going on, and maintaining level flight as well as a low descent rate."

Ditching training for Condor Airlines crewmembers includes open water (above) and simulator experience.

Techniques and procedures are recommended. "You have to consider the direction in which the swells are going," said Jennifer Ewald, a first officer for American Airlines and spokeswoman for the Allied Pilots Association. That point was emphasized in a 660-page special report on overwater operations safety published in 2004 by Flight Safety Foundation. The report included a detailed discussion of ditching procedures and considerations, concluding that the primary consideration is: *Don't land into the face of a swell.*[2]

Another recommendation for ditching preparation, said Ewald, is to closely follow the drift-down charts, which are unique to each aircraft. The charts tell what power setting to use to conserve fuel — if any power is still available — as well as the correct angle-of-attack. Weight of the aircraft, altitude and outside air temperature are all factored into extending the glide path of the aircraft.

Unified Approach

Specific ditching training for airline flight attendants and cabin instructors in recent years has dealt with evacuation and survival. But lately, pilots also have been participating in special programs independent of the initial and recurrent training requirements for flight crew — sometimes participating in new-hire training of flight attendants.

Condor Airlines, a German charter airline, for several years had offered post-ditching and survival training only for cabin crew in conjunction with the German navy. The training program now includes pilots. "We changed the program to add the pilots and to include aspects of handling the aircraft prior to ditching, as well as to improve communication among the crew," said Condor's Dietrich Langhof, a captain and flight safety and security standards manager who leads the three-day course. Condor inserted two chapters on ditching in its safety manuals, and the information is discussed during the course.

The extended operations (ETOPS) pilot training given every two years by Condor's training department also simulates a double engine failure, but the flight crew does not conduct a simulated water landing. Nevertheless, the three-day course and the separate ETOPS training go a long way to "changing the mindset of the pilots to a belief that ditching a commercial airliner in the ocean is survivable," Langhof said.

On the first day of Condor's three-day course, students arrive in Cuxhaven on the northern coast of Germany for an introduction and training materials. Day two consists of classroom and swimming pool training at the German naval air wing in nearby Nordholtz. Classroom topics include a "cold can kill" segment covering hypothermia, search and rescue (SAR) procedures, theory of survival, and a presentation on leading and organizing SAR operations. Students learn to use survival equipment, including how to fire flare guns.

In the afternoon, students go to the pool, where they learn the general principles of egress from a submerged aircraft. They are taught to maneuver in the water while wearing a cumbersome helicopter crewmember helmet and life vest, as well as how to delay the onset of hypothermia. This type of survival training covers techniques such as the heat-escape-lessening posture (HELP). To assume the HELP position, students wearing a life vest cross the inner sides of their arms against their chest, hold their thighs together and raise their legs to protect the groin area from the cold.

Early in the morning of day three, students board a German navy ship near Hamburg for open-sea training. They wear immersion suits to enable them to safely experience immersion in the North Sea and to board the type of 46-person life raft carried on airliners used in overwater operations. Afterward, they are "rescued" by a boat or helicopter.

Since 2002, Condor has conducted the ditching and survival course for its flight crews and those of several other airlines, including British Airways and Hawaiian Airlines. As to flight simulator training for ditching: "It's hard to find anything," Langhof said. "Many airlines have a ditching checklist, but there is often no time set aside to practice in a simulator."

Langhof said he is disappointed, but not surprised, that there has not been an increase in ditching training for pilots over the years. If the Air Transat A330 had been ditched in the ocean, rather than landed powerless at an island airbase, in August 2001, "I guarantee we would have seen changes in the regulations," he said.

The crew of Air Transat Flight 236 glided 85 nm (157 km) to a landing in the Azores after both engines flamed out over the Atlantic. The A330, en route to Lisbon, Portugal, from Toronto, had developed a leak in the fuel line of the right engine. When the pilots noticed a fuel imbalance, they opened a crossfeed valve to transfer fuel from the left tank to the right tank. The procedure compounded the problem, however, and fuel exhaustion resulted.

The incident prompted the French Direction Générale de l'Aviation Civile and the FAA to issue an airworthiness directive requiring operators of specific Airbus models to revise their flight manuals to direct flight crews to check if a fuel imbalance is due to a leak before opening the crossfeed valve.

Air Transat said that it has offered post-ditching training since the company's inception in 1987. However,

For added realism, Condor trainees are "rescued" from a life raft by a helicopter lift.

the airline does not offer pre-ditching simulator training for pilots.

Langhof and other trainers believe that pre- and post-ditching training might have helped the flight crew of Tuninter Flight 1153, an ATR 72 that crashed in the ocean off the coast of Sicily after running out of fuel in August 2005 (p. 26). Langhof said that the cockpit voice recording indicated a lack of coordination and ditching preparation by the flight crew.[3]

Training Needed?

The rarity of a large commercial jet ditching has been another reason why flight crew simulator training for such an event is not a high priority for airlines. "One of the reasons there has been foot-dragging on this issue is that there has been only a handful of [air carrier] aircraft in the last 50 years that have actually ditched," Alaska's Hull said.

During its research on overwater operations safety, the Foundation identified from available data from Jan. 1, 1976, to July 8, 2003, nearly 500 ditching accidents worldwide involving airplanes ranging from small piston


© Condor Airlines

singles to large multi-engine transports.[4] The bottom line, according to the Foundation's special report, is: "Believing that a ditching can't happen or won't happen is not supported by data."

Had the ditching of US Airways Flight 1549 ended badly, there likely would be a clarion call for ditching-related simulator training, said Hull and other trainers.

Nevertheless, ditching training is getting renewed attention from academia as a result of that event. "Many pilot training centers and university aviation programs are rethinking how they might add or improve ditching training in their curricula," said Richard Fanjoy, associate head for graduate education in the Department of Aviation Technology at Purdue University.

Fanjoy is among those who agree with Alaska's Johnson that simulator limitations have precluded such revisions. "Unfortunately, the visual and motion aspects of modern flight simulators just do not do a good job of realistically presenting a ditching flight condition," said Fanjoy.

The lack of software to adequately simulate ditching in fixed-wing aircraft is the main problem. "[Unlike] helicopter training for offshore operators, there is nothing [suitable] in the fixed-wing world," said Rick Bedard, director of training operations for FlightSafety International (FSI). Since the Flight 1549 accident, however, several of FSI's customers have asked about getting specific ditching training for fixed-wing aircraft, Bedard said.

New requirements for ditching training might be adopted by the FAA, which has proposed revisions of FARs Part 121 training requirements in Subparts N and O (*ASW*, 4/09, p. 39). The notice of proposed rule making (NPRM) includes performance training on survival equipment, both wet and dry, and other training events. It also proposes emergency procedures training and an observation drill on the deployment, inflation and detachment of evacuation slide-rafts.

The proposed performance standards are appropriate to each crewmember's task in the ditching, and the frequency requirements for recurrent training are different for pilots and flight attendants. The NPRM notably does not propose flight simulator training on ditching; it refers only to emergency procedures and preparing the aircraft for ditching — training that already is offered by many airlines.

The NTSB investigation of the Flight 1549 accident may or may not contain specific new recommendations for ditching training of flight crew and cabin crew. But the ditching of the A320 on the Hudson River by Capt. Chesley Sullenberger and First Officer Jeffrey Skiles, and the evacuation organized by the cabin crew, could yield new best practices.

"We are looking at using as much as we can from US Airways Flight 1549 [for classroom training] because it was a great example for everyone," said Alaska's Hull.

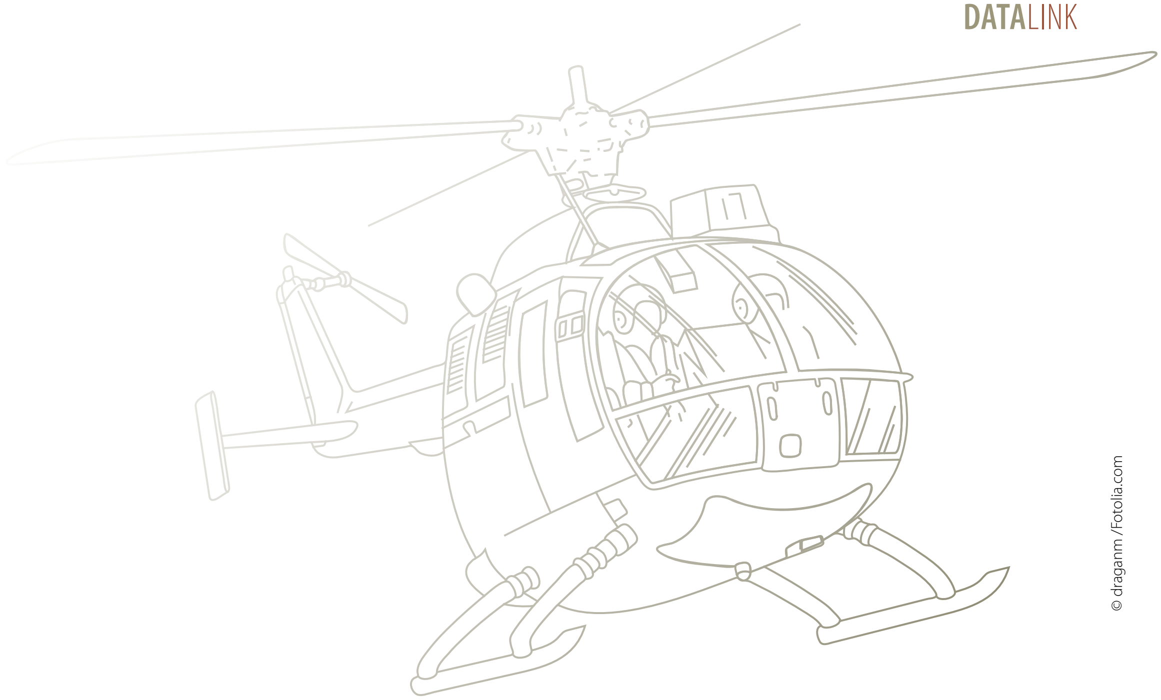
Robert Moorman has written about various aspects of the aviation business for over 25 years.


© Steven Day/Associated Press

Passengers await rescue after evacuating US Airways Flight 1549.

Notes

1. U.S. FARs Part 91.505, 91.1083, 135.331 and 121.417.
2. FSF Editorial Staff. "Waterproof Flight Operations." *Flight Safety Digest* Volume 22 and 23 (September 2003–February 2004).
3. A portion of the cockpit voice recorder recording has been published on the Internet by YouTube at <youtube.com/watch?v=rVPv_mrU95w>.
4. FSF Editorial Staff.



© draganm /Fotolia.com

Route Causes

For helicopters, the journey — not the destination — holds the greatest risk.

BY RICK DARBY

The largest percentage of European helicopter accidents in 2000–2005 studied by the European Helicopter Safety Analysis Team (EHSAT) occurred in the en route phase of flight.[1] That contrasts with fixed-wing commercial air transport operations, where the most recent European Aviation Safety Agency (EASA) annual safety review reported that approach and landing accidents represented the highest percentage.[2]

EHSAT is a component of the International Helicopter Safety Team and part of the European Strategic Safety Initiative, a 10-year program involving EASA, some national civil aviation authorities and many other aviation organizations. "Analysis of occurrence data, coordination with other safety initiatives and implementation of cost-effective action plans are carried out to achieve fixed safety goals," the report says.

It was estimated that about 6,860 helicopters were registered in EASA member states for civil use in 2007.[3] A total of 16 fatal civil helicopter accidents occurred in 2007, compared with 14 in 2006, the report says.

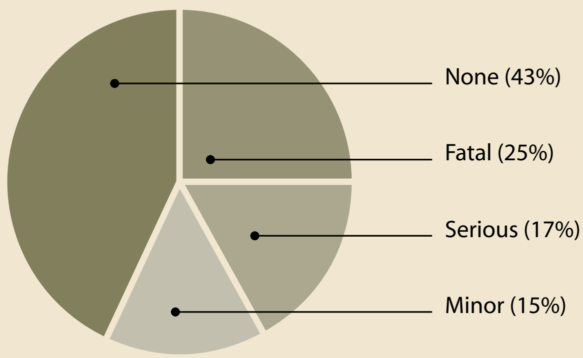
EHSAT regional teams familiar with the languages of the accident reports and the local context analyzed the accidents. The teams' judgments were based on, but not identical with, the official reports by accident investigation authorities.

The EHSAT preliminary report database included accidents occurring within EASA member states, and defined according to the International Civil Aviation Authority (ICAO) Annex 13, *Aircraft Accident and Incident Investigation*. Only accidents for which a final investigation report had been issued were included.

The database included 186 accidents. Of those, 40, or 22 percent, involved commercial air transport. General aviation represented the largest percentage, 39 percent, followed

Regional teams familiar with the languages of the accident reports and the local context analyzed the accidents.

Injury Levels, European Helicopter Accidents, 2000–2005

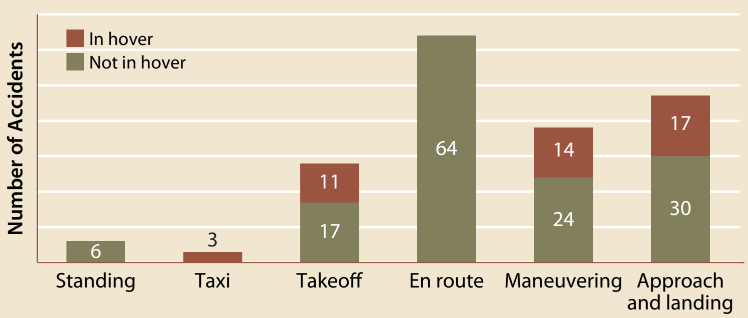


Note: Data are based on 186 civil aviation helicopter accidents analyzed by regional teams of the European Helicopter Safety Analysis Team. Accidents occurred in European Aviation Safety Agency member states.

Source: European Helicopter Safety Analysis Team

Figure 1

European Helicopter Accidents, by Phase of Flight, 2000–2005



Note: Data are based on 186 civil aviation helicopter accidents.

Source: European Helicopter Safety Analysis Team

Figure 2

by aerial work, 35 percent. Nearly a third of accidents resulted in some degree of injury, and one in four involved at least one fatality (Figure 1).

Most accidents — 64, or 34 percent — occurred in the en route phase of flight (Figure 2). Among the fatal accidents, 68 percent occurred in the en route phase (Figure 3). The helicopter was hovering in 24 percent of accidents in all phases.

Pilot experience in the accident helicopter type was weighted toward low time (Figure 4). In 14 percent of commercial air transport accidents and 9 percent of aerial work operations accidents, the pilot-in-command had fewer than 100 hours in type, the report says.

So that its work will be comparable to that performed by other teams worldwide, EHSAT uses standardized codes for factors judged to have been involved in the accidents. The codes are derived from two models:

- The standard problem statements (SPS) taxonomy was inherited from the International Helicopter Safety Team and the U.S. Joint Helicopter Safety Analysis Team. The report says, "The structure consists of three levels: The first level identifies the main area of the SPS, and the second and third levels go into more detail."
- The Human Factors Analysis and Classification System (HFACS), developed to encourage cross-study compatibility, was developed from James Reason's theories of latent and active failures. The report says, "The HFACS model describes human error at four levels: organizational influences, unsafe supervision, preconditions for unsafe acts and the unsafe acts of operators."

Level 1 SPS categories were tabulated for the 186 accidents in the database (Figure 5, p. 50). "Pilot judgment and actions" topped the list of categories, identified in 68 percent of the accidents. "Safety culture/management" was next most frequent, in 48 percent, followed by "pilot situation awareness" in 38 percent.

"Pilot judgment and actions" includes decision making, "unsafe flight profile," procedure implementation, crew resource management and human factors. "Safety culture/management" concerns safety management systems (SMSs), training, pilot disregard of a known safety risk, self-induced pressure and pilot experience. "Pilot situation awareness" covers in-flight factors such as reduced visibility and external obstacle or hazard awareness.

"The highest level of SPS, Level 1, only provides information on a general level," the report says. "To better understand what kind of factors played a role in the accident data set, one must look at a deeper level in the taxonomy" — Level 2 (Figure 6, p. 50).

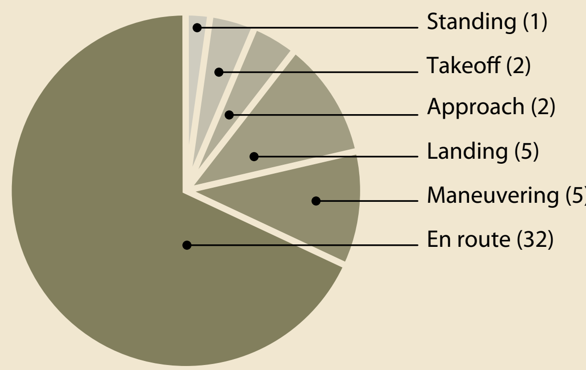
From Level 2 SPS, it appears that the main factors identified lie in the human factors domain. "Pilot's decision making," "mission planning" and "external environment awareness" were identified most frequently by EHSAT in the accident data set.

The prevalence of human factors findings led EHSAT researchers to adopt the HFACS model for further understanding, the report says. For the 186 accidents in the database, a total of 445 HFACS factors were counted, and in 78 percent of the accidents, at least one HFACS factor was found.

"In most accidents, unsafe acts or preconditions were identified," the report says (Figure 7, p. 51). "For the lowest level in the model [the results of latent causal factors], the unsafe acts, 84 percent of the identified factors concerned errors: activities that failed to achieve their intended outcome. Most errors were identified as … judgment and decision making errors, such as poorly executed procedures, improper choices or misinterpretation of information. These errors represent conscious and goal-intended behavior.

"Skill-based errors, on the other hand, are errors that occur with little or no conscious thought, such as inadvertent operation of switches and forgotten items in a checklist. These errors were identified in 28 percent of the errors. … Violations, willful disregard of rules and regulations, were identified in 16 percent of unsafe acts."

European Helicopter Fatal Accidents, by Phase of Flight, 2000–2005

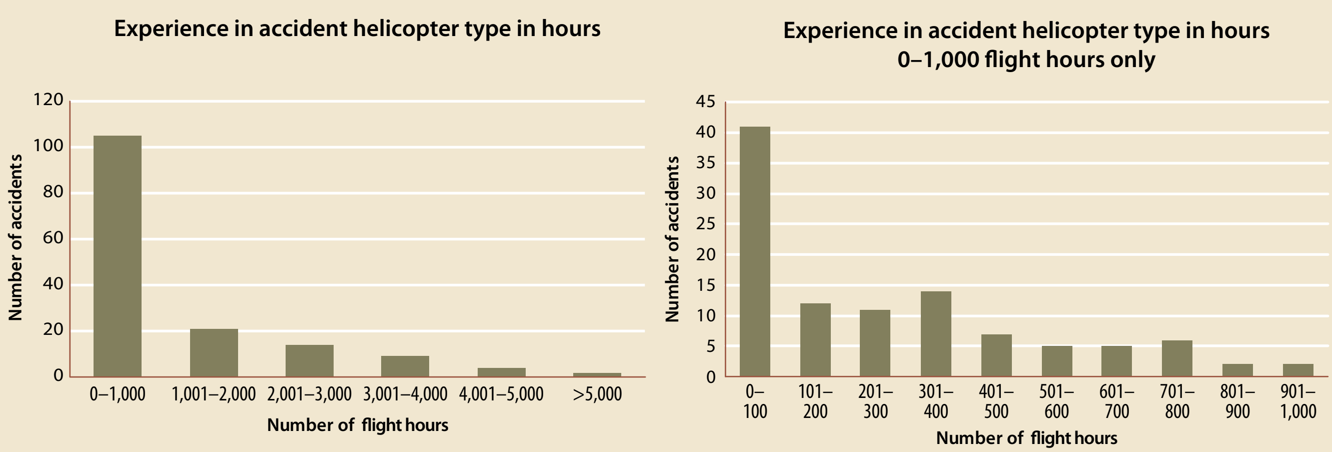


Note: Data are based on 186 civil aviation helicopter accidents.

Source: European Helicopter Safety Analysis Team

Figure 3

Pilot-in-Command Flight Experience, European Helicopter Accidents, 2000–2005

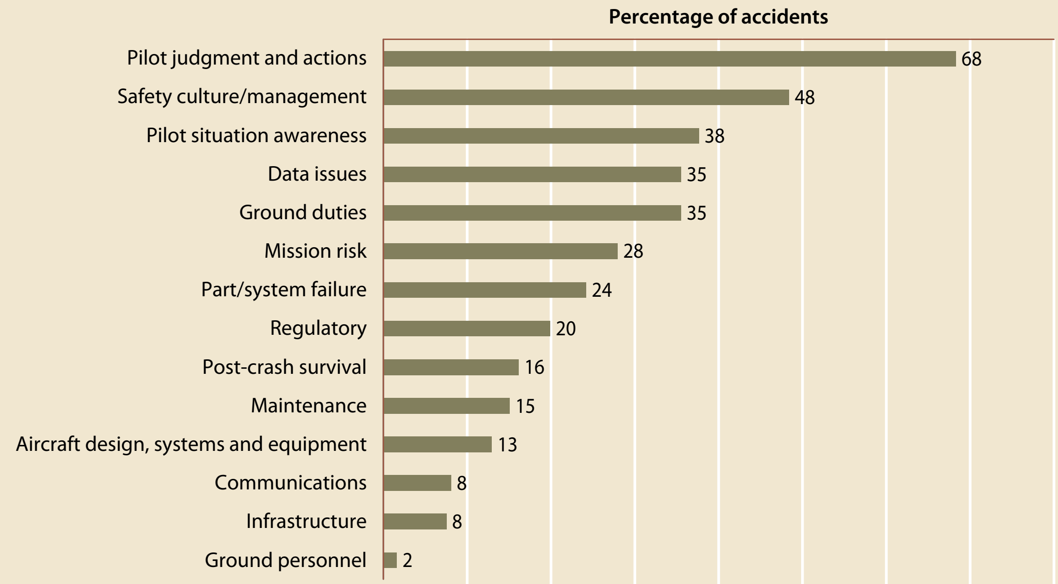


Note: Data are based on 155 civil aviation helicopter accidents, a subset of 186 such accidents.

Source: European Helicopter Safety Analysis Team

Figure 4

Level 1 SPS Categories Identified in European Helicopter Accidents, 2000–2005



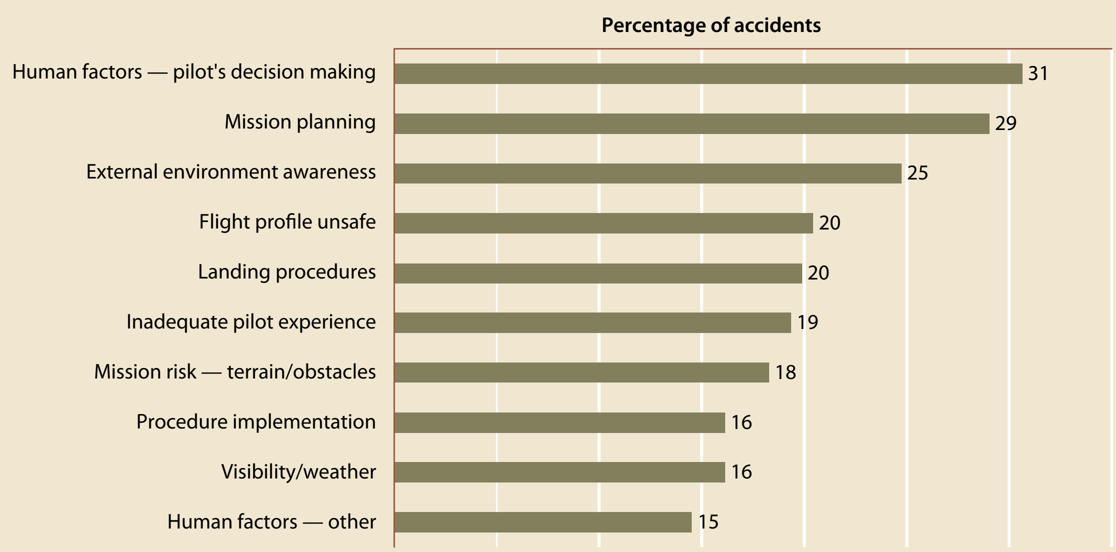
SPS = standard problem statements, a taxonomy

Note: SPS Level 1 is the most general level. Data are based on 186 civil aviation helicopter accidents.

Source: European Helicopter Safety Analysis Team

Figure 5

Level 2 SPS Categories Identified in European Helicopter Accidents, 2000–2005



SPS = standard problem statements, a taxonomy

Note: Data show the top 10 SPS Level 2 categories. SPS Level 2 is more specific than Level 1. Data are based on 186 civil aviation helicopter accidents.

Source: European Helicopter Safety Analysis Team

Figure 6

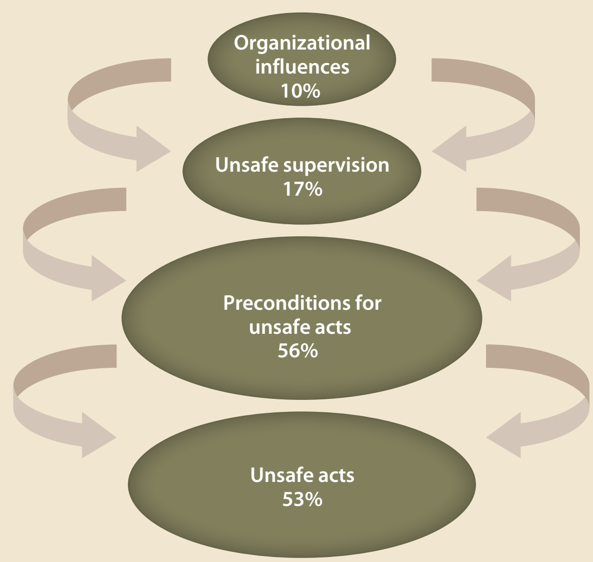
"Preconditions for unsafe acts," the next higher HFACS level, represent latent factors that enable or encourage unsafe acts. The report says that 60 percent of the preconditions in the accident database were individual rather than institutional. They included "overconfidence, channelized [narrowly focused] attention, 'press-on-itis,' inattention, distraction, misperception of operational condition and excessive motivation." Personnel-related factors, such as mission planning, accounted for 23 percent of preconditions. Environmental factors, such as restricted visibility, represented 17 percent of preconditions.

"Latent failures of middle management" were found in 17 percent of the accidents in the database — the next higher HFACS level, called "unsafe supervision." Of these supervision problems, 59 percent were labeled "planned inappropriate operations," such as failure to adequately evaluate mission risks or inadequate risk assessment programs. The other 41 percent came under the heading of "inadequate supervision," consisting of factors such as inadequate oversight and lack of policy or guidance. No cases were identified of "failure to correct known problem" or "supervisory violations," which if they had occurred would have been categorized as "inadequate supervision."

In 10 percent of the accidents, "organizational influences," the top level, were identified. Of these, 64 percent were classified as "organizational process," which included issues related to procedural guidelines and publications, as well as doctrine. A further 24 percent were classified as "organizational climate," and the remaining 12 percent came under the heading of "resource management."

EHSAT regional teams were asked to develop intervention recommendations to reduce the kinds of accident factors found in the study. The report says, "Examples of intervention recommendations are better training for specific missions — for example, mountain operations; better training for specific operating environments, such as inadvertent entry into instrument meteorological conditions; risk assessment training; promoting safety culture and introduction of [SMSs]; increase of obstacles awareness; requirements for flight data recording; [and] establishment of training requirements for aerial work operational crew other than flight crew."

HFACS Levels Identified, European Helicopter Accidents, 2000–2005



HFACS = Human factors analysis and classification system

Notes: HFACS levels range from the most remote causal factors (top level) to the most immediate (bottom level). Percentages represent the proportion of accidents where the HFACS level was identified at least once.

Data are based on 186 civil aviation helicopter accidents.

Source: European Helicopter Safety Analysis Team

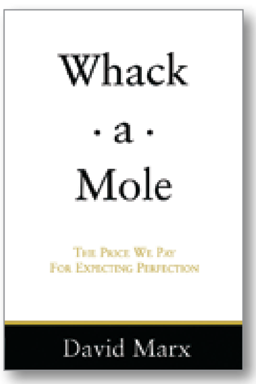
Figure 7

Notes

1. EHSAT. "Preliminary Results of Helicopter Accident Analysis." April 20, 2009. Available via the Internet at <www.easa.europa.eu/essi/EHSAT2.htm>.
2. EASA. "Annual Safety Review 2007." Available via the Internet at <www.easa.europa.eu/essi/documents/AnnualSafetyReview2007_EN_001.pdf>.
3. *Ibid.*

Erring on the Safe Side

Organizations need to distinguish among inadvertent error, at-risk behavior and deliberate noncompliance.



BOOKS

The Perfect Is the Enemy of the Best

Whack-a-Mole: The Price We Pay for Expecting Perfection

Marx, David. Plano, Texas, U.S.: By Your Side Studios. 221 pp. References, index.

"Whack-a-Mole" is an arcade and electronic game. The mole, a burrowing animal, pokes its head out of a hole and the player tries to "whack" it with a paddle before it disappears back into the ground, only to reappear at another hole.

Too much of the effort to improve safety resembles the whack-a-mole game, says Marx, a systems engineer. We try to find a visible actor who made an error that contributed to the accident, and punish that individual. "Bad outcome must mean bad actor," he says. "Whack that bad actor and the game is won." But another person committing the same, or a similar, error pops up at a different location.

"While we've learned in the game to lie in wait for the adverse event to pop up, ready to strike when we see the harm occur, we have largely given up on accountability for our personal choices," he says. "The game has made our performance all about the outcome." Not only does reacting mainly to outcomes offer minimal benefits in the big picture, Marx says, but it contributes to complacency because less than optimal behavior *usually* doesn't lead to harmful consequences; it just worsens the odds slightly. But when those odds are multiplied by many flights and flight hours, the accident rate increases.

"We spend far too little time addressing the system design that got us there and the behavioral choices of the humans in those systems that might have ultimately contributed to the adverse outcome," Marx says.

No one wants to be punished. No one wants to contribute to an accident. So why do people keep violating rules they are aware of and committing errors that someone has already been penalized for?

Does a mistake mean, Marx asks, "that we're all unintelligent or unprofessional, or perhaps just too lazy to give it our full effort? No. It simply demonstrates our human fallibility — even in the face of a relatively simple task of little consequence. We are not perfect machines."

"To err is human" is an indisputable cliché, but Marx says that there are additional, more-subtle reasons that people act in ways that go counter to safety.

For one thing, the evaluation depends on whether you are the doer or the observer. If you are the doer, you believe you can judge whether the extra risk you take is serious or negligible. You can calculate whether the odds are with you when you continue driving through the intersection as the traffic light changes from green to yellow. You know that you should unplug an electrical appliance by grasping the plug at the socket, not from several feet away by yanking on the cord. But which of us could take an oath that we have never disconnected the vacuum cleaner by pulling on the cord?

"Or we observe and decide that the increased risk is not worth the reward," Marx says. "While our friend engaged in the behavior may see it differently, we label it 'at-risk,' a label that implies a difference of opinion on the trade between risk and reward."

Sometimes observers expect us to take on a little extra risk and indicate their displeasure if we do not. This can be easily demonstrated by driving at exactly the speed limit in the fast lane of the highway. We "should" drive at more or less the same pace as the other cars in the lane, even if they are speeding … until we contribute to an accident, after which the other drivers will claim indignantly that we were going too fast.

In addition, once there is an accident or serious incident, the tendency of most organizations is to formulate a new rule prohibiting or restricting whatever behavior was involved. That gets added to the list of rules, regulations, guidelines, recommendations, best practices and helpful hints we are expected to know and practice. We can scarcely draw breath without consulting a mental manual telling us what to do and not to do. We aren't even supposed to *relax* spontaneously. We are told to sleep only at regular hours. Passengers on a long-haul flight should not touch alcohol, the health experts warn.

"I have only known a few people in my life that even give the impression of following all the rules," Marx says. "The rest of us are just trying to get by, just trying to get through the day without having a catastrophic failure. We look at those never-ending requirements and recommendations, and we choose. Is it laziness? No. Is it an uncaring attitude for those around us? No. It is instead the recognition that we cannot do it all. Sometimes, it's the recognition that the rules are inconsistent and that to follow one requires violating another."

Marx believes that organizations should differentiate among three categories: "Human error is the inadvertent action. At-risk behavior is, generally, the knowingly non-compliant place where there's a difference of interpretation around the behavior, where the observed believes they are still in a safe place but the observer judges otherwise. The reckless behavior is the choice to consciously disregard a substantial and unjustifiable risk. These are three different behaviors arising from three different causal mechanisms."

But many organizations, like many individuals, have only two criteria when something bad happens. *How* bad was it? *Who* was to blame? "The question is whether this strategy gets us where we want to be," Marx says. "Throughout this book, I make the argument that there are really only two inputs impacting our ability to avoid adverse events. The first is the design of the system in which we put ourselves … . The second input is the behavioral choices of the people within those systems. What we do not have such immediate control over are the human errors that we make, nor the adverse outcomes we produce, even when trying our best."

There are two basic categories of system design, Marx says: "We either take control and ask others to comply, or we delegate an outcome and leave the system design to others. … In some areas, particularly in high-risk industries, it's critical that personal preference not rule the day."

He cites the crash on takeoff of American Airlines Flight 191 at Chicago O'Hare International Airport on May 25, 1979, killing all 271 passengers, the crewmembers and two people on the ground. "In the case of Flight 191, the plane's left engine was changed 55 days before the catastrophic loss of the aircraft," Marx says. "In their investigation, the [U.S. National Transportation Safety Board] found that American Airlines maintenance technicians had developed an alternative means for removing the engine, based in part on perceived time constraints at the maintenance facility. Tragically, this alternate method physically stressed the pylon mounts on the wing, inadvertently fracturing the attachment bolts. As the aircraft rolled down the runway, the forces of engine thrust and the weight of the engine itself caused the engine to separate from the aircraft."

Marx says he has no doubt that in most aspects of aviation operations, following the prescribed regulations, rules and procedures is the best way — in fact, the only way. We do not want creative maintenance technicians designing brilliant short cuts that work fine until one day they don't. Usually we do not want pilots to be creative in the cockpit. Emergencies might sometimes be an exception, but even emergencies have checklists that were written by engineers and safety specialists who were able

Once there is an accident or serious incident, the tendency of most organizations is to formulate a new rule.

to think the scenario through without hurry, consult with others and conduct tests.

In a professional setting such as the aviation industry, most errors do not involve conscious or irresponsible violation of rules, regulations and procedures. And Marx is skeptical of the value of organizational codes of conduct that fail to make the necessary distinctions about causes of behavior.

He quotes from an actual, though de-identified, "progressive discipline policy" of one major U.S. airline. While acknowledging that some provisions are reasonable and necessary, he sees others as promoting the whack-a-mole approach. For example, "Any employee involved in any mishap resulting from a judgment error but who notifies management in a timely fashion (within 10 minutes of the mishap) will be disciplined as follows: For the first offense in an 18-month period, a letter of discipline will be retained in the employee's personnel file for 18 months, *and* the employee will receive five days off without pay. Any employee involved in two mishaps will be terminated."

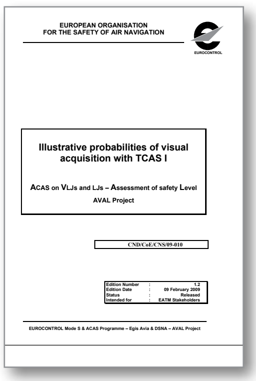
The honest employee who would like to confess and possibly help prevent the same kind of error from recurring in the organization will be whacked for it. "It's a provision that appears to make human error a very serious offense," Marx says. "Given the penalties, employees are unlikely to volunteer that they made a 'judgment' error."

Alternatively, Marx says, "Surely we can create a disciplinary policy that allows the station manager to take action when he sees reckless behavior, while also promoting an open learning culture around more basic human fallibility."

Many organizations where errors can have severe consequences are moving in the direction of a "just culture," which encourages people to report hazards but still maintains a reasonable accountability. Marx says that such a policy — minus the legal jargon — would tell the employee:

> *You are a fallible human being, susceptible to human error and behavioral drift. As your employer, we must design systems around you in recognition of that fallibility. When errors do occur, you must raise your hand to allow the organization to learn. When you make a mistake, you will be consoled. When you drift into a risky place, believing that you are still safe, we will coach you. When you knowingly put others in harm's way, we will take appropriate disciplinary action.*

— Rick Darby



EUROPEAN ORGANISATION
FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

Illustrative probabilities of visual acquisition with TCAS I

ACAS on VLJs and LJs – Assessment of safety Level

AVAL Project

CND/CoE/CNS/09-010

Edition Number	:	1.2
Edition Date	:	09 February 2009
Status	:	Released
Intended for	:	EATM Stakeholders

EUROCONTROL Mode S & ACAS Programme – Egis Avia & DSNA – AVAL Project

REPORTS

Putting TCAS to the Test

Illustrative Probabilities of Visual Acquisition with TCAS I: ACAS on VLJs and LJs — Assessment of Safety Level

Eurocontrol. Edition 1.2. Feb. 9, 2009. 70 pp. Available via the Internet at <www.eurocontrol.int/msa/public/standard_page/ACAS_AVAL.html>.

The airborne collision avoidance system (ACAS) is the International Civil Aviation Organization's general term for on-board avionics that reduce the risk of midair collisions. In Europe, use of ACAS II is required for civil turbine engine airplanes with a maximum takeoff weight of 5,700 kg/12,500 lb or a passenger seating capacity of more than 19.

"The advent of very light jets (VLJs) and light jets (LJs), aircraft weighing less than 5,700 kg, means that in the near future there may be a significant population of aircraft which fall outside the thresholds of the current ACAS II mandate to include these aircraft," the report says.

Eurocontrol has been studying whether it would be appropriate to extend ACAS II requirements to include VLJs and LJs. The project is called AVAL (ACAS on VLJs and LJs — Assessment of Safety Level).

It has been suggested that the appropriate level of equipment for VLJs and LJs is traffic alert and collision avoidance system (TCAS) I, which provides traffic advisories on a cockpit display, rather than TCAS II version 7.0, which provides resolution advisories (RAs) in addition to traffic advisories. TCAS I would warn of a collision hazard, but evasive action would depend on the traditional see-and-avoid principle.

The question is, how well does TCAS I work for VLJs and LJs as a see-and-avoid aid? The AVAL project Work Package 8 used a comparatively simple model of visual acquisition in a set of scenarios to quantify the probability of the pilot seeing a collision threat, both with and without TCAS I.

The visual acquisition model described mathematically the factors involved in a potential collision, the "collision geometry." The factors included the speed of the pilot's own aircraft, the speed of the threat aircraft, the angle between the tracks of the converging aircraft, the closing speed, the apparent direction of the threat and the angle from which the threat is viewed.

The report says that the study found that TCAS I "can undoubtedly enhance the prospect of visually acquiring a collision threat in certain scenarios":

- "It is most effective against the larger aircraft types (medium and large passenger aircraft) … ;
- "It is less effective against the smaller aircraft types (general aviation, military fast jets and VLJs) … ; [and,]
- "It is particularly ineffective against small-sized threats with high closing speeds in which there is virtually no prospect of visual acquisition, even when equipped with TCAS I, at the highest closing speeds."

TCAS I's effectiveness is "markedly decreased" when visibility is degraded by weather, the report says: "Even at the limit of visibility for [visual flight rules], the usefulness of TCAS I as an aid to visual acquisition is severely curtailed, even against the larger-sized threats. This effectiveness will obviously be further reduced, ultimately to nil, in [instrument meteorological conditions]."

The study also showed that even though TCAS I can under some conditions enhance the likelihood of the pilot visually acquiring a collision threat, the collision threat would not be reduced if the two aircraft use incompatible avoidance maneuvers. "The effect is most marked in TCAS I–equipped aircraft against threats which are equipped with ACAS II," the report says.

— *Rick Darby*

WEB SITES

Open Source

NTSB Electronic Reading Room,
<www.ntsb.gov/Info/foia_fri.htm>

The U.S. National Transportation Safety Board (NTSB) has begun posting all accident investigation public dockets on a Web site. The NTSB says, "This effort serves to further bring the [NTSB] into compliance with a number of legislative and executive mandates aimed at improving the U.S. government's use of electronic media to foster a more open and transparent government."

In the past, members of the public were required to make formal requests for information related to investigations through the Freedom of Information Act (FOIA). This recent change makes materials previously approved for release available to everyone. Interested parties are now able to view information related to specific accident investigations online, in full text and at no cost. Most documents may be printed or downloaded.

At the NTSB's Electronic Reading Room Web page under "Accident Dockets" are links to a directory of accidents listed by date and location. Opening a specific accident docket or file reveals a list of materials produced during the accident investigation — interviews and testimonies, regulatory and guidance documents, photographs, cockpit and data recorder transcriptions, maintenance records, and many other resources and items of evidence. Currently, accident dates range from June 2007 to the present. Dockets containing newly released information are flagged.

The Electronic Reading Room also contains links to the NTSB's accidents database; NTSB investigation manuals, procedures and guides; investigation documents related to the four Sept. 11, 2001 hijacked aircraft; and more.

Other information at the Web site

includes contact information for the NTSB records management division, identification of accessibility technology for researchers with special needs and the NTSB's policy for submitting FOIA requests.

— Patricia Setze

One Accident, Two Interpretations

The Erebus Story, <www.erebus.co.nz>

The New Zealand Air Line Pilots' Association (NZALPA) has launched a commemorative Web site marking 30 years since the fatal accident involving Flight TE 901 on Mt. Erebus, Antarctica. Capt. Mark Rammell, NZALPA president, says that "this site is dedicated to those lost to Erebus; our goal for this site is to ensure that the memories of those who perished are never forgotten. We have not set out to apportion blame but to show that even in the most tragic of accidents the lessons learned eventually lead to improvements in air safety."

The accident resulted in the deaths of 257 people aboard a McDonnell Douglas DC-10 for a sightseeing flight on Nov. 28, 1979. Audio and video recordings of events following the accident, news articles, photographs and a four-part television mini-series can be reviewed in the resources section of the Web site. A bibliography includes books, articles and Web sites devoted to the Erebus accident. Much of the information may be viewed online at no cost.

The Web site reflects the controversy that surrounded the accident, investigations and subsequent reports. Two investigations produced two accident reports — the official accident report by the Office of Air Accidents Investigation and a subsequent Royal Commission of Inquiry report. Differences in investigation procedures between the two organizations and their differing conclusions are discussed in detail.

The first investigation led to the Chippindale report, named after Ron Chippindale, chief investigator of air accidents. That report "determined the probable cause of the accident was the decision of the captain to continue the flight at low level toward an area of poor surface and horizontal definition when the crew was not certain of their position and the subsequent inability to detect the rising terrain which intercepted the aircraft's path."

Before the Chippindale report had been completed and released, the attorney general ordered a commission of inquiry to determine the cause of the accident; culpability for the accident; adequacy of existing laws, safety board investigational procedures and civil aviation authority actions; safety concerns related to the accident or arising from the investigation; and other issues. The commission's report, named after Justice Peter Mahon, determined that "the dominant cause of the accident was the act of the airline in changing the computer track of the aircraft without telling the aircrew."

The site may not intend to apportion blame, but the discussion of the Chippindale report reveals the writer's judgment in statements such as the following:

- "Chippindale makes the statement in paragraph 2.20 that the whiteout conditions made the snow slope appear to the pilots as 'an area of limited visibility.' Justice Mahon's coverage of the issue shows a far greater understanding of the illusion presented to the crew; [and,]
- "Whilst Mr. Chippindale pays scant attention to the reason for (or the consequences of) the error, paragraphs 224–255 of Justice Mahon's report detail his attempts to untangle Air New Zealand's obfuscation of those events. It is difficult reading, and one is left unable to disagree with the judge's infamous 'litany of lies' assessment."

Both reports are available in full text with annexes, photographs and graphics. They may be read online, downloaded or printed at no cost.

— Patricia Setze

Bangs and Flames

Compressor stalls plague a DC-8 on initial climb.

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

Unexpected Ice Built Rapidly on Inlets

Douglas DC-8-60F. No damage. No injuries.

People on the ground heard loud bangs, saw flames coming from the aircraft that was passing a few miles above their heads and called the Gardaí, the Irish police. About the same time, the approach controller's radar display showed the DC-8 entering a rapid descent.

The 1960s-vintage freighter, of U.S. registry, was departing from Shannon Airport's Runway 24 the night of March 28, 2008, for a cargo flight to Qatar. The aircraft was near maximum takeoff weight for the seven-hour flight, said the final report by the Irish Air Accident Investigation Unit.

The DC-8 had reached 1,000 ft while climbing through a cloud layer when the commander, the pilot flying (PF), called for the flaps to be retracted and for climb power to be set. As the flap lever was being repositioned, compressor stalls began to occur in the no. 1 engine. The flight crew shut down the engine and radioed the airport traffic controller that they required a vector to return to Shannon Airport. No reason was given.

"The aircraft was transferred to the approach controller's frequency," the report said. "At the time, the aircraft was approximately 4 nm [7 km] south of the airport. The approach controller initially gave the aircraft a heading toward a left downwind leg for Runway 24 and instructed it to climb to 3,000 ft. Although there is higher ground on a left-hand downwind, the approach controller was not then aware that the aircraft had a problem climbing."

Meanwhile, compressor stalls had begun to occur in the no. 2 engine. The PF initiated a rapid descent to increase airspeed above 208 kt, the minimum control speed with two engines on the same wing inoperative.

A minimum safe altitude warning was generated by the air traffic control (ATC) radar system as the freighter descended from 2,400 ft to 1,100 ft in 30 seconds — an average descent rate of 2,600 fpm. "[The approach controller] was concerned that the aircraft might not make it to the airport and gave it a heading directly toward Runway 06 at the airport, which would place it in an obstacle-free area over the River Shannon estuary," the report said.

Apparently anticipating that they would have to shut down the no. 2 engine and that the other two engines might develop similar problems, the crew declared an emergency and conducted the checklist for failure of all four engines. "This entailed opening the fuel crossfeed valves [and] switching on all fuel booster pumps and engine anti-ice," the report said. After the engine anti-ice systems were selected, the no. 2 engine stabilized, and the crew restarted the no. 1 engine. All four engines then operated normally for the remainder of the flight.

Apprised of the situation, the approach controller advised the crew that they would have a 17-kt tail wind for a landing on Runway 06 and

"As there was no evidence of airframe icing, the crew were slow in recognizing the cause of the engine abnormality."

offered vectors to establish the aircraft on a right downwind for Runway 24. The crew accepted the offer and conducted an uneventful instrument landing system (ILS) approach and an overweight landing on that runway. Postflight examinations revealed no damage to the airframe or engines.

Investigators determined that ice likely had accumulated rapidly on the inlet cowlings and guide vanes as the aircraft climbed through the cloud layer, disturbing airflow through the engines. The compressor stalls likely were the first sign of engine icing. "As there was no evidence of airframe icing, the crew were slow in recognizing the cause of the engine abnormality," the report said.

Visual meteorological conditions (VMC) prevailed at the airport, with no precipitation. However, there was convective activity near the airport, with isolated heavy showers and hail. Surface temperature was 6° C (43° F), and dew point was 3° C (37° F). Although the freezing level was higher than 2,000 ft, the convective conditions enabled the formation of supercooled water droplets in clouds below 2,000 ft, the report said.

The use of the anti-ice system causes a significant loss of power from the DC-8's Pratt & Whitney JT3D-7 engines. "Consequently, engine anti-ice is only used operationally when needed," the report said, noting that after the incident, the operator implemented a policy "to strongly encourage the use of engine anti-ice for departures when icing conditions are in any way suspect and the temperature is below 10° C [50° F]." The new policy also stated that in situations involving takeoff performance limitations, engine anti-ice should be selected upon completing second-segment climb at 400 ft above ground level (AGL).

Control Input Faulted in Bounced Landing

Boeing 767-300. Minor damage. 17 minor injuries.

The 767 was inbound to Tokyo International Airport with 210 passengers and 12 crewmembers the morning of June 15, 2005. A first officer scheduled to begin training as a captain was hand flying the aircraft from the left seat. The captain was in the right seat, and another first officer was in the observer's seat.

The airport had a 700-ft ceiling, 7 km (4 mi) visibility in rain and surface winds from 30 degrees at 16 kt. The flight crew was cleared to conduct the ILS approach to Runway 34L, said a report issued in May by the Japan Transport Safety Board.

The crew established a target approach speed of 142 kt — 8 kt above VREF, the reference landing speed. They saw the approach lights while descending through 1,000 ft. The first officer called 500 ft above airport elevation, and the captain responded that the approach was stabilized. Recorded flight data showed that the airspeed was 142 kt and descent rate was 784 fpm.

At 315 ft, the captain called "minimum," and the first officer responded "landing." As the 767 continued to descend, it encountered mechanical turbulence caused by a nearby hangar. The report said that the bank and pitch angles began to vary significantly because of flight control inputs, and the main landing gear touched down hard on the runway. The aircraft bounced, and the control column was pushed forward, causing the nosegear to strike the runway.

The report said that the flight deck microphone recorded "a very loud breaking sound … and then noises that sounded as if the aircraft was running on the metal parts of the wheels." The left nosewheel tire had burst, and the right tire had deflated and separated as the wheel rims were destroyed.

The crew brought the aircraft to a stop on the runway, shut down the engines and requested a tow. However, a tow was not possible because of the damage to the nosegear, and the aircraft was evacuated on the runway.

Seventeen passengers complained of neck and back pain. "One of them was examined at the airport clinic [and] was diagnosed as having suffered a whiplash injury and requiring one week for recovery," the report said.

Examination of the aircraft revealed damage to the nosegear axle, wheels and tires; a main landing gear tire; wing skins; slats; flaps; and engine fan blades and compressor blades. The report characterized the damage as minor.

Over-Torqued Bolts Cause Fuel Leak

Boeing 737-700. Minor damage. No injuries.

Shortly after reaching cruise altitude during a scheduled passenger flight from Brisbane, Queensland, Australia, to Hamilton Island the afternoon of Aug. 13, 2007, the flight crew noticed a fuel imbalance and determined that fuel was leaking from the no. 2 engine.

The crew shut down the engine and "diverted to Rockhampton, where a single-engine approach and landing was completed without further incident," said the report by the Australian Transport Safety Bureau.

Examination of the engine revealed that fuel was leaking from a partial separation between the main fuel-return pipe and the oil/fuel heat exchanger. The components had been disconnected two days before the incident, during unscheduled maintenance involving replacement of the no. 2 engine's fuel pump. Investigators found that while reconnecting the components, a maintenance engineer had applied excessive torque to the four bolts that are inserted through the fuel pipe flange, gasket and rubber seal into threaded inserts in the heat exchanger body.

The torque value used by the engineer was applicable to key-lock inserts used in a modified heat exchanger that was to be installed in the 737's engines during their next overhauls; the applied torque was about 15 percent higher than the maximum torque value specified for the threaded inserts in the no. 2 engine's original heat exchanger.

The excessive torque on the bolts had stripped the threads in all four inserts and had pulled the inserts partially out of the heat exchanger body. The report said that the gasket between the fuel pipe and the heat exchanger had prevented fuel from leaking during the post-maintenance engine test run and during three subsequent flights. However, vibration of the fuel pipe during these flights and the incident flight eventually resulted in the complete release of the inserts and the bolts from the heat exchanger, causing the fuel leak.

The report noted that the engineer was not aware of the different torque values and that his supervisor had been involved in other tasks when the engineer reconnected the components.

Smoke Traced to Overheated Capacitor

Fokker F28-70. Minor damage. Two minor injuries.

After an uneventful flight from the Netherlands on Sept. 29, 2008, the flight crew taxied the aircraft to the stand at Manchester (England) Airport with the right engine and auxiliary power unit operating, and the left engine shut down. When the right engine was shut down at the stand, the crew detected a strong odor of an electrical component burning and saw smoke accumulating on the flight deck.

"The flight crew believed the smoke was coming from multiple sources including behind the copilot, various vents and behind the instrument panel," said the report by the U.K. Air Accidents Investigation Branch (AAIB). "The commander firmly instructed the CSS [cabin service supervisor] to get the passengers off as quickly as possible."

The CSS used the public-address system to tell the passengers to "get off the aircraft now." Seeing very little response, the CSS said more assertively, "Hurry. Evacuate the aircraft but leave your baggage behind." The 70 passengers evacuated quickly through a cabin door and the right overwing exit. "Two of the passengers were treated by the ambulance service for minor injuries sustained when moving off the aircraft wing," the report said.

The source of the smoke was identified as an overheated capacitor in the power supply circuit for the emergency inverter cooling fan. The report said that the capacitor was "completely burned out [and] too badly damaged to allow any further analysis of why it had failed."

Noting that the Fokker 70 fleet had accumulated more than 1.2 million flight hours since the aircraft was introduced in 1994, the report said that maintenance records showed that only four inverters had been found to have overheated. The incidents were fairly recent, however. "Given the time since manufacture of the capacitors, the failure mode may potentially be a service-life-related issue," the report said. "This event is the first recorded incident where

"The commander firmly instructed the CSS [cabin service supervisor] to get the passengers off as quickly as possible."

smoke in the flight deck has been reported as a consequence of this capacitor overheating."

Thrust Control Lost on Approach

Eclipse 500. Minor damage. No injuries.

VMC prevailed with surface winds from 200 degrees at 18 kt, gusting to 26 kt, as the very light jet approached Runway 22L at Chicago Midway International Airport the afternoon of June 5, 2008. The airplane encountered wind shear at about 50 ft AGL, and the pilot increased thrust to arrest the resulting sink rate, said the report by the U.S. National Transportation Safety Board (NTSB). After touchdown, the pilot — who had 21,500 flight hours, including 300 hours in type — realized that although the throttle levers were at idle, the airplane was accelerating and both engines were producing maximum thrust.

The pilot initiated a go-around and told the copilot to declare an emergency. ATC cleared them to land on any runway. After finding that the quick reference handbook (QRH) provided no emergency procedures to address the situation, the pilots decided to shut down the right engine to reduce airspeed. However, airspeed decreased rapidly, and the stall-warning system activated. The pilot noticed that the left engine was producing idle power and was not responding to throttle lever movement. He was able to land the airplane on Runway 22R; the Eclipse came to a stop with both main landing gear tires deflated. The pilots and their two passengers were not injured.

Investigators found that the loss of thrust control had resulted from inadequate fault logic that had caused the full authority digital electronic control system to fail. The U.S. Federal Aviation Administration subsequently issued emergency airworthiness directives requiring corrective actions and the incorporation of emergency procedures for dual engine control failure in the QRH and the airplane flight manual.

Cleared to Land on a Closed Runway

Learjet 45. No damage. No injuries.

The airport traffic controller was aware that Runway 01/19 at Teterboro (New Jersey, U.S.) Airport was closed for maintenance the morning of June 25, 2008, but did not record that information on the automatic terminal information service. "He also failed to advise the local approach controller when the approach controller called him to advise that he had an airplane inbound to land on Runway 19," the NTSB report said. "The tower controller subsequently cleared the approaching airplane to land on the closed runway."

The airplane was a Learjet that had departed from White Plains, New York, at 0520 local time to pick up passengers in Teterboro. "According to the pilot-in-command, it was dark and the runway lights for Runway 19 were illuminated," the report said. "About 400–500 ft above touchdown, the flight crew noticed that there were men and equipment in the displaced threshold area for Runway 19 but not on the runway itself. … The flight crew briefly discussed the situation and verified with each other that they were in fact cleared to land on Runway 19."

The report said that the Learjet passed within 150 ft (46 m) of the workers while landing. "ATC did not advise the flight crew that they had landed on a closed runway, nor did the crew query the tower regarding the possibility that the runway had been closed," the report said.

"According to the pilot-in-command, there were no notices to airmen (NOTAMs) in effect [about] closing Runway 19 at Teterboro," the report said. "According to Teterboro Airport Operations, [a NOTAM] was in effect reflecting Runway 01/19 closed from 5:00 a.m. to 2:00 p.m."

NTSB determined that the probable cause of the incident was the airport traffic controller's "failure to follow published procedures and directives."

TURBOPROPS

Faulty Fuel Calculations

Beech King Air C90. Substantial damage. No injuries.

Before the first of several flights the morning of Sept. 15, 2007, the pilot observed that the fuel gauges indicated a total quantity of 2,611 lb (1,184 kg). He then conducted three flights without refueling. Before departing on the fourth flight — from Blairsville, Georgia, U.S., to a location not specified in the NTSB report — the pilot observed that the gauges indicated that 500 lb (227 kg) of fuel remained in the King Air's tanks. The pilot considered this as sufficient for the positioning flight.

About an hour after takeoff, the airplane was in instrument meteorological conditions and about 12 nm (22 km) from the destination when both engines flamed out. ATC provided radar vectors to the nearest airport — a 2,700-ft (823-m) grass strip in Bloomingdale, Georgia. "[The pilot] spotted the airport through breaks in the cloud layer and landed on the wet grass," the report said. "The airplane overran the runway and impacted trees." The King Air's left wing and engine nacelle were substantially damaged. The pilot escaped injury.

The pilot told investigators that, for flight planning, he used a fuel flow of 400 lb (181 kg) per hour and a true airspeed of 230 kt. The report said, however, that the C90 pilot's operating manual indicated that for the conditions representative of all four flights, average fuel flow was 443 lb (201 kg) per hour and average true airspeed was 217 kt.

NTSB concluded that the probable causes of the accident were fuel exhaustion and "the pilot's improper preflight planning and preparation," and that a contributing factor was "the pilot's reliance on inaccurate fuel gauges."

Unlocked Door Separates on Takeoff

Let 410. Substantial damage. No injuries.

The pilot was late, and a maintenance engineer volunteered to perform the preflight walk-around inspection of the aircraft before a skydiving flight the morning of June 20, 2008. The engineer, and the pilot, did not notice that the door/emergency exit on the right side of the cockpit was not locked before the aircraft departed with five parachutists from Peterborough, England.

The door, which hinges at the rear, opened just after liftoff, separated from the aircraft and struck the right propeller, engine nacelle and fuselage. "The aircraft made an immediate return to the airfield and carried out an uneventful downwind landing," the AAIB report said.

The door usually remains closed but had been opened to facilitate routine maintenance. The preflight checklist calls for a visual check of the position of the door-locking handles. "However, these handles are not conspicuous, being painted the same color as the surrounding structure," the report said.

A warning light illuminates if either the rear fuselage door or the cockpit door is unlocked. However, skydiving flights typically are conducted with the fuselage door locked open, and the warning light remains illuminated throughout these flights.

The report noted that a month before the accident, the European Aviation Safety Agency (EASA) had issued an airworthiness directive requiring, in part, the installation of a separate warning light for the cockpit door.

The door usually remains closed but had been opened to facilitate routine maintenance.

Mechanic Killed While Opening Door

Raytheon King Air B200. Substantial damage. One fatality.

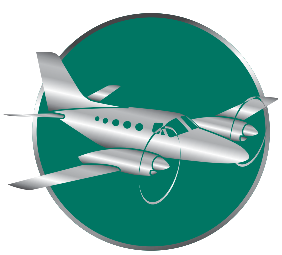
The pilot departed from Taylor (Texas, U.S.) Municipal Airport the morning of April 10, 2008, to conduct a post-maintenance test flight following replacement of the vertical speed indicator. He returned to the airport after hearing a loud, high-pitched noise emanating from behind the instrument panel. He summoned the maintenance technician by radio and left the engines running after landing.

"The pilot reported turning the environmental [system] controls off, which stopped the in-flow of cabin pressure," the NTSB report said. However, he did not check the pressurization system gauges for an indication of zero pressure differential and, thus, did not notice that the cabin was still pressurized. When the maintenance technician opened the cabin door, which is hinged at the bottom, the door blew open and struck the technician's head, killing him.

Examination of the airplane revealed that a vacuum line had separated from the vacuum controller at a "T" fitting. "The 'T' fitting was located in the area that the mechanic had worked in during installation of the vertical speed indicator," the report said. "The disconnected line disabled the entire vacuum system and subsequently disabled the airplane's pressurization system outflow valve."

The pressurization system safety valve also was disabled and remained closed. The safety valve, a backup to the primary outflow valve, opens to relieve cabin pressure when the pressurization "dump" switch is manually selected or a squat switch on the main landing gear is closed on touchdown.

The King Air's cabin door has a release button adjacent to the exterior door handle that must be pressed while rotating the handle to open the door. When the cabin is pressurized, a diaphragm inside the door presses against the release button. Although this resistance makes it more difficult to press the release button, it apparently does not prevent the door from being opened. "Testing confirmed that the airplane's door could be opened while the airplane was still pressurized, but that action would require more force to overcome the resistance [on the release button]," the report said.



PISTON AIRPLANES

Incorrect Switch Selection Silences Engines

Aero Commander 500S. Destroyed. Two fatalities.

The chief pilot of a U.S. on-demand cargo airline was performing a competency check of a newly hired pilot the morning of June 24, 2008. During such flights, the chief pilot — who had 10,500 flight hours, including 7,550 hours in type — was known to require pilots-in-training to select the fuel boost pump switches to the "ON" position before performing steep 360-degree turns and then to select the boost pump switches to "OFF" before configuring the airplane for landing, in preparation for maneuvers at low airspeed.

The accident check flight was performed below a 2,600-ft broken ceiling. Data recorded by the global positioning system receiver showed that after steep turns were performed, airspeed and altitude began to decrease. The NTSB report said that witnesses heard both engines "sputter and quit" and saw the Aero Commander pass low over a grove of trees, stall and strike terrain near Linwood, Kansas.

"The landing gear was down, and the flaps were in the approach setting," the report said. "Both propellers were in the low-pitch/high-rpm setting and bore little rotational signatures. Both engine fuel supply lines contained only residual fuel."

The report said that the pilot-in-training, who had seven flight hours in type, likely had inadvertently selected the fuel shutoff valve switches to the "CLOSED" position when he was instructed to turn off the boost pumps, causing both engines to lose power due to fuel starvation. The shutoff valve switches are unguarded and are adjacent to the boost pump switches on the overhead panel. "Contributing to the accident was the chief pilot's inadequate supervision of the pilot-in-training," the report said.

Neglected Gear Ruins Water Landing

De Havilland DHC-2. Substantial damage.
Two fatalities, three minor injuries.

The amphibious-float-equipped Beaver departed from a paved runway at one end of Lake Chelan, Washington, U.S., on May 17, 2008, for a 40-nm (74-km) charter flight to Stehekin, which is at the other end of the lake. The pilot neglected to retract the landing gear into the floats after takeoff and attributed the subsequent lower-than-normal cruise airspeed to the prevailing high-density-altitude conditions on the unusually warm afternoon, the NTSB report said.

The Beaver has two sets of lights indicating gear position: blue for retracted and green for extended. The accident airplane also had been modified with an auxiliary gear advisory system that illuminates an annunciator light when airspeed decreases below a target value and generates aural advisories either that the "gear is up for water landing" or "gear is down for runway landing."

"During the flight, the air was bumpy and turbulent, and this resulted in the gear advisory system activating numerous times," the report said. "The pilot disabled the system by pulling its circuit breaker because the alerts were becoming a nuisance. He intended to reset the breaker during descent but did not do so."

A water landing was required at the destination, and the Beaver touched down on the lake with the landing gear extended. The airplane flipped over and came to rest inverted. The pilot and two passengers escaped with minor injuries; two passengers drowned.

The report said that fatigue possibly was a contributing factor in the accident. The pilot told investigators that he had been engaged in office duty and flight duty for 19 consecutive days.

HELICOPTERS

Simulated Engine Failure Turns Real

Eurocopter AS 332L2 Super Puma. Minor damage. No injuries.

During a proficiency check the night of Nov. 20, 2007, the training captain used the helicopter's training idle system (TIS) to simulate a failure of the left engine at 39 ft and 28 kt during takeoff from Aberdeen (Scotland) Airport. The pilot-in-training rejected the takeoff and was raising the collective control about 10 ft above the runway to cushion the landing when both pilots heard the sound of an engine accelerating, a bang and the low rotor speed warning. The training captain took control and raised the collective to its travel limit, but the helicopter continued to descend and touched down hard on the runway.

The AAIB report said that the right input drive gearbox freewheel unit had failed, causing the right engine to accelerate rapidly to 115 percent N_1 (low-pressure rotor speed), and the overspeed protection system had automatically shut down the right engine. Sensing a decrease in right engine speed, the TIS had commanded an increase in power from the left engine.

The freewheel unit disconnects the main rotor from the engine if the engine fails or is shut down. Failure of the freewheel unit in the accident helicopter was traced to excessive internal wear.

Investigators found no record that tests were conducted during development or certification of the TIS to simulate failure of the operating engine while the TIS is in use. Moreover, the report said that the flight manual supplement for the TIS "does not appear to accurately reflect the behavior of the helicopter or the technique to be employed following a failure of the operating engine and may provide a false sense of security."

Based on these findings, the AAIB recommended that Eurocopter and EASA revise the information in the flight manual supplement based on data gathered during flight tests of the system.

Control Lost in Downwind Takeoff

Robinson R44 II. Destroyed. Four fatalities.

The helicopter was departing from a logging road in forested, mountainous terrain near Easton, Washington, U.S., the afternoon of Aug. 2, 2007. Density altitude was 6,841 ft, and the R44 was 77 lb (35 kg) over maximum gross weight for hovering out of ground effect, the NTSB report said.

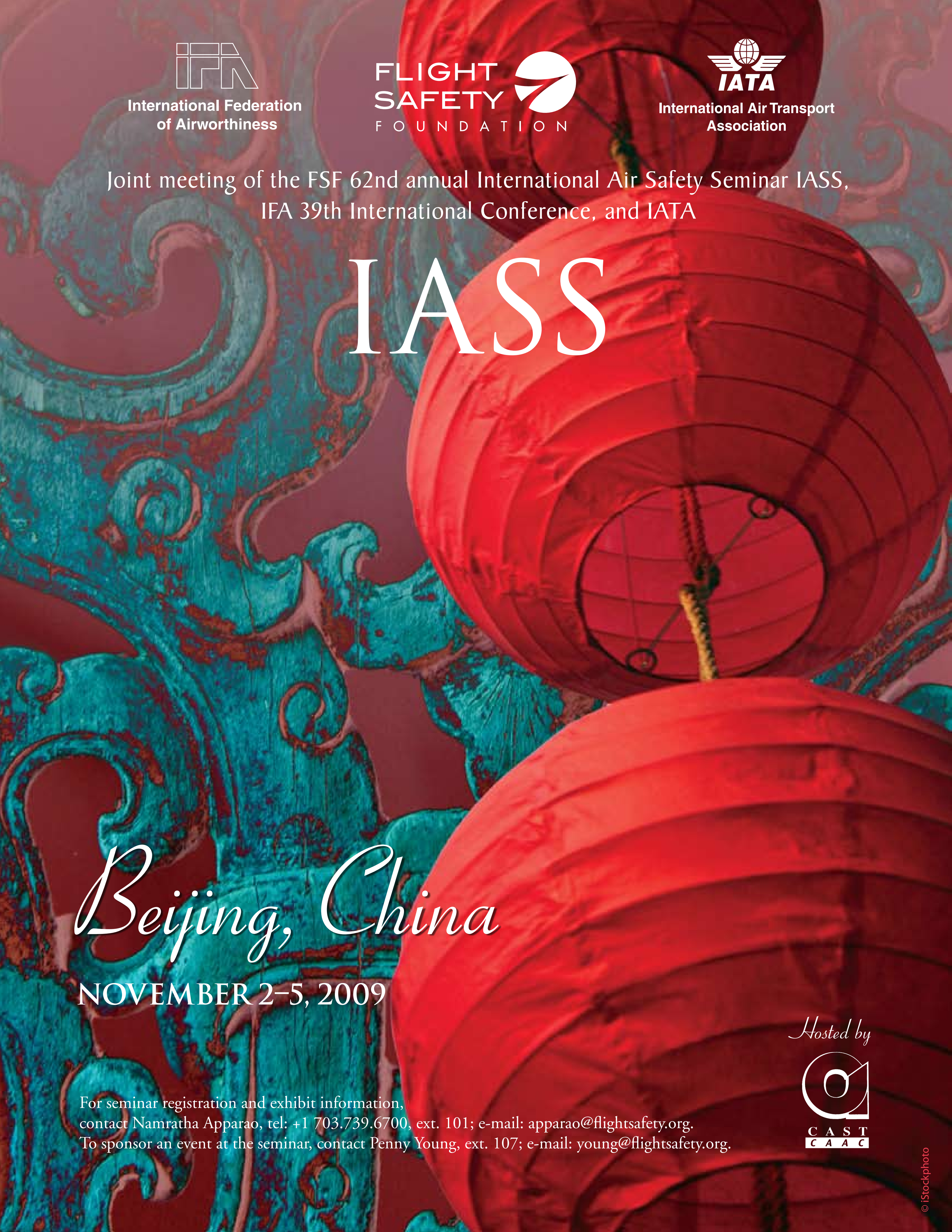
Winds were from the west at 8 kt, gusting to 16 kt when the R44 lifted off. "A witness observed the helicopter lift off vertically, oriented in a southerly direction, to an altitude of about 40 ft before turning 90 degrees to the left and proceeding down the hillside to the east," the report said. "The helicopter began to sway back and forth after traveling about 100 to 150 ft [30 to 46 m], then it impacted the ground in a nose-low, left-bank attitude."

Examination of the R44 revealed no sign of a pre-impact anomaly. NTSB determined that the probable cause of the accident was the pilot's loss of control during an attempted downwind takeoff in high density altitude conditions.

Preliminary Reports, May 2009				
Date	**Location**	**Aircraft Type**	**Aircraft Damage**	**Injuries**
May 1	Cerro Chirripó, Costa Rica	Bell 206	destroyed	2 fatal
The helicopter was on an aerial photography flight when it crashed in the jungle.				
May 8	Riyadh, Saudi Arabia	McDonnell Douglas MD-90-30	substantial	8 none
The MD-90 veered off the runway while landing at Riyadh during a positioning flight from Jeddah. The right main landing gear collapsed.				
May 9	Minden, Nevada, U.S.	Beech A55 Baron	destroyed	5 fatal
After a low pass over an outdoor party, the Baron entered a steep climbing left turn, stalled and descended to the ground.				
May 10	Utila, Honduras	British Aerospace Jetstream 32	destroyed	1 fatal, 2 minor
Night instrument meteorological conditions prevailed when the Jetstream crashed near the Utila airport after its fuel was exhausted. Authorities reportedly found 1,500 kg (3,307 lb) of cocaine aboard the airplane.				
May 10	Port Sudan, Sudan	Piper Twin Comanche	destroyed	2 fatal
The airplane struck mountainous terrain about 26 nm (48 km) northwest of Port Sudan during a flight from Luxor, Egypt.				
May 11	Johannesburg, South Africa	Boeing 747-400	none	NA
During takeoff, the thrust reverser unlock lights for the no. 2 and no. 3 engines illuminated at 124 kt and 163 kt, respectively, and the slats retracted just before rotation. Climb rate was 200 fpm. The flight crew dumped fuel, returned to the airport and landed the 747 without further incident.				
May 14	Guatemala City, Guatemala	Piper Aztec C	destroyed	6 fatal
The Aztec crashed in a residential area shortly after departing for a flight to Belize.				
May 16	Kaktovic, Alaska, U.S.	Helio H-295 Super Courier	substantial	3 none
The single-piston-engine airplane crashed while landing at 6,200 ft on a glacier during a charter flight.				
May 18	Long Beach, California, U.S.	Cessna 310P, Cessna 172	destroyed	3 fatal
The pilot of the 310 and the pilot and passenger in the 172 were killed when the airplanes collided about 5 mi (8 km) offshore.				
May 19	Miami, Florida, U.S.	Boeing 777-200	none	1 fatal
Heavy rain was falling when a baggage loader fell from the baggage-handling device onto the ramp.				
May 20	Madiun, Indonesia	Lockheed C-130H	destroyed	100 fatal, 14 NA
The airplane was on approach when it struck four houses and crashed in a rice field. The fatalities included two people on the ground.				
May 22	Vitória da Conquista, Brazil	Robinson R44	destroyed	2 fatal
The helicopter was on a night flight from Montes Claros when it crashed on approach.				
May 22	Fallon, Nevada, U.S.	Cessna 320D	destroyed	4 fatal
Strong, gusting winds prevailed when the airplane crashed while maneuvering to land.				
May 23	Puchkirchen, Austria	Bell 206B	destroyed	4 minor
The JetRanger crashed in a field during an emergency landing. Part of a rotor blade was found 200 m (656 ft) from the accident site.				
May 23	Porto Seguro, Brazil	Raytheon B350 King Air	destroyed	14 fatal
The King Air crashed 200 m from the runway threshold during a night approach.				
May 25	Daytona Beach, Florida, U.S.	Rockwell Aero Commander 500S	destroyed	1 fatal, 1 serious
The pilot reported a problem during departure and attempted to return to the airport. The airplane stalled and crashed 200 ft (61 m) from the runway.				
May 26	Isiro, Democratic Republic of Congo	Antonov An-26	destroyed	3 fatal, 1 serious
The An-26 was on a cargo flight from Goma when it crashed on approach to Isiro.				
May 30	Lahore, Pakistan	ATR 42-500	substantial	47 NA
The airplane veered off Runway 36R while landing, struck a drainage ditch and came to a stop on the parallel runway. No fatalities were reported.				
May 31	Atlantic Ocean	Airbus A330-203	destroyed	228 fatal
The A330 crashed about four hours after departing from Rio de Janeiro, Brazil, the night of May 31 for a flight to Paris. Strong convective activity was reported in the area.				

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.


International Federation of Airworthiness
FLIGHT SAFETY FOUNDATION
IATA
International Air Transport Association
Joint meeting of the FSF 62nd annual International Air Safety Seminar IASS,
IFA 39th International Conference, and IATA
IASS
Beijing, China
NOVEMBER 2–5, 2009
Hosted by
CAST
CAAC
For seminar registration and exhibit information,
contact Namratha Apparao, tel: +1 703.739.6700, ext. 101; e-mail: apparao@flightsafety.org.
To sponsor an event at the seminar, contact Penny Young, ext. 107; e-mail: young@flightsafety.org.
© iStockphoto