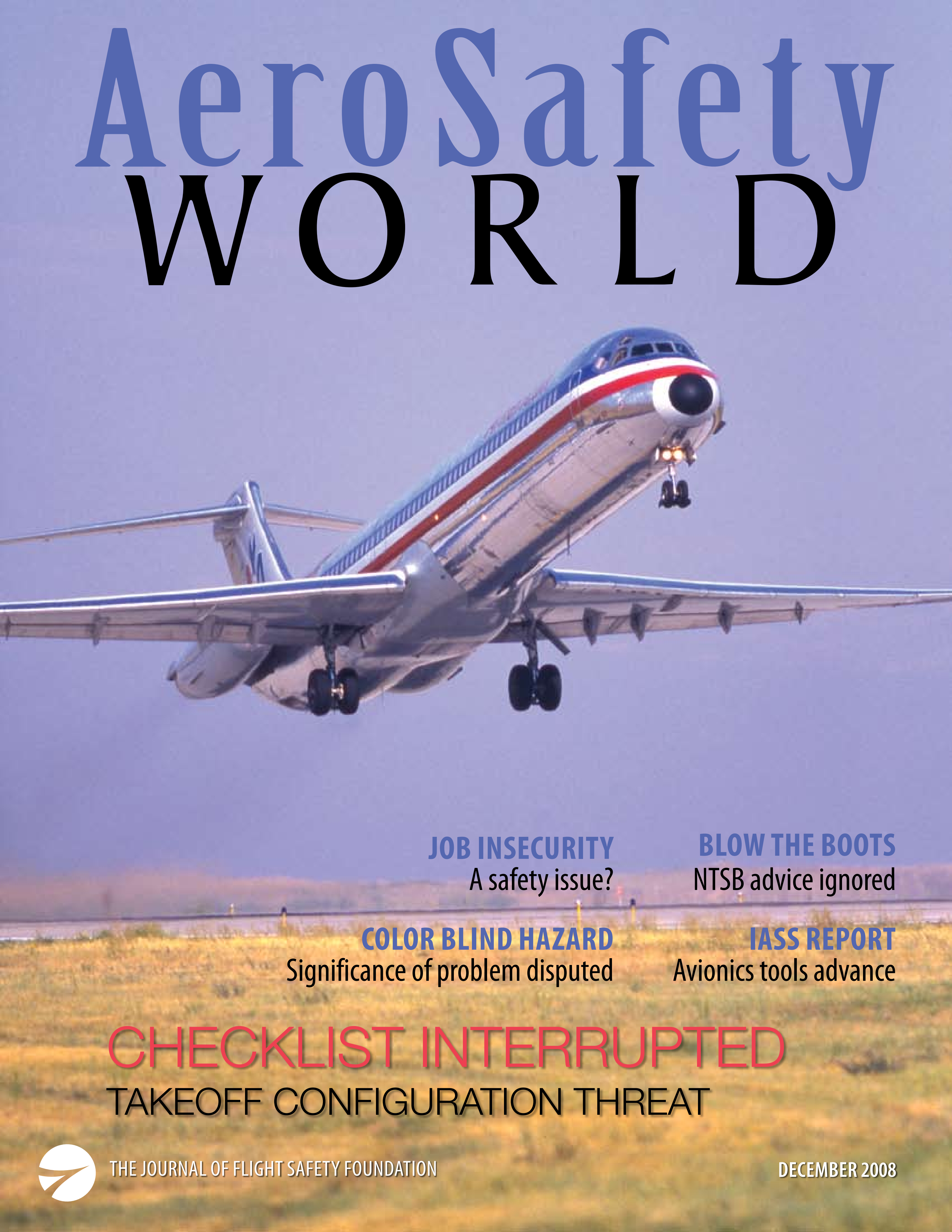
AeroSafety WORLD



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A safety issue?

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COLOR BLIND HAZARD
Significance of problem disputed

IASS REPORT
Avionics tools advance

CHECKLIST INTERRUPTED
TAKEOFF CONFIGURATION THREAT

THE JOURNAL OF FLIGHT SAFETY FOUNDATION
DECEMBER 2008

DATA Gaps

We know how to run a safe aviation system; we're pretty sure about that. Not perfectly safe, but far safer than most people thought possible several decades ago. One of our most powerful safety tools, as you've heard us say over and over, is the careful collection and analysis of data from accidents and incidents.

We at Flight Safety Foundation have believed that the best use of our time would be spreading knowledge about this process to places around the developing world where there are many of the types of accidents that this process can stop.

But safety system gaps in the developed world sometimes reveal that there is much other work yet to be done there, as well.

At the International Air Safety Seminar in Honolulu this past October, two presentations illuminated the lack of attention being paid to the maintenance process.

Mick Skinner, deputy director (engineering) with the U.K. Confidential Human Incident Reporting Program (CHIRP), said that studies of eight years of maintenance error data indicated "that regardless of the investment in training and a focus on maintenance staff, the same errors were occurring year on year with very little change being realized."

The solution, he said, is two-pronged: First, develop the capability for safety management, including an empowered safety structure and — surprise — data collection processes; and second, gain employee trust of the safety management system (SMS). Sound familiar? Skinner's report confirmed that good SMSs do improve the efficiency and effectiveness of the maintenance process, which equals increased safety margins.

But it was Philip Hosey, technical committee member, International Federation of Airworthiness, who highlighted a gap we should have seen earlier: "Every accident and most incident reports provide data on the overall and recent experience of the flight crew, even if this factor has no bearing on the accident. Few, if any, accident reports give similar data for the person or persons involved in the maintenance considered to be the causal factor. Why?

"Almost every accident report we have ever seen faithfully and properly sets out the qualifications, experience and recent duty periods of the crew, as required by International Civil Aviation Organization Annex 13. The same can be said for almost all incident reports. We would like someone to show us equivalent data for maintenance staff who are implicated in an error leading to or contributing to an accident!"

Without data, it is nearly impossible to build a case either for or against the damaging effects of fatigue on the maintenance floor on the basis of accidents and incidents tied to maintenance errors by tired crews.

Ramp workers also might be prone to make dangerous mistakes when tired, Hosey said, but once again there is little data on which to base a judgment.

In this same vein, a few days ago I read a Federal Aviation Administration report on vehicle drivers' errors on the airport surface. The author of this piece was surprised to discover that the drivers were sometimes not asked how they got so confused. Rather, the cause was inferred by observed behavior, and the assumed cause is what got "fixed." The questions must be asked.

During these tough economic times we hear the phrase, "Cash is king." I propose a grammatically incorrect variant of that be enshrined in aviation managers' offices around the world: "Data is king."

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

AeroSafetyWORLD

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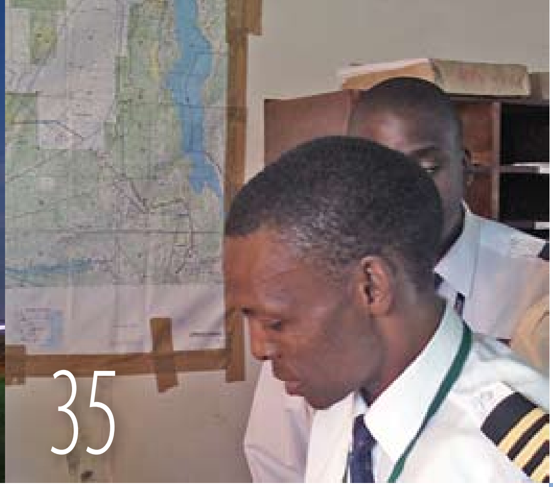

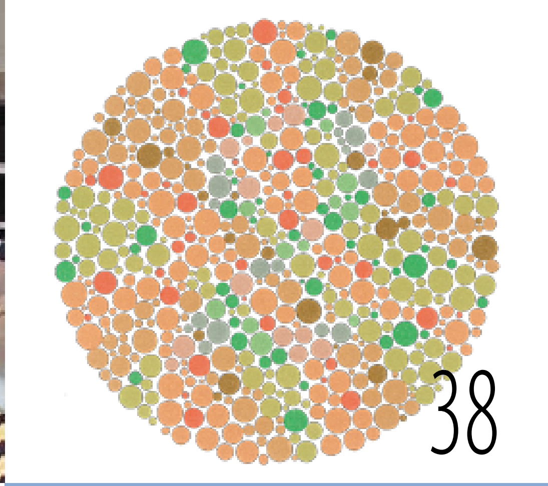

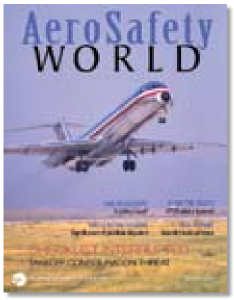

About the Cover
Checklist interruptions can threaten correct aircraft configuration.
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If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about aviation safety, we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

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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.

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Adapting the rules

One of the reasons for Bill Voss's message [*ASW*, 8/08, p. 1] that the aerospace community is getting the point, but that the rest of the world needs convincing, is that the rules as devised by politicians also leave something to be desired. Hence, everywhere around the world rules are bent, because these rules are not perfect.

It is the same with aerospace procedures; usually they are made after the design of a new ATC system or aircraft. Seldom are the procedures made first and then the system designed to meet these procedures. The net result is that we adapt the procedures and hope that the crews around the world will manage the difficulties, and guess what, they do quite admirably.

What fascinates me so much is what happens at an airport that handles, for instance, 60 aircraft per hour on a dual runway system. As soon as ATC handles aircraft "by the book," this capacity drops to, say, 40 aircraft per hour. In my opinion, that means the procedures devised to handle these 60 aircraft per hour were wrong in the first place.

In any case, if politicians and lawmakers, judges, etc. wonder why we do business like we do — ever since these wonderful 1944 ICAO rules (the material coming from accidents can only be used for analysis to prevent the next one from happening, not to prosecute people) which has made this system so safe and far better — safer than any political system — then tell them that their system is not perfect either, that what is missing are primarily reasonable laws and rules, and sadly more often than not they are definitely not reasonable.

The good news is that aerospace rules are usually reasonable. That's a big advantage.

Rudi den Hertog
Fokker Services

More on the great footrest question

Editor's note: *Continuing a discussion that began in Air Mail,* ASW *9/07, Mr. Chaney wrote that "it is beyond me why any aircraft manufacturer would put a footrest in the cockpit in the first place, or an operator would allow such a device in the cockpit, especially if it is collocated with any instrument or controls."*

Being a regular reader, from cover to cover, of *AeroSafety World*, I was astonished to read Mr. Mark S. Chaney's letter. I'm wondering if *ASW* regards this letter as a contribution for safety in aircraft design, concerning cockpit footrests, or to improvement in cockpit procedures, concerning footrest use.

Mr. Chaney's opinion seems to me totally foreign to professional aviation knowledge. This would be just tolerable in the general press, but surely not in a professional publication. Or am I just missing something about flight safety standards, or the editor's criteria in *ASW*? The publication of such a letter doesn't favor *ASW*'s credibility.

Manuel Chagas
Airline pilot (A310)
Portugal

The editor replies: *When we print a letter, that does not mean we endorse the thoughts expressed in the letter or the letter writer. Mr. Chaney is in change of a number of airplanes, and we thought it was interesting that someone in such a position would hold this opinion, and we wanted to share that knowledge with everyone else. Knowing the range of thought that exists in the industry on all matters can help in formulating changes and strategies.*

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>.

DEC. 1-3 ➤ 5th Annual FAA International Aviation Safety Forum. U.S. Federal Aviation Administration. Washington, D.C. Victoria Frazier, <victoria.frazier@faa.gov>, <www.faa.gov/news/conferences_events/2008safetyforum>, +1 202.267.3781.

DEC. 2–4 ➤ Regional Global Aviation Safety Roadmap Workshop. AviAssist Foundation. Maputo, Mozambique. <icaoacip@icao.unon.org>, <www.aviassist.org>, +31 (0)20 714.3148/12.

DEC. 3–5 ➤ Emergency Response Planning Workshop. European Joint Aviation Authorities. Hoofddorp, Netherlands. <training@jaat.eu>, <jaa.nextgear.nl/courses.html?action=showdetails&courseid=133>, +31 (0)23 567.9790.

DEC. 8–10 ➤ STAMINA Human Factors Maintenance Training Course. European Joint Aviation Authorities. Hoofddorp, Netherlands. <training@jaat.eu>, <www.jaa.nextgear.nl/courses.html?action=showdetails&courseid=26>, +31 (0)23 567.9790.

DEC. 10–11 ➤ Human Factors Analysis Classification System Workshop. Embry-Riddle Aeronautical University. Las Vegas. Diane Kim, <info@hfacs.com>, <www.hfacs.com>, +1 386.226.4926, 800.320.0833.

DEC. 13–14 ➤ Advanced Airport Safety and Operations Specialist School. American Association of Airport Executives, Guam International Airport Authority and U.S. Federal Aviation Administration. Tamuning, Guam. Teakoe Coleman, <teakoe.coleman@aaae.org>, <events.aaae.org/sites/081005/index.cfm>, +1 703.824.0500, ext. 173.

DEC. 17–19 ➤ Airside Safety Training Course. European Joint Aviation Authorities. Hoofddorp, Netherlands. <training@jaat.eu>, <www.jaa.nextgear.nl/courses.html?action=showdetails&courseid=209>, +31 (0)23 567.9790.

JAN. 13–15 ➤ Safety Manager Course. Aviation Research Group/U.S. Houston. Kendra Christin, <kchristin@aviationresearch.com>, <www.aviationresearch.com/press_detail.asp?id=46>, +1 513.852.5110, ext. 10.

JAN. 19–23 ➤ International Civil Aviation Organization Operational Safety Audit (IOSA) Auditor Training. Aviation Research Group/U.S. Denver. Kendra Christin, <kchristin@aviationresearch.com>, <www.pros-aviationservices.com/iat_training.htm>, +1 513.852.5110, ext. 10.

JAN. 26–28 ➤ 1st CANSO Middle East ANSP Conference. Civil Air Navigation Services Organisation. Jeddah, Saudi Arabia. Marc-Peter Pijper, <marcpeter.pijper@canso.org>, <www.canso.org/Canso/Web/events/middle+east>, +31 23.568.5386.

JAN. 26–28 ➤ Safety Management Systems II. MITRE Aviation Institute. McLean, Virginia, U.S. Cheryl Andrews, <andrewsc@mitre.org>, <mai.mitrecaasd.org/sms_course>, +1 703.983.6275.

JAN. 29 ➤ Safety Management Systems Audit. MITRE Aviation Institute. McLean, Virginia, U.S. Cheryl Andrews, <andrewsc@mitre.org>, <mai.mitrecaasd.org/sms_course>, +1 703.983.6275.

FEB. 3–4 ➤ Aviation Crisis Management 2009. International Airport Review. Abu Dhabi, United Arab Emirates. Georgina Hooton, <ghooton@russellpublishing.com>, <www.regonline.com/builder/site/Default.aspx?eventid=665587>, +44 (0)1959 563.311.

FEB. 10–12 ➤ Aviation Ground Safety Seminar. National Safety Council, International Air Transport Section. Orlando, Florida, U.S. B.J. LoMastro, <B.J.LoMastro@nsc.org>, <www.nsc.org>, +1 630.775.2174.

FEB. 9–12 ➤ Annual International Aircraft Cabin Safety Symposium. Southern California Safety Institute. Torrance, California, U.S. <www.scsi-inc.com>.

FEB. 11–12 ➤ Asian Business Conference and Exhibition (ABACE). National Business Aviation Association. <info@abace>, <www.abace.aero>, +1 202.783.9000.

FEB. 17–19 ➤ Airside Safety Training Course. European Joint Aviation Authorities. Hoofddorp, Netherlands. <training@jaat.eu>, <www.jaa.nextgear.nl/courses.html?action=showdetails&courseid=209>, +31 (0)23 567.9790.

FEB. 22–24 ➤ Heli-Expo 2009. Helicopter Association International. Anaheim, California, U.S. <heliexpo@rotor.com>, <www.heliexpo.com>, +1 703.683.4646.

MARCH 1–4 ➤ 2nd Asian Ground Handling International Conference. Ground Handling International. Bangkok. Jean Ang, <jean@groundhandling.com>, <www.groundhandling.com/GHI%20Conf%202/index.html>, +44 1892 839203.

MARCH 11–13 ➤ AAMS Spring Conference. Association of Air Medical Services. Washington, D.C. Natasha Ross, <nross@aams.org>, <www.aams.org/AM/Template.cfm?Section=Education_and_Meetings>, +1 703.836.8732, ext. 107.

MARCH 17–19 ➤ ATC Global Exhibition and Conference. Civil Air Navigation Services Organisation, Eurocontrol, International Federation of Air Traffic Controllers' Associations and International Federation of Air Traffic Safety Electronics Associations. Amsterdam. Joanna Mapes, <atcevents@cmpi.biz>, <www.atcevents.com>, +44 (0)20 7921 8545.

MARCH 18–20 ➤ MBAE 2009 and Heli-Mex. Mexican Business Aviation Exhibition and Heli-Mex. Toluca, Mexico. Agustin Melgar, <exposint@prodigy.net.mx>, <www.mbaeexpo.com>, +52 333.647.1134.

MARCH 24–26 ➤ Safety Manager Course. Aviation Research Group/U.S. Trenton, New Jersey, U.S. Kendra Christin, <kchristin@aviationresearch.com>, <www.aviationresearch.com/press_detail.asp?id=46>, +1 513.852.5110, ext. 10.

MARCH 29–APRIL 1 ➤ CHC Safety and Quality Summit. CHC Helicopters. Vancouver, British Columbia, Canada. Adrienne White, <awhite@chc.ca>, +1 604.232.8272.

MAY 4–6 ➤ 6th International Aircraft Rescue Fire Fighting Conference and Exhibits. *Aviation Fire Journal.* Myrtle Beach, South Carolina, U.S. <avifirejnl@aol.com>, <www.aviationfirejournal.com/myrtlebeach/index.htm>, +1 914.962.5185.

MAY 12–14 ➤ Safety Manager Course. Aviation Research Group/U.S. Denver. Kendra Christin, <kchristin@aviationresearch.com>, <www.aviationresearch.com/press_detail.asp?id=46>, +1 513.852.5110, ext. 10.

JUNE 9–11 ➤ Aviation Ground Safety Seminar. National Safety Council, International Air Transport Section. Bournemouth, England. B.J. LoMastro, <B.J.LoMastro@nsc.org>, <www.nsc.org>, +1 630.775.2174.

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

EMS Safety 'Most Wanted'

The U.S. National Transportation Safety Board (NTSB) has added enhanced safety in emergency medical services (EMS) flight operations to its list of "most wanted" safety improvements.

"Our Most Wanted List, which was created in 1990, was designed to raise the public's awareness and support for transportation safety issues," said NTSB Acting Chairman Mark V. Rosenker. "The safety issues on this list are critical to improving transportation safety. When acted upon, these recommendations will reduce accidents and save lives."

The NTSB noted that nine fatal helicopter EMS accidents and 35 fatalities occurred between December 2007 and Oct. 15, 2008.

"The safety board is concerned that these types of accidents will continue to occur if a concerted effort is not made to improve the safety of emergency medical flights," the NTSB said. "Specifically, the following actions would help … : implementation of a flight risk evaluation program for EMS operators; establishment of formalized dispatch and flight-following procedures, including up-to-date weather regulations; installation of terrain awareness and warning systems on aircraft; and conduct of all flights with medical personnel on board in accordance with [the stricter regulations that govern commuter aircraft operations]."

The NTSB has recommended these safety actions to the U.S. Federal Aviation Administration (FAA) in recent years but considers the FAA's responses unacceptable.

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The NTSB has scheduled a three-day public hearing on helicopter EMS operations beginning Feb. 3, 2009, in its Washington, D.C., board room and conference center. Robert Sumwalt, the NTSB member who will serve as chairman of the hearing, said the session will "provide an opportunity to learn more about the industry so that possibly we can make further recommendations that can prevent these accidents and save lives."

The 2009 Most Wanted List discusses recommendations in 15 "areas of concern," including six areas that affect aviation operations. In addition to safer EMS operations, the other aviation recommendations are related to runway safety, flight in icing conditions, cockpit image recording systems, improved crew resource management training for on-demand carriers, and reduction in the number of accidents and incidents caused by human fatigue. Other areas of concern involve operations in other modes of transportation.

Opposition to Single-Pilot Cruise

Adoption of the single-pilot cruise concept (SPCC) suggested by some aircraft manufacturers would harm airline flight safety, the International Federation of Air Line Pilots' Associations (IFALPA) says.

SPCC would allow flight crewmembers to rest in an area outside the flight deck for extended periods during cruise, with one pilot remaining at the controls. IFALPA said that the concept would be the equivalent of "flying solo in an aircraft designed to be operated by two pilots. …

"The SPCC is based on the continuing development and introduction of emerging technologies, for example, voice recognition, data-based automation and even electronic flight bag concepts which may include attempts to extend the product's functionality for future use in SPCC operations."

Among the SPCC safety issues raised by IFALPA are the absence of cross-checking while only one pilot is on the flight deck, the absence of fatigue-avoidance countermeasures such as conversation, and no safeguard against inadvertent napping on the flight deck. In addition, existing procedures are based on the assumption of a two-pilot operation, IFALPA said.

"One of the cornerstones of flight safety is redundancy," IFALPA said. "The SPCC provides no backup for the pilot at the controls, should he become unconscious or otherwise incapacitated."

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Protecting Volunteered Safety Information

Flight Safety Foundation has announced support for statutory protection against the release of information gathered by voluntary self-disclosure reporting programs.

"We can and must do everything possible to ensure the continued flow of critical safety information that is increasingly coming under assault in courts around the world," said Foundation President and CEO William R. Voss.

Kenneth P. Quinn, the Foundation's general counsel, told participants in the FSF International Air Safety Seminar in Honolulu in late October, "Since prosecutors and courts are not protecting the confidentiality of voluntarily supplied safety information, legislatures need to step in to prevent critical sources of safety data from drying up."

The Foundation endorsed a plan to grant voluntary self-disclosure reporting programs — such as the aviation safety action program (ASAP), flight operational quality assurance (FOQA) and the aviation safety information analysis and sharing (ASIAS) system — a "qualified exception" from the legal discovery process. U.S. law currently provides such protection for cockpit voice recorder (CVR) recordings and transcripts.

Airlines and civil aviation regulators use the predictive information gathered by these self-disclosure reporting programs to identify threats to safety and to develop strategies to mitigate the threats. Supporters estimate that 98 percent of the safety information obtained through these programs would no longer be available if participants in the programs were exposed to prosecution and reprisals.

The Foundation's action followed a recent judicial decision that ordered the release of confidential ASAP data in a case involving the August 2006 fatal crash of a Comair Bombardier

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CRJ100ER in Lexington, Kentucky, U.S. The judge said that Congress had the authority to extend the same protection to ASAP information that it had to CVR recordings and transcripts but had never done so.

The Foundation also noted several recent criminal prosecutions in Europe that have relied on information voluntarily provided to accident investigators.

Accident Investigation Guidelines

Aviation accident investigators should improve regional cooperation in accident and incident investigation to provide assistance in countries without the expertise to conduct their own investigations, safety specialists said during a meeting sponsored by the International Civil Aviation Organization (ICAO).

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They also agreed that all final accident reports should be made available to the public, and that better coordination is needed between safety investigations and related judicial processes.

The specialists' recommendations will be reviewed by the ICAO Air Navigation Commission, which will submit proposals to the ICAO Council.

During their October meeting, ICAO Secretary General Taïeb Chérif praised investigators for their "important role in the holistic approach to safety pursued by all aviation stakeholders, which is key to air transport's envied position as the safest mode of passenger transportation."

Omari Nundu, president of the Air Navigation Commission, told participants that continued safety improvement can be achieved only through "an unimpeded flow of safety information from sources such as accident and incident investigations, which is not possible when such information is used for other than safety-related purposes."

Red Dye Warning

Maintenance personnel are being warned not to use some types of liquid red dyes in nondestructive testing of critical safety components. The Civil Aviation Safety Authority of Australia (CASA) says that although the dyes are being used increasingly in such tests, "there are limits and prohibitions on their use in aviation."

CASA warns against the use of Type II liquid visible dye in final acceptance of inspection of aerospace products and in conjunction with fluorescent dye penetrant systems.

CASA said in an airworthiness bulletin that before maintenance personnel use dye penetrant in nondestructive testing, they should "familiarize themselves with the applicable standard for the method they employ and the procedure for inspection of the aircraft component or material."

In Other News …

The **U.S. Federal Aviation Administration** (FAA) has convened a government-industry council to implement a systemic approach to improving runway safety. The Runway Safety Council will analyze the root causes of runway incursions. … The **Civil Aviation Safety Authority of Australia** is reviewing the risks presented to aviation safety by wind farms located near airports and determining what regulations would enhance safety.

Correction … An OnRecord item in the October 2008 issue incorrectly stated that the airport traffic control tower at the airport in Keene, New Hampshire, U.S., was closed. The airport is uncontrolled.

Controller Convictions Protested

The International Federation of Air Line Pilots' Associations (IFALPA) is asking a Japanese court to overturn the convictions of two air traffic controllers involved in the January 2001 near collision of two Japan Air Lines airplanes.

The two controllers — a student air traffic control officer and his supervisor — were found guilty of professional negligence and given suspended prison sentences in connection with the incident, in which the Boeing 747 and McDonnell Douglas DC-10 came within 100 m (328 ft) of each other. A number of passengers and crewmembers were injured during evasive maneuvers by the crew of one of the airplanes.

© Victoria Alexandrova/iStockphoto

"To pursue this conviction not only does nothing to improve safety in air transport, it may actually harm it," IFALPA said, calling on the Japanese government to enact legislation to enable the Japanese courts to comply with International Civil Aviation Organization provisions that discourage criminal prosecution of aviation personnel for their involvement in accidents or incidents.

WAAS Approaches Becoming Common

Wide area augmentation system (WAAS)-based area navigation instrument approaches in the United States now outnumber ground-based instrument landing system (ILS) approaches, the U.S. Federal Aviation Administration (FAA) says.

U.S. Federal Aviation Administration

The FAA said that it passed a "key milestone" in September, with publication of the 1,333rd WAAS-based localizer performance with vertical guidance (LPV) approach. The LPV approaches serve 833 airports.

"This is clearly a turning point for aviation and the way pilots navigate," the FAA said.

Plans call for publication of 500 new WAAS-based instrument approach procedures every year "until every qualified runway in the [national airspace system] has one," the FAA said, noting that WAAS improves safety by increasing the number of approaches with vertical guidance.

WAAS was commissioned in 2003 to improve the accuracy of information received from global positioning system (GPS) satellites. A 2003 Flight Safety Foundation study found that the use of WAAS-based instrument approaches could prevent 141 accidents and 250 fatalities over a 20-year period.

TOW Checks Required

Flight crews on airplanes in the McDonnell Douglas DC-9/MD-80 series must add a check of the takeoff warning (TOW) system before starting the engines for every flight, according to an airworthiness directive issued by the European Aviation Safety Agency (EASA).

The TOW system warns flight crews if flaps and slats have not been correctly set.

The EASA action follows the issuance by Spanish investigators of a preliminary report on the Aug. 20 crash of a Spanair DC-9-82 on takeoff from Madrid. The airplane was destroyed in the crash, which killed 154 people and resulted in serious injuries for 18. Preliminary indications were that the flaps were not set properly for takeoff. Investigation of the crash is continuing.

The European Joint Aviation Authorities simultaneously issued an operational directive for operators of the same aircraft, calling for operators to include the TOW check in the prestart checks for every flight.

Compiled and edited by Linda Werfelman.

DEADLY

Human memory fails in predictable patterns that can be avoided by paying close attention to SOPs when distractions occur.

© André Garcez/Jetphotos.com

BY ALAN DEAN AND SHAWN PRUCHNICKI

In August 1987, a McDonnell Douglas DC-9 flight crew taxiing to Runway 03C at Detroit Metropolitan Wayne County Airport (DTW) failed to conduct the taxi checklist. Consequently, the flaps were never set for takeoff, causing the lift-deficient aircraft to crash immediately after takeoff. As a result, 156 souls perished when the aerodynamically stalled aircraft crashed in a parking lot just off the end of the runway.

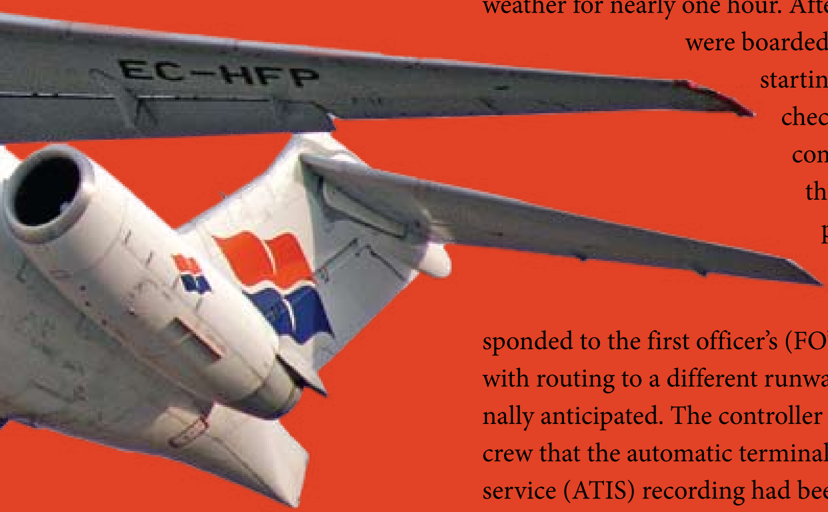
Nearly 21 years later, in January 2008, a Bombardier CRJ200 crew committed the identical checklist omission at another major U.S. Midwest airport. However, instead of the omission culminating in a fatal accident, a "config flaps" aural warning sounded and the takeoff was safely aborted.

In the case of the DTW DC-9, the aural warning never sounded. And, although the reason for the failure of the warning system was never determined, it is important to understand that the system's failure is the only variable that separates the DC-9 crash from the CRJ aborted takeoff. Aside from this single difference, these two events are human factors equivalents of identical twins.

Omissions

Alarmingly, these types of events may be more common than realized. Preliminary investigation of the August 2008 Spanair McDonnell Douglas MD-82 takeoff accident in Madrid, Spain, found that the aircraft's flaps were in the retracted position. A recent study of the U.S. National Aeronautics and Space Administration's Aviation Safety Reporting System data base revealed numerous reports of airline crews failing to properly configure flaps for takeoff. Seeking to understand the human factors commonalities of these types of incidents, we assembled summaries of the DC-9 and CRJ events.

Boarding of the DC-9 had been delayed by weather for nearly one hour. After passengers were boarded, the before starting engines checklist was accomplished and the aircraft departed from the gate. Ground control responded to the first officer's (FO's) taxi request with routing to a different runway than originally anticipated. The controller also advised the crew that the automatic terminal information service (ATIS) recording had been updated to include a warning that low-level wind shear advisories were in effect due to convective activity in the area.



This Spanair MD-82 crashed on takeoff from Madrid with retracted flaps.

As the captain (CA) initiated taxi, the FO obtained the new ATIS information and recalculated takeoff performance numbers. While the FO was "head down," visually focused inside the cockpit, the CA passed by an assigned taxiway. Ground control redirected them, and the taxi resumed with some miscellaneous conversation regarding the earlier weather delay. This delay was significant because the crew's next flight was to an airport with an arrival curfew.

Seven minutes after leaving the gate, the DC-9 crew was cleared to taxi into position and hold on the runway. Although the CA failed to call for the before takeoff checklist, the FO verbalized all associated items prior to receiving a takeoff clearance. As the CA commenced the takeoff roll, the FO was initially unable to engage the autothrottle system. This issue was resolved as the aircraft rapidly approached 100 kt. Next, the cockpit voice recorder (CVR) captured the FO verbalizing "V1," then "rotate," closely followed by the sounds of the stick shaker and subsequent ground impact.

The CRJ crew had completed the before taxi checklist after passenger boarding and requested permission to taxi. As the CA called "flaps 20, taxi checklist," he initiated a right turn as instructed by the controller but quickly realized that this would send them in the wrong direction. Stopping the aircraft, he interrupted the FO's checklist routine in order to seek clarification. Once that issue was resolved, they maneuvered along a congested ramp toward their assigned runway. As soon as they reached the runway, the tower controller cleared the crew for immediate takeoff. The line-up checklist was called for and the FO read it, concluding with, "Takeoff config okay … line-up check complete." Aircraft control was then transferred to the FO, who began advancing the thrust levers. The "config flaps" aural warning immediately sounded, and at approximately 30 kt the CA aborted the takeoff.

External Pressure

From the narratives, it is apparent that both crews experienced external pressures to expedite their departures. For the delayed DC-9's crew, it was an airport arrival curfew, while the CRJ crew felt rushed when they were cleared for immediate takeoff.

Both crews likewise encountered distractions as soon as they departed from their gates. For the DC-9 crew, as the taxi began it became necessary to obtain updated ATIS information and confirm performance data for the unexpected runway change. The CRJ crew received erroneous taxi instructions which needed clarification. It is important to note that both crews' distractions came at the exact point when the flaps would normally be extended for takeoff according to the taxi checklist.

But to simply say these flights were plagued with errors resulting from rushing and distractions is too simplistic. Many more insidious threats were lurking on each flight deck; threats and human limitations which went untrapped — that is, undetected and unmanaged — ultimately causing both crews to skip entire checklists. Some of those threats included experience/repetition, memory problems, expectation bias and checklist discipline.

Experience and Repetition Threats

So, how do experienced pilots omit entire checklists? Clearly, experience has many benefits, but experience can also undermine even the most seasoned experts when they are conducting repetitive tasks such as running a checklist.

The first critical concept is that, as experience is gained, repetitious tasks such as conducting checklists become cognitively ingrained as simple flow patterns. Consequently, a pilot can automatically move from checklist item "A" to item "B" to item "C" with minimal mental engagement.

The second important concept is that each subsequent checklist item (A, B, C …) is mentally cued to be accomplished by the *perception* that the preceding item has been completed.

And third, initiation of a repetitious task such as a checklist must be prompted by a cue. This initiating cue can come from a verbal command ("flaps 20, taxi checklist"), a condition (engine fire) or even an environmental indicator (proximity to the runway). And here is where the threat lies. Interruptions, distractions and deviations from standard operating procedures (SOPs) can break mental flow patterns, create false memories and even mask or eliminate initiating cues. As demonstrated by the flap-setting omission by both flight crews, the end result may be a significant failure that goes untrapped.

In the DC-9 and CRJ scenarios, each crew encountered immediate interruptions as they began to taxi. This is significant because taxi initiation and proximity to the gate are typical conditional and environmental cues prompting pilots to execute the taxi checklist. In effect, the interruptions of having to obtain ATIS information and clarify taxi instructions masked those cues, leading to omission of the checklist which called for flap extension. Then, as the aircraft continued toward their departure runways, the crews continued to move even farther away from the environment which could have reminded them to perform the taxi checklist.

Furthermore, as each crew approached the runway, new cues were encountered prompting them to execute other checklists. For the CRJ crew, nearing the runway was an environmental cue to run the before takeoff checklist. By now the crew was mentally so far from the earlier taxi check that there was little hope that the omitted checklist would be remembered.

Memory Threat

There is another elusive human factors threat associated with repetitive tasks that can harmfully influence human memory. Specifically, when presented with cues which are frequently associated with conducting a particular task — such as entering the runway cues the line-up checklist — the brain can actually plant false memories of events that never occurred. This phenomenon is especially prevalent after interruptions.

For example, it is highly likely the CRJ crew intended to perform the taxi checklist after sorting out their taxi instructions. In fact, the CA originally called for the checklist as the aircraft began to move. But then he immediately interrupted the FO from initiating the checklist to clarify the taxi routing. In interruption scenarios like this, the mind can create false memories based on previous experiences. So, later, when running the before takeoff checklist, the errant crew may have falsely "remembered" completing the taxi checklist. That false memory was created out of the hundreds of other flights in which a checklist would have been completed at that point in the taxi.

This concept is known as *source memory confusion*. Humans are especially susceptible to source memory confusion when interrupted or rushed, variables which existed for both the CRJ and DC-9 crews.

Another human weakness related to memory is that, generally, humans are not good at remembering to perform tasks which have been deferred for future execution. Known as *prospective memory failure*, a deferred task is often forgotten until an overt indication — for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example, a "config flaps" aural warning — alerts us to our omission. A simple example is when a controller requests a pilot to advise him when "proceeding direct" following a course deviation for weather. This deferred task often is forgotten until the pilot is queried by air traffic control, "Are you direct now?"

Obviously, both FOs made a decision to delay extending the flaps; clearly, the deferred task was not remembered. The CRJ crew received an overt indication of their omission when the "config flaps" aural warning sounded; the DC-9 crew was less fortunate.

Obviously, both FOs made a decision to delay extending the flaps; clearly, the deferred task was not remembered.

Expectation Bias Threat

Another threat that lurked on both the CRJ and DC-9 flight decks is known as *expectation bias*. In simple terms, expectation bias is "seeing" what you expect to see even when it is not there. In the case of the CRJ departure, the final item on the line-up checklist is verifying that the "T/O CONFIG OK" advisory message is posted on the electronic display. Among other things, the message confirms that flap settings are appropriate for takeoff. Even though it was not posted, the FO revealed in a post-incident debrief that he "thought" he saw the message.

Understanding such an aberration is difficult, but one explanation provides a plausible answer. Experience conditioned the FO because he always saw "T/O CONFIG OK" displayed when taking the active runway. With an established 100 percent success rate of always seeing the message, expectation bias may have led him to believe that it was present. Perhaps a casual glance at the electronic display was adequate for expectation bias to take place — the FO "saw" the message he was expecting to see.

Checklist Discipline Threat

Aircraft and procedures are designed with multiple layers of defenses to prevent errors from developing into accidents. The DC-9 CVR recording concludes with the sound of the stick shaker, another layer of defense. Under normal circumstances, a crew receiving a stick shaker warning would decrease pitch and increase thrust to rectify a slow speed encounter. However, not realizing the aircraft's insufficient lifting capabilities, the DC-9 CA increased the pitch angle, assuming the reason for the stick shaker was a wind shear encounter. His decision in a time-critical environment was not unfounded, as the ATIS noted that low-level wind shear advisories were in effect. However, post-accident investigation revealed no wind shear involvement.

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So, although the aircraft's stall warning system functioned properly, the captain's misperception of a wind shear event negated the aircraft's built-in defenses. This outcome highlights the extreme importance of the layer of defense existing just prior to the aircraft's defenses — the human layer. It also exposes how human error and limitations can readily defeat multiple, robust layers of defense.

And, like aircraft defensive systems, human defensive systems function through sophisticated algorithms. On the flight deck, one of those algorithms is the checklist.

From the narrative, it is apparent that the DC-9 CA never requested the taxi or before takeoff checklists in accordance with SOPs. By not following standard checklist protocols, the CA became reliant upon the FO to ensure that necessary procedures were accomplished. Because of this SOP deviation, it is conceivable that the FO was task-saturated, having to obtain the new ATIS information, confirm takeoff data, perform his normal functions and anticipate checklists the CA failed to request.

Additionally, the CA's reliance on the FO to conduct checklists on his own accord negates a critical two-pronged safety factor associated with checklist design. When correctly applied, the proper method is for a pilot to call for a checklist based upon the flight phase and which pilot is flying the aircraft. As a backup, if the designated pilot fails to call for a checklist, the other pilot should issue a challenge. By transferring checklist initiation to one pilot, that critical safety backup is nullified.

A CA can transfer responsibility for checklist initiation passively or actively. He or she can actively promote the transfer by telling the FO to "run the checklists at your leisure." Alternatively, the CA can passively transfer checklist responsibility by allowing an overly assertive FO to simply run checklists without being commanded. Either way, the practice is not acceptable because it greatly undermines a critical layer of defense. Both pilots must retain their shared responsibility to ensure that checklists are completed.

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A mental slip and a warning system failure doomed this DC-9 in Detroit.

Cognitive Saturation

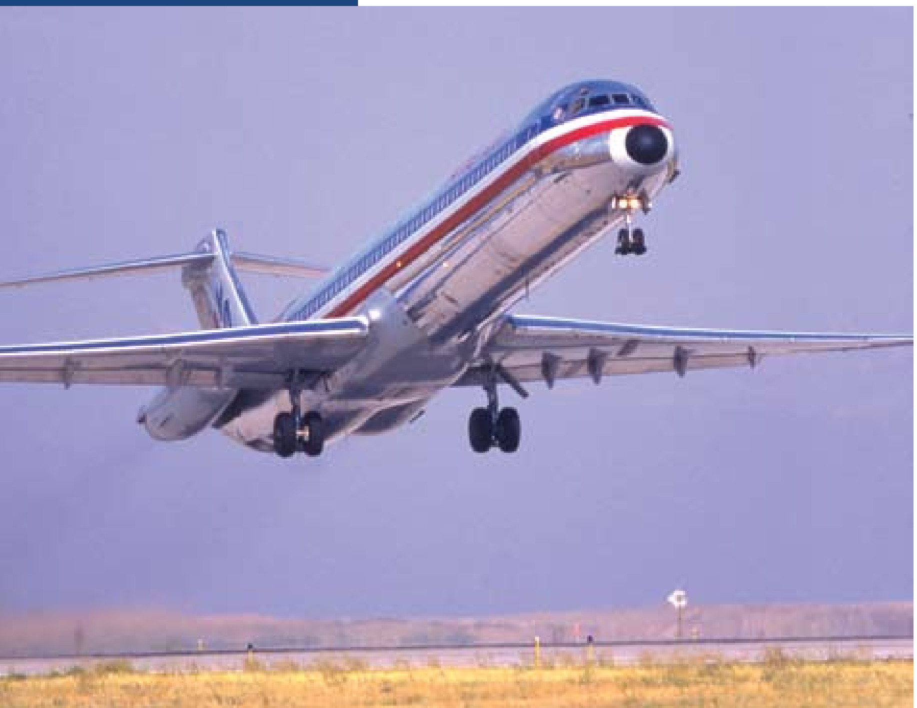
Maintaining a "sterile cockpit" merits discussion here as well. The human brain has amazing capabilities. But, like a computer, each task accomplished and each variable assessed places cognitive demands on the brain. When these demands exceed an individual's capacity, newly presented information may not be perceived or understood.

This situation is referred to as *cognitive saturation* and its occurrence prevents the accomplishment of further tasks. Even the act of ignoring nonpertinent conversation requires mental effort, which may compromise safety. For example, while listening to a CA speak about his weekend plans, an FO may fall victim to source memory confusion, causing him to incorrectly believe he's completed a checklist.

Some argue that light conversation serves to facilitate crew bonding. While this is true, the timing of such conversation must respect cognitive limitations and the safety advantages of adhering to sterile-cockpit regulations.

Mitigation Strategies

These threats represent inherent weaknesses associated with the flight deck environment and the professionals who strive to perform flawlessly within it. Unfortunately, a minor slip or deviation from SOPs can put crew and passengers in harm's way. Individually, some violations are seemingly inconsequential — an incomplete taxi briefing, or a minor violation of the sterile cockpit rule. But when combined



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with other lost layers of protection, sometimes unknown to the crew, the margin of safety can rapidly erode, causing the flight to slip closer to an accident.

When presented with threats, professional pilots want to know how to counter them. The following mitigation strategies outline proven techniques to overcome normal human limitations that may erode safety margins:

- Recognize that interruptions can alter human behavior and seriously erode safety margins. Interruptions are threats and should be regarded as accident precursors. Treat any interruption with caution.
- Overcome prospective memory failure by clearly informing your flying partner if interruptions or operational necessity dictate delaying a checklist. When doing so, also verbalize a specific plan detailing when the delayed task will be accomplished. This can enable the other crewmember to confirm that the task will be performed.
- Understand that memory is heavily influenced by cues. A memory aid recognized by both crewmembers can serve as a reminder to perform a delayed task.
- If interrupted while performing a checklist, re-run the entire checklist. Doing so greatly reduces the probability of succumbing to source memory confusion.
- To overcome expectation bias, use the *say-look-touch* confirmation technique. For example, when confirming proper flap settings while conducting a checklist, say what the setting should be, look at the flap position indicator and touch the flap handle. By incorporating multiple sensory inputs, a higher level of task attentiveness is achieved.
- Slow down. Rushing is a primary initiator of human factors related failures, including those associated with repetitive tasks.
- Checklists should be specifically called for by the appropriate pilot in accordance with SOPs. Doing so ensures that the check-and-balance philosophy built into them remains intact. It also enhances situational awareness, as both pilots can remain apprised of the aircraft's status. Do not advocate the idea of executing checklists "at your leisure."

If interrupted while performing a checklist, re-run the entire checklist.

Alan Dean is chief of safety for a large corporate aviation flight department. He also has extensive air carrier experience as an airline captain, line check airman and flight safety manager. For nearly a decade, Dean served as a flight safety investigator for the Air Line Pilots Association, International (ALPA).

Shawn Pruchnicki, a CRJ200 captain with Comair Airlines, is a former accident investigator and director of human factors for ALPA, and has participated in numerous accident investigations. He teaches classes related to system safety, human factors and accident investigation at Ohio State University.

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U.S. Coast Guard

Helicopter operators should be required to do more to make passengers aware of life raft operations, the NTSB says.

Watery WARNINGS

BY LINDA WERFELMAN

Citing the death of an Air Logistics Bell 206L1 passenger while awaiting rescue following a crash in the Gulf of Mexico, the U.S. National Transportation Safety Board (NTSB) is recommending additional information to tell passengers how to activate externally mounted life rafts.

The NTSB cited the Dec. 29, 2007, crash of the Air Logistics helicopter in a letter accompanying two safety recommendations to the U.S. Federal Aviation Administration (FAA). The investigation of the accident was continuing. Preliminary findings indicated that the pilot and all three passengers survived the crash, which occurred in instrument meteorological conditions during the approach to an offshore platform in the Gulf, but one passenger died of hypothermia associated with "asphyxia from drowning" — suffocation because of water in the airway — before rescuers arrived. The other two passengers received minor injuries, and the pilot was seriously injured.

The NTSB said that the three passengers had boarded the helicopter about 1430 local time at a platform in the Gulf for a 20-minute flight to the base platform. The two surviving passengers said that the pilot had not conducted a safety briefing before takeoff.

U.S. National Transportation Safety Board

Life rafts on the Bell 206L1 could be activated from inside the helicopter or by pulling either of two red external T-handles.

The pilot told investigators that, as the helicopter approached the base platform, he encountered a "sloping cloud deck" and a tail wind and observed indications of a "settling with power" event. He said that because of the low altitude, he was unable to recover the helicopter or deploy the emergency flotation devices before the helicopter struck the water. He estimated that weather conditions included ceilings between 300 ft and 500 ft and visibility between 1 mi (2 km) and 5 mi (8 km).

The NTSB letter that accompanied its safety recommendations said that the helicopter was in an "inadvertent descent, which was not arrested before the helicopter impacted the water and rolled to an inverted position.

"Because of the inadvertent descent, the pilot was likely not aware that the helicopter was about to contact the water, and the skid-mounted floats were not activated or deployed before the helicopter entered the water."

After the impact, as water flooded into the helicopter, the pilot and passengers evacuated and inflated their life vests. However, they did not deploy the two external six-person life rafts. Once in the water, the pilot and passengers attempted to swim to the unstaffed base platform, about 100 yd (96 m) away, but they became separated by the 8- to 10-ft (2- to 3-m) swells, a preliminary accident report said.

After about two hours, a fisherman heard the two surviving passengers' cries for help and pulled them, along with the body of the third passenger, into his boat, the NTSB letter said. The fisherman relayed their location to the U.S. Coast Guard, which rescued the pilot about two hours later; because of his lengthy exposure to the water, which was 49 degrees F (9 degrees C), he was "severely hypothermic," the NTSB said.

The helicopter's float assembly consisted of six floats — forward, center and aft floats on both the left and right skids — that were inflated by activation of a float-inflation handle on the pilot-side cyclic. The life rafts were "integral to the center floats" and were designed to inflate when any one of three T-handles — one located inside the helicopter on the pilot's console and the other two outside, on the forward cross tubes — was pulled.

The NTSB said that, during an interview, the pilot "provided no indication why he did not deploy the external life rafts using the internal T-handle when the helicopter entered the water, even though he had received training on external life raft deployments. The pilot stated that, after evacuating the helicopter, he climbed onto its belly and asked the passengers to pull the 'red handle' (that is, one of the external T-handles) for the life rafts but that the passengers could not locate either T-handle. One of the surviving passengers stated that he thought the pilot was referring to the red inflation tabs on their [life vests]. Both surviving passengers stated that they did not know that the helicopter was equipped with external life rafts with external activation handles."

Instructions for operating the T-handle in the cockpit were printed on a placard on the ceiling above the pilot's seat, but there were no placards outside the helicopter describing where the external T-handles were located or how to operate them.

In a 2007 letter to the FAA in support of another safety recommendation, the NTSB cited four helicopter crashes in the Gulf of Mexico in which passengers and crews survived the impact but either were unable to find the life raft or did not have enough time to retrieve it. The 2007 letter also described three other Gulf helicopter accidents in which there were no fatalities; in these accidents, the pilots deployed the external life rafts, and in one of these, the pilot also deployed the floats during autorotation.

"In this accident, if the pilot had deployed the external life raft using any of the T-handles, then the occupants might not have been directly exposed to the 49 degree F water temperature for a prolonged time, and the passenger who died would have likely survived."

In June 2008, the NTSB was told that the manufacturer of the float/life raft system was designing a placard for the external life raft T-handles and planned to issue a service bulletin to make the placard available to helicopter operators, and that the FAA planned to issue a special airworthiness information bulletin (SAIB) to recommend installation of the placard.

Nevertheless, because SAIBs are not mandatory and only float/life raft systems from one manufacturer would be affected, the NTSB issued a safety recommendation in October calling on the FAA to "require operators of turbine-powered helicopters with externally mounted life rafts to install a placard for each external T-handle that clearly identifies the location of and provides activation instructions for the handle."

The recommended action is needed because the NTSB believes that external placards would "assist passengers in finding and activating the external T-handles, especially if the pilot were unable to do so."

The NTSB also recommended that the FAA "require all operators of turbine-powered helicopters to include, in pilot preflight safety briefings to passengers before each takeoff, information about the location and activation of all flotation equipment, including internal or external life rafts."

U.S. Federal Aviation Regulations Part 135, "Commuter and On-Demand Operations," require pilots to ensure before takeoff that all passengers have received oral briefings about the location of survival equipment, and that, if a flight involves "extended overwater operation" — more than 50 nm (93 km) from shore or from an offshore heliport — the briefing must include life rafts and other flotation equipment. The accident flight did not meet the definition of an overwater operation.

The Air Logistics *Flight Operations Manual* contains a requirement for preflight briefings on the location of survival equipment but does not specifically include life rafts among the items to be discussed in such briefings.

The NTSB noted that it had recommended in 1999 that the FAA require preflight briefings on the use of flotation equipment for passengers on air taxi and air tour flights over water at altitudes that "would not allow them to reach a suitable landing area, including those flights less than 50 miles from the shoreline." A subsequent FAA rule issued such a requirement — applicable to air tour operations but not air taxi flights.

"The circumstances of this accident demonstrate the need for passenger briefings on all flotation equipment aboard helicopters, regardless of the distance from a suitable landing area or the shoreline," the NTSB said.

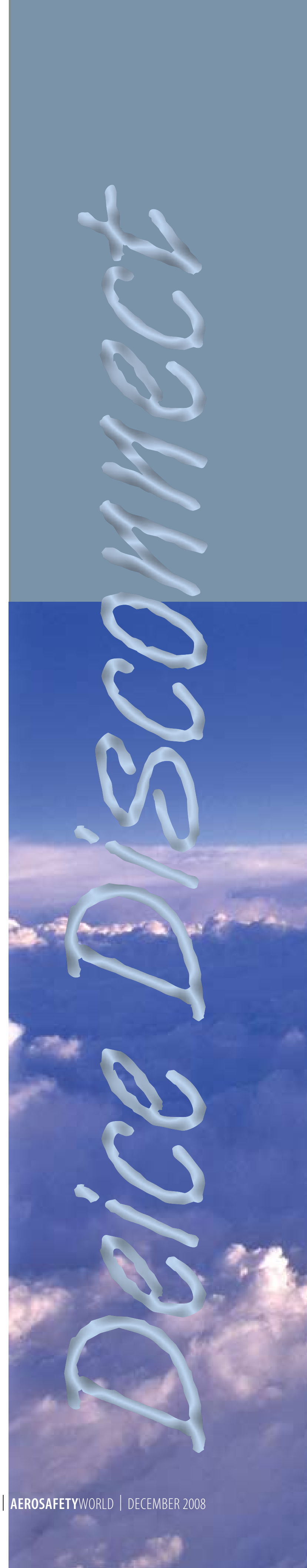
In an interview with accident investigators, the accident pilot gave no indication why he had not conducted the required preflight safety briefing.

"If the accident pilot had provided the passengers with this briefing and if the Air Logistics *Flight Operations Manual* had specifically required company pilots to include, in this briefing, information about the use of flotation equipment, then the passengers might have had a heightened awareness of the existence of the external life rafts and the method by which the life rafts could be deployed," the NTSB said. "Although the passenger safety briefing cards contained information about the external life rafts, briefing cards by themselves are not sufficient for conveying critical safety information because passengers may not read them or fully understand their content."

Both surviving passengers stated that they did not know that the helicopter was equipped with external life rafts with external activation handles.

Further Reading From FSF Publications

FSF Editorial Staff. *Waterproof Flight Operations*, a special issue of *Flight Safety Digest*, September 2003–February 2004, available on compact disc from Flight Safety Foundation.



The U.S. National Transportation Safety Board (NTSB) is pointing to a recent ice-related accident involving a Cessna Citation as yet another product of what NTSB Chairman Mark Rosenker calls "the ongoing disconnect" between traditional guidance about cycling pneumatic deice boots and research that has shown the guidance to be baseless and dangerous. The board has campaigned for more than 10 years to change both the outdated guidance and the habits it has fostered. The apparent problem for NTSB and others seeking change is that a substantial number of people in the aviation industry have not been convinced that change is necessary.

Generations of pilots have been taught to wait until a specific amount of ice accumulates on the wing leading edges before cycling pneumatic deice boots. Traditional training warns pilots that premature activation of the boots could make them prey to a hazardous phenomenon called *ice bridging*, which renders the boots useless beneath a bridge, or sheath, of ice.

The report on the March 17, 2007, Citation 500 accident, published in August, is brief, a product of what NTSB calls a "limited" investigation, but highlights the board's decade-long effort to change the way deice boots are operated.

'No Buffet, No Warning'

The Citation pilots were conducting an air ambulance flight from their base in Punta Gorda, Florida, to Beverly, Massachusetts, with a paramedic, an emergency medical technician, a patient and the patient's husband aboard.

The pilot, 45, had 4,950 flight hours, including 3,200 hours in type. The copilot, 60, held a Boeing 737 type rating and had 25,982 flight hours, including 25 hours in the Citation. The airplane was built in 1974 and had accumulated more than 22,000 hours of operation. It was not equipped with an ice-detection system or a stall-warning device such as a stick shaker. Stall warning is provided aerodynamically with inboard wing leading edge strips that cause buffeting 5 kt above stall speed in the landing configuration. This assumes an uncontaminated airframe; stall speed increases as ice accumulates.

Beverly Municipal Airport was reporting surface winds from 310 degrees at 8 kt, 1 mi (1,600 m) visibility in mist and a 500-ft overcast. A circling approach to Runway 34 was in use, but the pilots told air traffic control that their operations manual prohibited circling approaches when the ceiling is lower than 1,500 ft. They requested and received clearance to conduct the global positioning system approach straight in to Runway 16.

The pilots activated the anti-ice systems when the airplane entered clouds at 3,500 ft (Figure 1). "Moments later, the copilot noticed that they were picking up a trace amount of rime ice on the windscreen," the report said. "However, since neither pilot saw any ice on the wings, the deice boots were never activated."

The pilots acquired visual contact with the airport as the airplane neared the minimum descent altitude, 600 ft, and continued the descent at 107 kt — 10 kt above the reference landing speed.

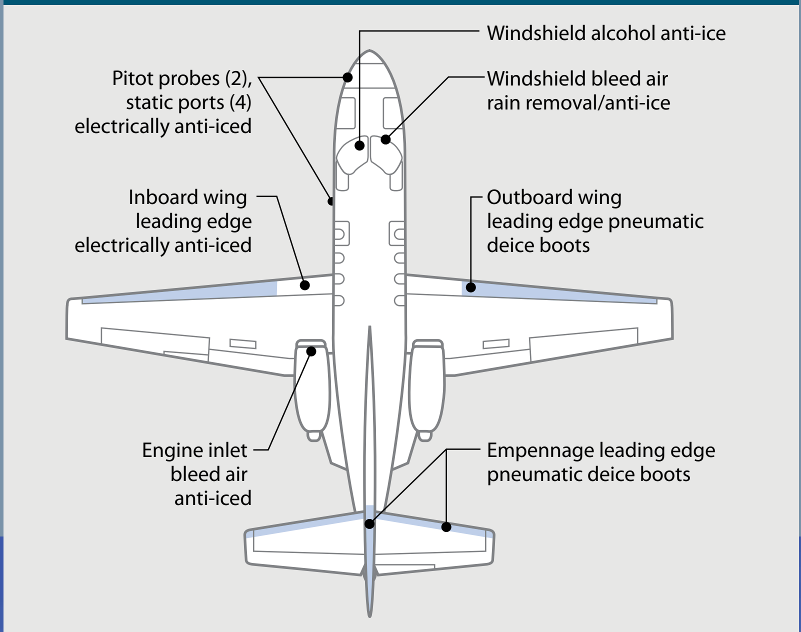
The pilot told investigators that shortly after crossing a treeline, the right wing suddenly dropped. "There was no buffet and no warning, just a sudden loss of lift," he said. "I attempted to roll the wings level and added power to arrest the sink but was unable to before the right wing struck the runway." He said that the airplane then "tracked straight down the runway and was taxied to the ramp without further incident." None of the people aboard was hurt.

'Hollowed-Out Area'

Both pilots believed that the upset had been caused by wind shear. However, no turbulence had been reported, and the flight crew of a Canadair Challenger that was landed on Runway 16 shortly after the Citation said that they had not encountered wind shear on approach.

"After taxiing to the ramp, the [Citation] flight crew conducted a post-flight inspection of the airplane," the report said. "They noted that the right wing was bent upward about 10 degrees and light rime ice was present on the leading edges of the wings [and] horizontal stabilizer." The pilots said that the ice was less than

Citation Ice Protection Systems



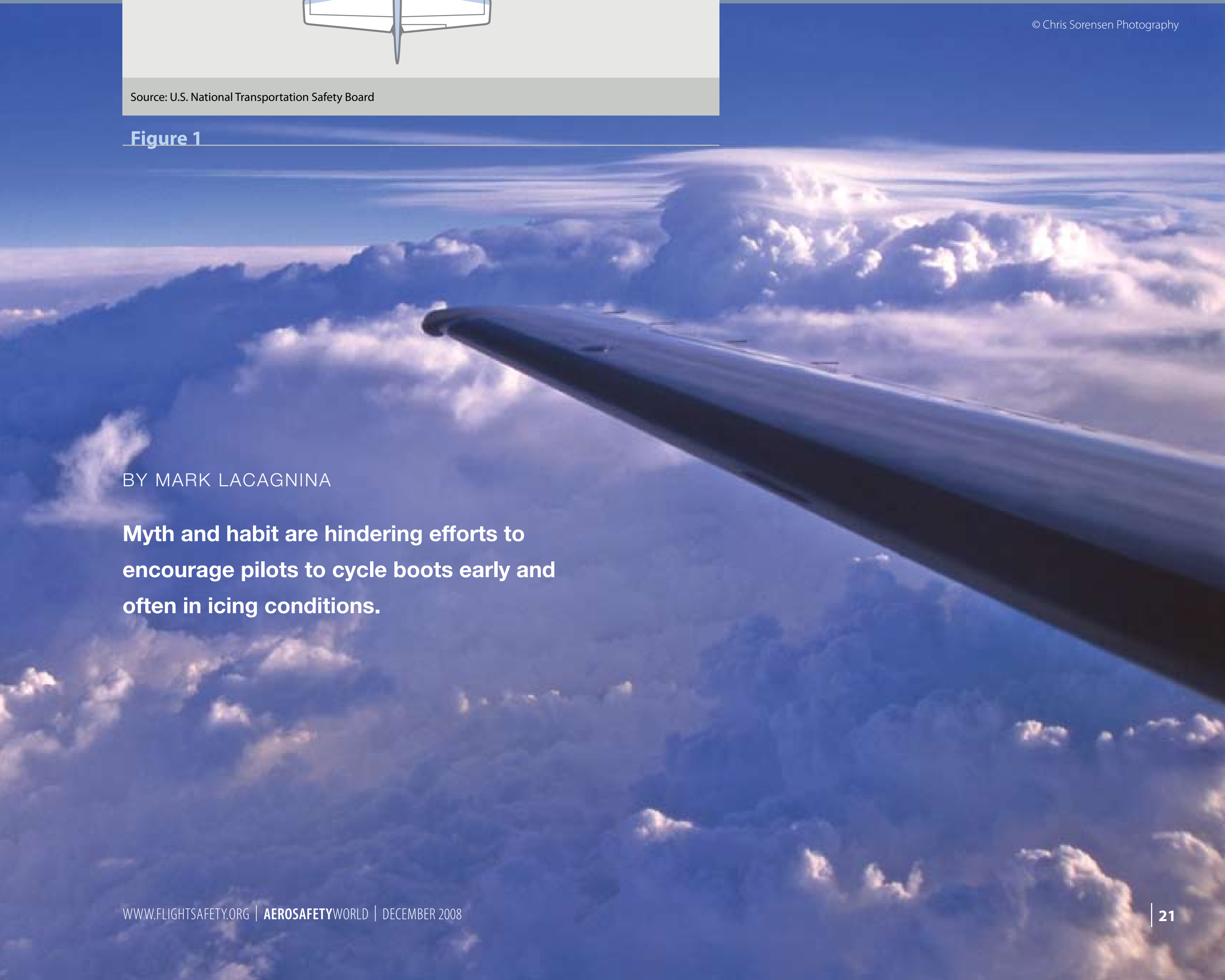
Source: U.S. National Transportation Safety Board

Figure 1

1/4 in (6 mm) thick. A customer service agent on the ramp estimated that the strip of rime ice on the wing leading edges was 1/16 to 1/8 in (2 to 3 mm) thick and 2 in (5 cm) wide.

An examination of the airplane by a U.S. Federal Aviation Administration (FAA) inspector revealed substantial damage. "The upper wing skin on the right wing/fuel tank had been breached, exposing the main spar," the report said. "The spar was broken, and the outboard portion of the right wing and aileron had been bent in an upward direction."

Investigators found that the pilots had operated the Citation's ice-protection systems as required by the airplane flight manual (AFM). The



BY MARK LACAGNINA

Myth and habit are hindering efforts to encourage pilots to cycle boots early and often in icing conditions.

manual says that the anti-ice equipment should be activated when operating in visible moisture with an indicated outside air temperature between 4 degrees C and minus 30 degrees C (40 degrees F and minus 22 degrees F). The pilots had done so before entering the clouds on descent.

The AFM also says, "Surface deice [the boots] should be used when ice buildup is estimated between 1/4 and 1/2 in [13 mm] thickness. Early activation of the boots may result in ice bridging on the wing." Both pilots said that they had visually checked the wings after entering the clouds and saw no ice; therefore, they did not cycle the boots.


U.S. Federal Aviation Administration

Residual ice remains on a Mitsubishi MU-2 deice boot after the first cycle during flight tests conducted behind a tanker airplane dispensing colored water.

The pilot told investigators he had been taught that if you "blow [the boots] too soon, you can get a hollowed-out area." The copilot said that he had little experience with boot-equipped airplanes but had learned that "boots have some adverse features" and should not be activated "unless you have 1/4 to 1/2 in of ice."

Ice Bridging

Finding little to fault in the pilots' performance, NTSB laid the blame for the Citation accident squarely at the feet of the FAA and Cessna Aircraft Co. The report said that the probable causes of the accident were "the inadequate guidance and procedures provided by the airplane manufacturer regarding operation of the pneumatic deice boots. Also causal [were] the FAA's inadequate directives, which failed to require manufacturers to direct flight crews to immediately operate pneumatic deice boots upon entering icing conditions."

The report noted that many other AFMs direct pilots to delay operation of their deice boots until 1/4 to 1 in [25 mm] of ice has accumulated. "This guidance was included to prevent the occurrence of ice bridging, though the FAA and manufacturers have been unable to substantiate its existence," it said.

In theory, ice bridging begins with a thin, malleable layer of ice that deforms, rather than shatters, when a deicing boot is inflated. The layer is molded into the shape of the inflated boot, then hardens, accretes more ice and creates a shell (bridge) that is impervious to further inflation and deflation of the boot.

Concern about this phenomenon was found to have been involved in the Jan. 9, 1997, crash of Comair Flight 3272 in Monroe, Michigan. The crew of the Embraer 120 Brasilia was being vectored for an approach to Detroit Metropolitan Wayne County Airport when the autopilot disconnected during a turn at 4,000 ft. The twin-turboprop airplane rolled nearly inverted and descended rapidly to the ground, killing all 29 people aboard.

The cause of the accident, according to NTSB, was a small amount of rough ice that accumulated and triggered a stall as the airplane was slowed for the approach. Following company guidance, the pilots had not cycled the deice boots.

The investigation revealed that about a year before the accident, Embraer had revised the AFM to advise pilots to activate the boots at the first sign of ice accumulation. NTSB found, however, that because of concern about ice bridging, Comair and six of the nine other operators of Brasilias in the United States had not incorporated the revision into their procedural guidance. Comair's flight standards manual (FSM) said that pilots should not activate the boots until 1/4 to 1/2 in of ice accumulates because premature activation could "result in the ice forming the shape of an inflated deice boot, making further attempts to deice in flight impossible."

The investigation of the Comair accident generated several recommendations, including a call for an industrywide effort "to educate manufacturers, operators and pilots of [turboprop airplanes] regarding the hazards of thin, possibly imperceptible, rough ice accumulations, the importance of activating the leading edge deice boots as soon as the airplane enters icing conditions … and the importance of maintaining minimum airspeeds in icing conditions." Subsequent ice-related accidents prompted NTSB to include operators of boot-equipped jets in similar recommendations.

Mass Revisions

In July 1999, the FAA cited the Comair accident and several other ice-related accidents in proposing rule making to revise the AFMs of 43 airplanes to "include requirements for activation of the airframe pneumatic deice boots … at the first sign of ice accumulation [anywhere on the airplane or upon annunciation by an ice-detection system] to prevent reduced controllability due to adverse aerodynamic effects of ice adhering to the airplane prior to the first deice cycle." Among the proposed requirements was continued operation of the boots until the airplane exits the icing conditions.

In the proposal, the FAA discussed a workshop that was held in Cleveland in November 1997 to explore the phenomenon of ice bridging. The workshop was attended by 67 representatives of aircraft and deice boot manufacturers, the airlines, pilot groups, the National Aeronautics and Space Administration, NTSB, and civil aviation authorities. The participants shared and discussed the results of icing wind tunnel and flight tests.

The boot manufacturers, for example, said that they had been unable to reproduce ice bridging under any wind tunnel or laboratory conditions and that reports of ice bridging they had investigated turned out to actually have involved residual or intercycle ice — ice that remains on the boot after an inflation/deflation cycle and ice that accumulates between cycles.

"The general consensus of the workshop participants was that ice bridging is not a problem for modern pneumatic deice boot designs," the FAA said.

Deice boots essentially are fabric-reinforced rubber sheets cemented to the leading edges of the wing and tail. A pressure source is used to inflate tubes within the boots and to create a vacuum that deflates the boots and holds them flat against the leading edges.

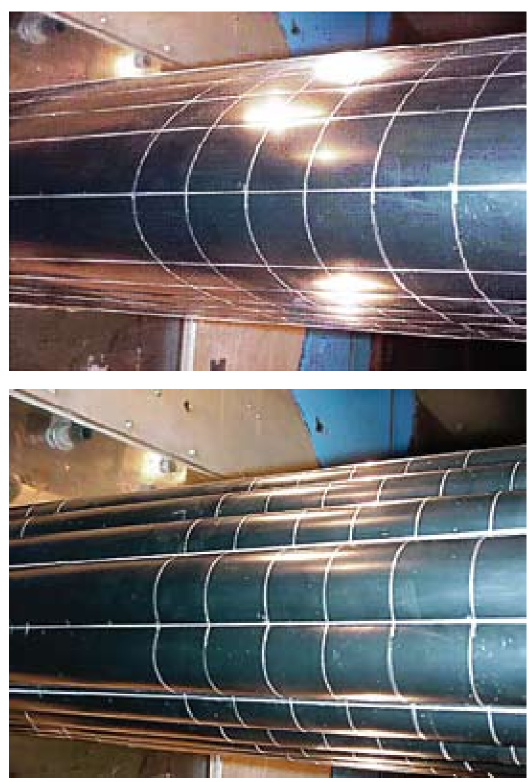
Modern boots have short, segmented, small-diameter tubes that are operated by relatively high-pressure engine bleed air. Older boot designs, which date back to the 1930s, have long, unsegmented, large diameter tubes typically operated by engine-driven pneumatic pumps at pressures that are relatively low and vary according to engine speed. "This low pressure, coupled with long and large-diameter tubes caused early deice systems to have very lengthy inflation and deflation cycles and dwell times [i.e., the period in which the boot remains completely inflated]," the FAA said.

The results of extensive icing wind tunnel tests in 2006 supported activation of deice boots at the first sign of ice.

Doubting Thomases

Several people who commented on the rule-making proposal pointed to airplanes on the list that have no history of ice-related accidents. One said that the FAA merely was speculating that the proposed AFM revisions will improve safety and challenged the agency to test the proposed procedure on each of the airplanes. The FAA rejected these comments, saying that "the potential still exists for reduced

U.S. Federal Aviation Administration



© Chris Sorensen Photography

Old-design deice boots, like those on the Gulfstream I, have longer and larger tubes that cycle much more slowly than those in modern boots.

controllability of all airplanes equipped with pneumatic deice boots due to the adverse aerodynamic effects of ice adhering to the airplane."

Other comments reflected the reasons, beyond concern about ice bridging, that many operators prefer to wait until some ice accumulates before cycling the boots. Chief among them is the perception that boots work best, shedding ice more cleanly, if cycling is delayed. The FAA acknowledged that residual ice and intercycle ice can cause adverse aerodynamic effects but pointed out that persistent ice accretions result even when boots are cycled after 1/4 to 1/2 in of ice builds up. It said that the proposed procedure, which calls for continuous cycling of the boots while flying in icing conditions, "will minimize the residual and intercycle ice accretions." The FAA pointed out that "the residual and intercycle ice accretion thickness resulting from this procedure is less than the ice accretion thickness typically recommended prior to operation of the pneumatic deice boots."

Among other objections were that cycling boots early and often increases pilot workload and maintenance costs associated with wearing out the boots. The FAA rejected these comments, also.

Citations Withdrawn

NTSB's conclusion that the FAA's "inadequate directives" were a causal factor in the Citation air ambulance accident referred, in part, to the withdrawal of Citation 500-series airplanes — about 1,400 total — from the proposed rule making.

The FAA's decision not to pursue Citation AFM revisions was based on flight tests conducted by the manufacturer. Cessna fitted artificial ice shapes simulating 1/2 in of clear and rime ice to a Citation 550, which has a similar wing and tail as the original 500 and 501 models, and a Citation 560. Evaluation of the airplanes' stall characteristics was performed in level flight and steep turns. The FAA said that the flight tests demonstrated "acceptable stall protection and maneuver margins at operational speeds" and showed that the airplanes "can safely operate with ice accretions associated with the AFM normal operations procedures of the deice boots."

The Jetstream 41 also was withdrawn based on original ice-certification flight test data provided by British Aerospace. The Douglas DC-3 and the Gulfstream I were among other airplanes withdrawn from the proposed rule making because they have old-design boots and may be prone to ice bridging.

'Accidents Could Still Occur'

The FAA and several other civil aviation authorities have published guidance based on what has been learned about icing from research and recent accident investigations. For example, in Advisory Circular (AC) 91-74A, the FAA says that "even a thin layer of ice at the leading edge of a wing, especially if it is rough, can have a significant effect in increasing stall speeds" and recommends that deice systems be activated at the first indication of icing.

The agency currently is considering whether to make this recommendation a requirement for newly manufactured transport category airplanes. NTSB has called on the FAA to expand the proposed requirement to all airplanes with deice boots. Noting that Cessna removed the reference to ice bridging from the Citation AFM in February but retained the recommendation to wait until 1/4 to 1/2 in of ice builds before activating the boots, the board said that many AFMs contain similar guidance.

NTSB said that since 1982, it has investigated 43 ice-related turbine-airplane accidents that have resulted in 201 fatalities and 16 serious injuries. "If pilots continue to adhere to guidance about delaying deice boot activation, similar accidents could still occur," the board said.

Bob Vandel *Stepping Down*

The Foundation salutes its retiring executive vice president.

Only one person has spent more time with Fight Safety Foundation, advancing its causes and developing new solutions to old problems, than Robert H. Vandel, and that was the Foundation's founder, Jerome Lederer. At the end of December, after more than 20 years with the Foundation, Bob Vandel's time with the organization comes to a kind of end as he retires from his position as executive vice president.

We note his "retirement" in conditional terms. No one with Bob's energy level truly retires, and it seems likely we'll see him in a Foundation role for some time to come.

But going back to August 1988, when John H. Enders, then president and chief executive officer of the Foundation, hired Bob to be director of technical programs, Bob already had a significant career behind him.

Bob's start in aviation was as a U.S. Army helicopter pilot. Two tours flying helicopter gunships in Vietnam in the early and mid-1960s brought him challenges so profound that he received the Distinguished Flying Cross three times and the Air Medal 47 times. Between and after his combat tours, Bob filled a number of roles, teaching flying and serving as a standardization pilot until the late 1970s, when he assumed command of a major U.S. forces aviation facility in South Korea.

His talent for being able to communicate with people was becoming known, and in the early 1980s, he was education and training management officer for the U.S. Army. Presaging his eventual FSF role, he co-authored a plan for the organization and management of air safety for the Army, providing data, trends and analysis for the Army safety program.

Seeing an opportunity to be the Army's liaison with the Federal Aviation Administration (FAA), Bob moved over to the civil agency and became immersed in air traffic control issues. He designed advanced precision approach procedures and initial traffic alert and collision avoidance system procedures, and provided technical advice to the U.S. representative to the International Civil Aviation Organization while still staying in touch with rotary-wing issues.

He stayed in the FAA liaison position until that fateful phone call in 1988 from Jack Enders. Bob retired from his military career to come to the Foundation.

Joining the Foundation widened Bob's scope to big-vision issues at a time when safety advances were maturing but needed high-level coordination to come to fruition on an operational level, and he excelled in that role.

Here's a partial list of some of the FSF programs he organized and led:

- Safety indicators study.
- Crew-associated accident study.
- Flight operational quality assurance (FOQA) program, creating a template for airlines to establish their own FOQA programs.
- Wind shear training application study, creating training and techniques for aircrews to use to handle wind shear events.
- Controlled flight into terrain (CFIT) accident reduction study, developing training and procedures to reduce what then was the most deadly cause of aircraft accidents.
- Approach and landing accident reduction (ALAR) study, developing the tool kit that is helping pilots worldwide avoid this most common of accidents.
- Continuing airworthiness risk evaluation study.
- Fatigue in corporate aviation operations study, establishing an industry standard for managing fatigue.
- Co-chairman of an international working group that defined crewing parameters for the safe introduction of ultra-long-range aircraft operations.
- Co-chairman of the ground accident reduction effort.
- International aviation safety workshops, conferences and seminars.

When James M. Burin joined the Foundation in 1999 as director of technical programs, Bob became FSF's executive vice president. Among the important programs with which he has been associated in that position were those that spread both the CFIT and ALAR tool kits around the world.

Lately, after a protracted development period, the FSF FOQA program for corporate operators began to bear fruit and now is rapidly expanding as more and more operators seek to add new levels of risk-reduction to their programs while benefiting from the insight flowing from the analysis of their FOQA data aggregated with other participating firms.

Serving for six years with Jack Enders, Bob then worked under Stuart Matthews for 12 years before William R. Voss took the FSF helm a little more than two years ago.

The time spent working with the Foundation team and all the people in the aviation industry who support FSF efforts made an impression on Bob. "Shortly after I came to the Foundation, I was talking with [a safety colleague]. He told me that I had the best job in aviation," Bob said this past October at the International Air Safety Seminar (IASS).

"I have always remembered that comment, and I have come to agree very much with his assessment, with one caveat. It is not the job that is so great. It is the people that you get to work with … people who are very successful in their jobs, who are totally consumed by their individual jobs but who find the time to volunteer their individual expertise to the Foundation in the pursuit of improved safety."

Don Bateman, corporate fellow–chief engineer, flight safety technologies, Honeywell Aerospace, and inventor of the Ground-Proximity Warning System (GPWS) and Enhanced GPWS, wrote this to Bob: "You have been the driving force for the FSF and improving safety for all of us. I know that flight safety people like you are very exceptional and are always needed."

In closing his remarks at an IASS ceremony honoring Bob for his service, he shared with colleagues his appreciation for his time at the Foundation, "for allowing me to work on my passion for the last 20 years. I believe we have had a wonderful relationship and accomplished much along the way.

"As I leave, I see the Foundation in a strong position with excellent leadership under Bill Voss and with a great staff. With each of you helping where you can and with the expertise you have, the Foundation can move to the next level."

Bob received a citation honoring his service from Bill Voss at the most recent IASS.

BY PAT ANDREWS

It's Personal

Fifteen months ago, I retired after a safe and successful career in corporate aviation. Walked away from every landing, sometimes smiling with head held high, sometimes not so much. But aviation was largely good to me during 28-plus years of professional piloting and, ultimately, managing a good-sized flight department. Challenges presented themselves every day — weather, air traffic, equipment malfunctions, passenger issues and more — but the bottom line was a career free of Federal Aviation Administration violations, National Transportation Safety Board hearings, crumpled metal or tragic loss of life.

Most retired pilots have a similar story. Despite the rapid technical and environmental changes that have been characteristic of our industry over the last century, the vast majority of those who pursued aviation as a profession adapted well to those changes and look back with satisfaction on their safety records. Likewise, most aviation professionals who haven't reached retirement will get there with the same record.

You can chalk up aviation's great safety record to many things. Manufacturers build strong, reliable airplanes with redundant systems designed to give pilots lots of options to get from point A to B without incident. Training historically has been widely available and widely utilized by most aviation professionals. And for the majority of aviation organizations, standard operating procedures are "the way we do things around here." But when it comes right down to it, one of the most important factors contributing to the safety of aviation is simply that it's personal.

Whether we build, fly, maintain or clear aircraft to take off and land, each of us starts with the knowledge that our success or failure to do so safely will have a lifelong effect on us as individuals. It's a powerful motivator, and one way we see that motivation play out is in the decisions of folks to get involved in safety initiatives, either within their own organizations or as part of broader industry endeavors.

Pat Andrews, chairwoman of the FSF Corporate Advisory Committee, retired as manager of aviation services for ExxonMobil Corp.

Flight Safety Foundation's standing consultation bodies — International Advisory Committee, European Advisory Committee and Corporate Advisory Committee (CAC) — and working groups are good examples. Composed of volunteers, these groups engage in collaborative efforts to identify and counter safety threats. Problems such

I knew the passengers who had died, having flown them myself many times.

as wind shear, controlled flight into terrain (CFIT), approach and landing accidents, fatigue and many more have been the focus of the Foundation's volunteer efforts. Over the years, the groups' carefully crafted recommendations and products have benefited our entire industry. While these problems have not been solved entirely, significant advancements have been made, and wise guidance is now available for those who seek it.

Why do individual aviation professionals spend their time and efforts seeking ways to advance aviation safety? If asked, they might say they enjoy the time with colleagues away from the daily grind of their real jobs. Or they might say that they are interested in safety and want to make a contribution. But for each, there is usually also a personal side to the decision.

I was two years into my first aviation job flying light twin charter airplanes when I learned a hard and lasting lesson about the personal side of aviation safety. Turning on the news early one December morning, I was shocked to hear that a colleague's aircraft had impacted terrain on a go-around late the previous evening. Fog had closed our home airport, so he was shooting an approach to an alternate about 10 miles away. With conditions worsening, he descended below minimums. Too late, he began a missed approach, and the airplane caught the top of a ridge a couple of miles short of the runway. My colleague survived, but his passengers didn't. The destroyed airplane was one I had flown just the previous day. The spare key labeled with the tail number was still in my jacket pocket. I knew the passengers who had died, having flown them myself many times. It wasn't my accident, but it was personal and incredibly painful.

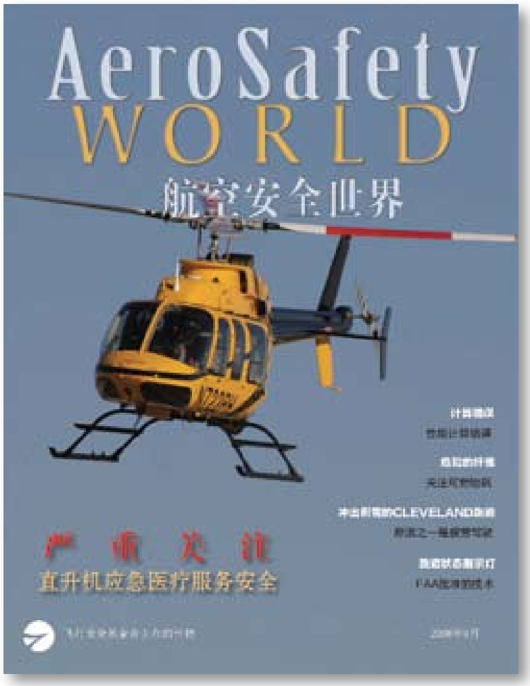
When the Foundation was seeking participants for its CFIT and approach and landing accident reduction (ALAR) projects, my hand went up, not for altruistic reasons, but to try to find out how these types of accidents happen and how they can be prevented. Since that long-ago December morning, I had read numerous accounts of accidents resulting from CFIT or mismanaged approaches and landings. In many of the accidents, the pilots involved were professional, well trained and considered safe by those who knew them. I always wondered — could that have been me or someone I knew? Truth be told, the answer was sometimes yes, and at that point it became very important at a personal level to get to the bottom of what happened and why.

None of us will ever know for sure why we get to the end of our aviation careers without incident or accident. Good decision making, good equipment, good training and perhaps a little good fortune sprinkled in. But I have to believe that sitting around a table, earnestly seeking solutions to the threats in our business with like-minded colleagues, helped my cause. I never left a CAC meeting or an ALAR working group session without new insights and fresh resolve about how to be a little safer in my own work. My fellow volunteers were my teachers, every bit as much as my simulator and ground school instructors.

We on the CAC continue to teach each other. Our focus now is on threat and error management, corporate flight operational quality assurance and, most recently, next generation aviation professionals, assuring the personnel competencies and qualifications necessary to continue aviation's good safety record. Working groups are active in these areas, and we welcome ideas from any and all who recognize that they have a personal stake in the outcome. And we look forward to seeing continuing attendance growth at our annual Corporate Aviation Safety Seminar, where high quality presentations and lots of informal networking provide opportunities to advance aviation safety in our various organizations.

But let us never forget this: It all starts with a single individual who regards safety as a personal matter. If we all treat it that way, there will continue to be safe and satisfactory careers for those of us privileged to call ourselves aviation professionals.

航空安全世界



Introducing *AeroSafety World* in Chinese

Thanks to the initiative and hard work of a group of volunteers, Chinese translations of a number of *AeroSafety World* issues are now available on the Flight Safety Foundation Web site, and more will follow. To see the first four issues of *ASW* in Chinese, go to <www.flightsafety.org/asw_chinese.html>.

This nonprofit volunteer group, SaferSky Flight Safety Service Team, works independently of other organizations not only to maximize its freedom of action but also in recognition of the neutral nature of the most effective air safety work. The team is composed of members from the Chinese aviation community with a range of skills.

Their enthusiasm for the information found in *AeroSafety World* developed into this effort to share the publication with the large and quickly growing Chinese aviation industry in which English language skills are in early development.

Translating every word in a 64-page magazine and producing new layouts to fit the original space of the English version is a major challenge, especially when performed as a part-time activity by people with full-time jobs. When the team began, it did not translate every issue. However, "We have made up our minds to translate each issue after August 2008," a team director says.

"Our team has a sense of mission and has decided to dedicate itself to the air safety cause," the director added. "We are eager to support Flight Safety Foundation in its efforts to improve global air safety, so we will try our best to help the Foundation spread the information."

Working with limited resources, the team makes a concerted effort to contain expenses while ensuring the quality of the translation. The team hopes that the Chinese *ASW* will be so successful that it will provide increased resources to dedicate to the job.

Indeed, the Chinese edition will increase the publication's circulation, extending *ASW's* reach around the globe to this new audience. This expansion potentially makes the publication a more appealing platform for advertising. Advertisements purchased for the dedicated Chinese issue may provide financial support for the team.

The Chinese edition initially will be available only via the Internet. However, should demand and financial support achieve critical mass, the team holds out the possibility that paper copies of the Chinese *ASW* can be printed and distributed.

It is hoped that the Chinese *ASW* project will provide the basis for a continued expansion of the SaferSky Flight Safety Service Team. Check out what other services the team offers on its website, <www.safersky.cn/>.

Rising Stars

Safety may be the only thing inconspicuous about light-emitting diodes.

BY WAYNE ROSENKRANS

Background, solar-powered LED runway edge light system; foreground, LED runway guard lights.

Guiding flight crews on the ground with light-emitting diodes (LEDs) coincides with airports' growing realization of how much this technology offers beyond mere replacement of red obstruction lights and blue taxiway edge lights. Each LED among those arrayed in an airfield lighting fixture is a semiconductor chip. When electric current passes through its thin layers of semiconductive material, the material emits either white light or one saturated color of light. Often, LEDs — also known as *solid-state lighting (SSL)* — cannot be made visually identical to their incandescent counterparts.[1]

As soon as required LED colors and sufficient light output became available, some in this decade, designers had to overcome challenges such as insufficient heat output to melt snow and ice in some airport environments and the occasional unplanned circuit shutdown. Today, designers can specify taxiway and runway guidance devices that outshine earlier xenon flash tubes and incandescent-filament lamps, such as full-spectrum tungsten-halogen lamps with color-filtered lenses.

Many aviation-safety advantages of LEDs seem indirect, not obvious, but that has not dissuaded airports or manufacturers from seeking new applications. A year ago, the airport subcommittee of the U.S. Federal Aviation Administration (FAA) Research, Engineering and Development Advisory Committee recommended that the agency and the Lighting Research Center at Rensselaer Polytechnic Institute continue to cooperatively pursue the development of LED technology for airport lighting through fiscal year 2010.[2]


Fixture: Siemens Airfield Solutions Runway: Carmanah Technologies

Encrypted wireless communication remotely controls a self-contained, solar-powered LED airfield light with integrated battery and energy management.

One indirect safety advantage is the newfound feasibility of installing permanent, temporary or backup airfield lighting at airports where none existed. A 2008 FAA advisory circular (AC) for one type noted reasons that apply to many types: "When coupled with recent technology advances in photovoltaic solar panels and associated components like batteries, solar-powered LED [obstruction] lights … in many cases can be designed for half the cost of [extending] a commercial power line."[3]

Solar-powered LED obstruction lighting systems have been installed at airports throughout the United States, the FAA said. "With no trenching or cabling required, a two-person crew can install [lighting to establish] a fully operational 5,000-ft [1,525-m] runway in one hour or less, making it ideal for use during emergencies or natural disasters," said Carmanah Technologies, a manufacturer. Some airports also have focused on taxiway/runway guidance upgrades.

Another indirect safety advantage is compatibility of LED synchronization and fixture-status monitoring with runway safety initiatives, including advanced surface movement guidance and control systems. Addressable runway guard lights "use communications on the series circuit to synchronize the flashing of the lights in a hold bar, and also use communications on the circuit to collect status of the fixtures to ensure the operational state is known," an FAA report said.[4]

Besides safety, airports turn to LEDs for several reasons, including reduced energy consumption; a typical operating life 10 times longer than incandescent sources and, for example, solar- and battery-powered taxiway lights that can go five years without significant maintenance; reliability/durability, including greater resistance to vibration and shock/impact than incandescent lamp filaments; relatively small size and weight; instantaneous on/off capability that shaves critical milliseconds from human reactions to a threat; and directional control.

One of the earliest FAA research projects on LED airfield lighting explored displays of numbers and symbols to supplement/replace paint markings on airport movement areas, and found that ice and snow could obscure the LEDs.[5] The need for auxiliary heaters to be incorporated into some LED taxiway edge lighting prompted further FAA-sponsored research.

The Lighting Research Center found that positioning blue filters over white incandescent lights is a relatively inefficient way to consume energy, compared with installing modified, aviation-blue glass-filter optics over blue LEDs. "To meet FAA regulations for weatherability, some LED-based fixtures incorporate electric heaters that, when switched on during winter months, nearly negate the energy-savings benefit of converting to LED sources," the report said. The most successful alternative was a prototype fixture with eight blue LEDs around a circular aluminum heat sink. This enabled convection and conduction of sufficient heat — melting ice and snow at ambient temperatures of minus 40 C (minus 40 F) — to the fixture optics from the power supply–LED connection point.[6]

The center also studied LEDs for remote airports that have insufficient electrical infrastructure for conventional fixtures. Pilots evaluated simulated nighttime conditions by


Carmanah Technologies

observing a scale model that varied the intensity, color, flash pattern, viewing angle and spatial arrangement. "Subjects viewed different lighting scenarios and were asked to locate the airfield and determine the runway's orientation," the report said. "Researchers measured subjects' elapsed time, accuracy rate and confidence level in locating the appropriate airfield." Prototype LED fixtures for runways were installed for flight tests in Alaska and North Dakota to validate the laboratory results.

LEDs can affect the level of safety in airport maintenance. Workers spend far less time exposed to hazards in the airport movement area as they check, but rarely need to replace, LED fixtures, the argument goes. "There is very low voltage inside the LED runway end identifier lights [REIL] versus the 2,000-volt direct current common in traditional xenon fixtures," said Siemens Airfield Solutions.

Improved conspicuity also has been cited by government and industry. Siemens said that its elevated and in-pavement LED runway guard lights, for example, can be programmed to emulate incandescent lights or set for instant on/off operation with 45 to 50 flashes per minute of the alternating yellow lights. FAA researchers have validated, by airport field testing of elevated runway guard lights, that this characteristic is perceptibly superior to the longer rise and decay times of standard incandescent fixtures.

Ongoing FAA research includes collecting data to establish "acceptable LED-based performance criteria to take the place of traditional lighting standards," said Don Gallagher, the FAA's visual guidance research manager. "The introduction of economical and efficient LED [airfield lighting] represents the greatest potential change in the lighting of airport visual aids in decades. … We need to further study how LED technology interacts when interspersed with standard incandescent lights on airport circuits; how LED intensity changes can be effected; and how LEDs can be seen on an enhanced vision display [on the flight deck]." Airfield lighting specialists from Canada, France, Germany, Italy and the United States meanwhile have been collaborating on the Visual Aids Working Group of the ICAO Aerodrome Panel. "The [working] group will be providing guidance material on using LED technology in visual aids that will be included in the *ICAO Aerodrome Design Manual, Part 4 – Visual Aids,*" the FAA said.[7]

LED runway end identifier lights.

LED-related circuit instability prompted the FAA to begin recommending in 2005 system design and maintenance solutions. A related change likely will be the first standardized, low-power airfield circuits that will match LED characteristics.

When LED fixtures began to be retrofitted at U.S. airports, some of their constant current regulators (CCRs) — a voltage-protection device that maintains the current at a specific level — became unstable and automatically shut down airfield circuits. "Some CCRs turn off due to overvoltage or overcurrent because of LED taxiway edge lights," said an FAA report on the issue. "There are no standards for LED fixtures that require any specific load behavior on the part of the fixture. … When designing circuits that include LED fixtures, the peak and nominal volt-ampere (VA) loads should be considered to assure adequate margins. … Extreme care should be taken when considering the use of LED fixtures on circuits that share other high initial peak VA components."

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Celebrating *Excellence* in Aviation Safety

Remarkable talents of communication, persuasion and forging agreement set apart all the award recipients during the Joint Meeting of the Flight Safety Foundation 61st annual International Air Safety Seminar (IASS), International Federation of Airworthiness (IFA) 38th International Conference and International Air Transport Association (IATA) in Honolulu.

Capt. Bertrand de Courville, director of flight safety, Air France, accepted The Laura Taber Barbour Air Safety Award for distinguished management of the airline's safety programs — including its confidential event reporting, crew resource management training, flight data monitoring analysis and safety management system implementation — and for contributions at the international level. While leading or participating in organizations such as the IATA Safety Group, IATA Accident Classification Task Force, European Runway Incursion Prevention Program and various Eurocontrol safety initiatives, he championed proactive safety awareness and analytical methods to increase the visibility of accident precursors and to enable in-depth defenses against human error.

From left, FSF Chairman Amb. Edward W. Stimpson, de Courville and FSF President and CEO William R. Voss; Chip Geisthardt of IHS Aviation Information, Learmount and Stimpson; and Stimpson, O'Brien and Steve M. Atkins of The Boeing Co.

David Learmount of Flight Group received the FSF Cecil A. Brownlow Publication Award for his comprehensive range of insightful articles in *Flight International,* mastery of aviation operations issues and outstanding worldwide perspective on safety, which have been a model for journalists reporting on safety threats and the aviation industry's drive to reduce them. By broadening understanding of safety trends as a speaker and writer, reaching people inside and outside the industry, he also helped to set the stage for mitigating accident causal factors.

John E. O'Brien, retired director, engineering and air safety, Air Line Pilots Association, International (ALPA), received the Flight Safety Foundation–Boeing Aviation Safety Lifetime Achievement Award for advisory committee/study group leadership and consensus building behind the scenes of many advances in accident and incident investigation, accident prevention, pilot training, flight operational quality assurance programs and standard operating procedures. As a member of the FSF International Advisory Committee, he was instrumental in identifying controlled flight into terrain and approach and landing accidents as urgent safety issues and in mitigating related risks through analytical working groups, workshops, training aids, tool kits and awareness programs.

Evgeny Nikolaevich Lobachev, adviser to the Russian Federation minister of transport, was named a recipient of the FSF President's Citation for developing the Russian Air Code, Russian and international safety procedures and oversight, accident investigation and improvements to the Universal Safety Oversight Audit Program of the International Civil Aviation Organization. In 2007, he oversaw drafting of the State Civil Aviation Safety Program of the Russian Federation and began serving as secretary to the interagency aviation safety commission that implements the program.

Nicholas A. Sabatini, associate administrator for aviation safety of the U.S. Federal Aviation Administration, received the FSF President's Citation for leadership in creating synergy by encouraging broad-based, cooperative initiatives involving the aviation community and government through programs such as the aviation safety information analysis and sharing program, maintenance line operation safety audits, a call to action for reduction of runway incursion risks, voluntary reporting programs and safety management systems.

Lt. Col. James MacGillavry and Lt. Col. Rik van Zwol, members of the Royal Netherlands Air Force, received the IFA Whittle Safety Award for significant contributions to military aviation safety, including the formation of the Military Aviation Authority in the Netherlands and the introduction of a new regulatory framework based on a total aviation safety concept.

From left, Voss and Sabatini; and van Zwol, MacGillavry and IFA presenter Joe Sutter.

Photos: Wayne Rosenkrans

The Industry Safety Strategy Group (ISSG) Global Aviation Safety Roadmap provides a valuable plan for data-driven safety improvements, but as with all good plans, the test comes in turning ideas into reality.

Flight Safety Foundation and its regional affiliate in East and Southern Africa, the AviAssist Foundation, in 2007 were the first to dedicate a think tank meeting to the application of the Roadmap, where participants looked at the Roadmap in relation to the African region, which perhaps needs it most.

The Roadmap, launched in 2006, still is far from being commonly known and applied. Further, the African region faces an extra difficulty in accessing information that is readily available elsewhere on the Internet, as Internet access in the region is still very limited.

Workshops and political persuasion are early but important steps.

AviAssist Foundation

APPLYING THE SAFETY ROADMAP IN AFRICA

BY TOM KOK

However, the International Civil Aviation (ICAO) African Comprehensive Implementation Program (ACIP) is assisting. With the launch of ACIP, ICAO is making a genuine effort to go beyond mere consultancy. ACIP requires countries to attend a regional Roadmap workshop to harvest further benefits from ACIP in improving their safety. Once a country has attended a Roadmap workshop, ACIP can conduct a gap analysis to define the work that needs to be done, again based on the Roadmap. In turn, that analysis becomes the basis for further assistance under the umbrella of ACIP.

In 2008, ACIP has conducted two regional workshops on the use of the Roadmap. Those workshops are critical in making the Roadmap accessible. A third regional workshop is planned for Mozambique in December 2008. ACIP has conducted Roadmap-based gap analysis for the seven African states that are signatories to the Banjul Accord, plus the Seychelles. Further gap analyses are planned in the region. Once ACIP has started training national experts to provide safety management system (SMS) and state safety program (SSP) training, the same pool of experts can possibly provide training on the use of the Roadmap.

The challenge will be to sustain the momentum, presently building, once the temporary ACIP ceases to exist in a few years. This is even more complicated in the African region where changes in directors general of civil aviation and other industry and policy leaders are much more frequent than, for example, in Europe and the United States. This will mean the institutional memory on safety issues at the highest management levels may be much shorter. These regular changes also lead to a state of mind that "no condition is permanent," which is not an environment conducive to sharing information that may be used differently by the next group of managers.

An important achievement of the Roadmap is that it is slowly starting to close the gap between industry and governments. Traditionally, ICAO certainly consulted stakeholders in its work in Africa, but that may have mainly meant working with the International Air Transport Association (IATA) offices in Montreal and Johannesburg, South Africa. Very little direct, regular interaction with operators took place. This is important in a region where the majority of operators are small or medium-sized, and may not even be IATA members.

The ICAO audits include visits to the industry, visits primarily designed to get an impression of a state's safety oversight. Under the Roadmap gap analysis, the team visits the industry in sessions that enable the national industry representatives to get their views across on required improvements. That is a constructive and critical step in beginning a genuine culture change to properly implement safety management and a just culture. The performance expectations of which the Roadmap speaks — and that will be a crucial part of the safety oversight audit programs of the future — cannot function without data shared in a just culture.

ACIP held its first SSP meeting in Ethiopia Sept. 23–26, 2008. The SSP highlights a number of elements that can be clearly recognized in the Roadmap. This allows the development of SSPs and the Roadmap to move in sync. The Roadmap further provides clearly defined best practices that can be used by African countries

Three Possible Organizational Cultures for Information Management

	Pathological	Bureaucratic	Generative
Information	Hidden	Ignored	Sought
Messengers	Shouted	Tolerated	Trained
Responsibilities	Shirked	Boxed	Shared
Reports	Discouraged	Allowed	Rewarded
Failures	Covered up	Merciful	Scrutinized
New ideas	Crushed	Problematic	Welcomed
Resulting organization	**Conflicted organization**	**"Red tape" organization**	**Reliable organization**

Source: International Civil Aviation Organization state safety program

Table 1

U.S. National Aeronautics and Space Administration to prioritize their activities in implementing their SSPs.

The SSP introduces the need for states to collect data to establish the basis for an agreement on acceptable levels of safety performance. The SSP will insert quality assurance components into a state's safety oversight role and should do away with merely prescribing regulations in favor of a more interactive approach to setting safety targets. Such an interactive approach will work best in a generative organizational culture in the regulator (Table 1). It could play an important role in bridging the gap between the regulator and the industry. Making that gap smaller will be a critical element of changing a safety culture.

A problem with the Roadmap is its complexity, which makes it less than ideal for drumming up political understanding and support. On the surface, it is a document written by technical experts for technical experts. If a greater political understanding and increased political will are to be mobilized to support aviation safety, the aviation community needs to learn from innovative companies like Philips Electronics and Apple that focus on simplicity and ease of use and access. Roadmap-based work will have to embed those concepts to secure the much-desired political support in a region where aviation must compete for funding with primary needs such as education and healthcare. Moving up aviation safety on the political agenda will require political leaders to absorb the essence of the message from plain-language documents.

Flight Safety Foundation and AviAssist Foundation are working to issue such plain-language informational leaflets on states' international responsibility for aviation safety and the role of a civil aviation authority. In the first quarter of 2009, the AviAssist Foundation will begin its second parliamentary information campaign in the African region to sensitize communities beyond aviation to the importance of just culture.

Informational leaflets are distributed to parliamentary transport committees that play a vital role in enacting new aviation safety regulations. They will also be distributed to new ministers and permanent secretaries of transport and to the news media in the East and Southern African countries.


AviAssist Foundation

Though safety data collection is very limited in Africa, the Roadmap is the first plan that provides clear leads about data analysis on which national aviation safety policies may be based. Many, if not most, African operators use aircraft that cannot economically be retrofitted with quick access recorders for digital data collection. Nonetheless, a tradition of safety data collection can begin with flight safety event reporting and analysis, which is generally the first type of analytical tool that an airline will acquire.

Even the air safety reports that are the basis for those systems are uncommon in sub-Saharan Africa so far. But with the help of fairly simple and readily available computer applications such as Microsoft Excel, safety trend analysis can begin. Initially, occurrence reports may have to be mostly in-company, because the legal regimes in many African countries do not foster non-punitive information sharing. Going forward, it will be important to map the legal obstacles to a just culture in the East and Southern African region.

With the help of fairly simple and readily available computer applications, safety trend analysis can begin.

The Flight Safety Foundation and the AviAssist Foundation remain committed to supporting two of the four main components of the rollout of SSP and SMS: safety assurance and safety promotion.

Tom Kok is director of the AviAssist Foundation.

COLOR deficient?

Aviation medical specialists are trying to define the role of color vision in safe flight operations.

BY LINDA WERFELMAN

As technological advances infuse flight decks with increasingly colorful displays, disagreements persist among pilots, aeromedical specialists and regulators on a basic underlying question: What level of color vision is required for safe flight operations?

The International Civil Aviation Organization (ICAO) says that the increasing reliance on color-coded information in flight displays "means that adequate color perception continues to be important for flight crew and air traffic controllers."[1]

ICAO also says that, unfortunately, "there is very little information which shows the real, practical implications of color vision deficiencies on aviation safety."

Dr. Anthony Evans, chief of ICAO's Aviation Medicine Section, said, "Many individuals seem to function very well with a degree of deficiency, and flying instructors are often ready to attest to the visual ability of some color deficient individuals. On the other hand, some — actually very few — safety tasks rely on good color vision for their safe execution."

Defining Deficiencies

Color vision deficiency is the inability to see some shades of color or, in the most severe cases, to be color "blind" — that is, to see all colors as black, white or gray. A color vision deficiency usually is an inherited condition but also can be caused by diseases such as diabetes, macular degeneration or sickle cell anemia, or by some medications used to treat heart problems, high blood pressure and other conditions. Color vision also may deteriorate with advancing age.

People see colors because light-sensitive pigments in the photoreceptors, or *cones*, in the retina of the eye enable each cone to detect the wavelength associated with either red, green or blue light. The information gathered by the cones travels through the optic nerve to the brain, which distinguishes among hundreds of shades of colors. When the cones are missing one or more pigments, the affected individual is unable to see the associated shades. Color vision deficiencies range from mild to severe, depending on how much pigment is missing from the cones.[2,3]

ICAO statistics show that about 8 percent of men and 0.8 percent of women have color deficiencies that cause them to fail color perception tests — although percentages vary according to geographical regions. Of these, more than 99 percent have red-green deficiencies — that is, they are unable to differentiate some shades of red and green.[4]

Nevertheless, ICAO and civil aviation authorities around the world recognize that many people with mild color vision deficiencies can safely operate aircraft, and thousands of pilots who are unable to pass the most frequently administered test of color vision have been issued medical certificates after passing alternate tests.

ICAO's standards instruct civil aviation authorities to test pilots and air traffic controllers "for the ability to correctly identify a series of pseudoisochromatic plates" — printed patterns that include numbers and backgrounds composed of differently shaded dots. According to ICAO's standards, those who fail this test can still be considered fit for flight or air traffic control duties if they pass another test of their abilities to "readily distinguish the colors used in air navigation and correctly identify aviation colored lights."

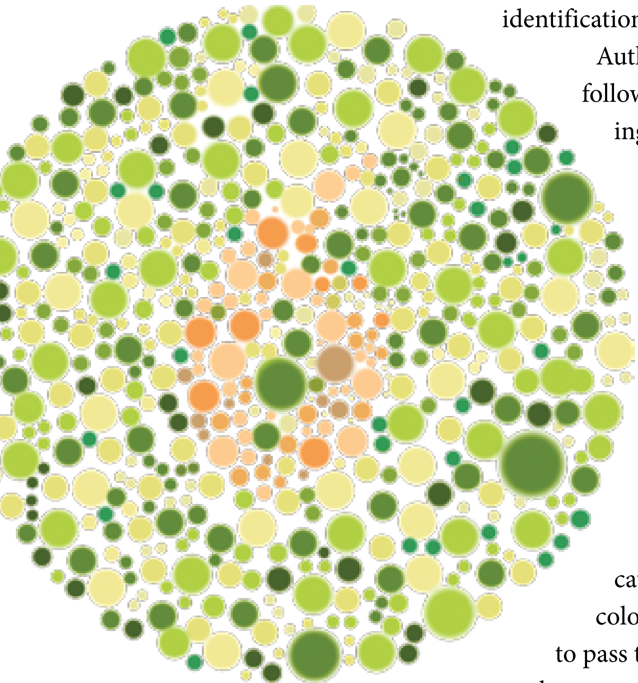
"There is very little information which shows the real, practical implications of color vision deficiencies on aviation safety."

Little Uniformity

Beyond these requirements, there is little uniformity in color vision standards established by civil aviation authorities in different countries.

"Every regulatory agency in the world has its own standards, its own exams," said Dr. Russell Rayman, executive director of the Aerospace Medical Association. "If you go to 20 different countries, you'll probably get 20 different answers."

For example, a 2005 review found that the European Joint Aviation Authorities (JAA), the Australian Civil Aviation Safety Authority (CASA) and the U.S. Federal Aviation Administration (FAA) all authorized a screening test using the same set of 15 pseudoisochromatic plates. Requirements for a passing score differed, however; the JAA required correct identification of all 15 plates,[5] CASA required correct



identification of 13, and the FAA, correct identification of nine.[6]

Authorities also differ in their follow-ups to a failed screening test. For example, the FAA allows applicants who fail the initial test to request one of several authorized alternate tests, administered by an aviation medical examiner or, in some cases, at schools of optometry. Those who pass are issued medical certificates without limitations for color vision but are required to pass the same test again at subsequent medical evaluations.

Alternatively, an applicant can request a one-time test at an FAA flight standards district office. Those who fail this test receive medical certificates with permanent limitations "not valid for night flying or by color signal control." The JAA says that if an applicant for a Class 1 medical certificate fails the pseudoisochromatic plate test, he or she can be considered "color safe" by subsequently passing "extensive testing with methods acceptable to the [JAA Aeromedical Section]." A failure results in the applicant's assessment as "color unsafe" and not fit to fly.[7]

"We have seen a number of color deficient pilots and controllers perform well, without any adverse impact on safety."

"There's some commonality in regulatory standards, but there are also definitely differences," Rayman said. "Some people think there's no need for color vision testing. Others on the opposite side feel very strongly that it should be tested, should be a criterion for aeromedical qualification. I asked the question of a group of pilots one day, and they thought that in today's modern cockpit, there should be a requirement for reasonably normal color vision."

Dr. Quay Snyder, president and CEO of Virtual Flight Surgeons, an aeromedical consulting firm, said that in older aircraft, "you needed to identify light signals or navigation lights, and the displays tended to be monochrome. Now, with multifunction displays, both in the aircraft and in the air traffic control environment, there are multitudes of hues and intensities that are used, and the color deficient individual may have problems perceiving some of those displays."

Snyder, also an associate aeromedical adviser for the Air Line Pilots Association, International, added, "We have seen a number of color deficient pilots and controllers perform well, without any adverse impact on safety."

Among those who agree is Dr. Arthur Pape, a former official of the Aircraft Owners and Pilots Association of Australia and a designated aviation medical examiner who won a court challenge of CASA's color vision policies in the late 1980s. Pape, who has a color vision deficiency and holds a commercial pilot license, argued that color vision deficiencies were irrelevant to a pilot's safe operation of an aircraft.

"The disability of defective color perception is confined to reduced sensitivity to that property of light defined by its wavelength," he wrote in a paper published in 1994. "Color defectives have the same capacities as color normals to perceive form, motion, depth, luminance contrast, and so on … [and] the same capacities as color normals for complex perceptual motor skills that form a part of … flying airplanes."[8]

Contributing Factor

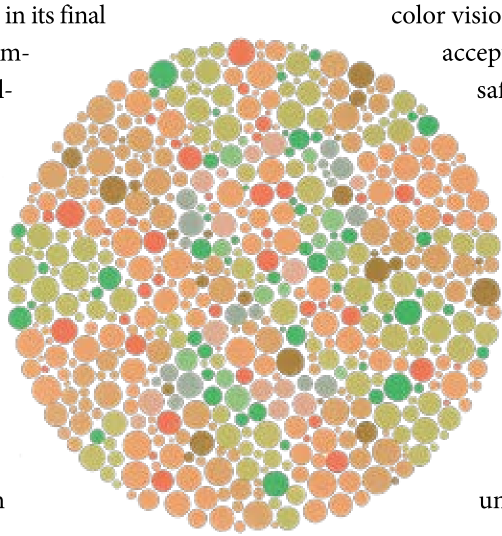
Only a few accidents[9] have been officially associated with a color vision deficiency, most notably the July 26, 2002, crash of a Federal Express Boeing 727-200F during a visual approach to Tallahassee (Florida, U.S.) Regional Airport in nighttime visual meteorological conditions. The three crewmembers were seriously injured and the airplane was destroyed in the crash, which the U.S. National Transportation Safety Board (NTSB) attributed to "the captain's and first officer's failure to establish and maintain a proper glide path."[10]

The NTSB cited as one of several contributing factors "the first officer's [the pilot flying's] color vision deficiency," which interfered with his ability to discern the red and white lights of the precision approach path indicator (PAPI).

Records showed that the first officer had passed all color vision tests during his 16 years as a U.S. Navy pilot but failed a test administered during an FAA medical evaluation in 1995; the test indicated that he had a mild red-green deficiency. The FAA issued a first-class medical certificate with a statement of demonstrated ability (SODA), based on his years as a Navy pilot and the results of his Navy color vision tests. His subsequent medical certificates were issued with the same SODA.

During a post-accident evaluation, the first officer passed the Farnsworth Lantern (FALANT) color vision test, which was designed to differentiate between people with mild red-green deficiencies, who pass the test, and people with more significant red-green deficiencies, who fail. He also passed a light-gun-signal test administered by an FAA medical examiner. However, he failed seven other red-green color vision tests and was determined to have a "severe congenital deuteranomaly" — a red-green deficiency that is the most common color vision defect.

As a result of its investigation, the NTSB included in its final report two recommendations calling on the FAA to research the effectiveness of color vision tests used by aviation medical examiners and use the research findings to develop a new standard battery of color vision tests.



Wikipedia

The FAA agreed to what it said would be a "substantial" research program, likely to continue for several years, saying that it recognized that color vision deficiencies, as well as the tests used to evaluate them, are controversial.

By late 2008, research had been completed but not yet made public on whether mild hypoxia might have contributed to the 2002 Federal Express crash. The study involved several color vision tests that were administered in an altitude chamber at simulated altitudes of 12,400 ft and 8,000 ft, with comparisons to test results recorded for participants at ground level.

Other research, cosponsored by the U.K. Civil Aviation Authority, was conducted under an FAA grant to City University London to compare pass/fail performance on various color vision tests with performance on simulated approaches involving PAPI lights.

Color vision research programs are continuing in several countries, not only to further explore the role of color vision in safe flight operations but also to develop new color vision testing protocols.

"A vast amount of work still has to be done in order to establish which color vision deficiencies can be accepted without loss of safety," the JAA said in its *Manual of Civil Aviation Medicine.* Ultimately, that work will aid in decisions about which color vision tests can "effectively divide applicants into 'color safe' and 'color unsafe' groups."[11]

Notes

1. ICAO. *Manual of Civil Aviation Medicine*. Part III, "Medical Assessment," Section 11.8, "Color Vision." Preliminary unedited version, October 2008.
2. American Optometric Association. *Color Vision Deficiency*. <www.aoa.org/x4702.sml>.
3. Mayo Clinic. *Poor Color Vision*. <www.mayoclinic.com/print/poor-color-vision/DS00233/>.
4. ICAO.
5. A similar requirement is included in a proposal under consideration by the European Aviation Safety Agency.
6. Evans, Anthony D.B.; Barbur, John L. "Colour Vision Standards in Aviation." *ADF Health* Volume 6 (October 2005): 62–66.
7. JAA. *Joint Aviation Requirements, Flight Crew Licensing — Medical*. Section 1, "Requirements," Item 3.225 "Colour Perception." Dec. 1, 2006.
8. Pape, Arthur. *The Aviation Colour Perception Standard*. Association Colours in Cockpit Web site, <www.vfcev.de/content/eng-index.html>.
9. In its response to two NTSB safety recommendations, the FAA said that, in addition to the Federal Express crash in Tallahassee, it had identified two other accidents involving pilots with valid medical qualifications in which a color vision deficiency was cited as a contributing cause. One was an Aug. 29, 1992, incident in which the pilot of a Mooney 20F with "a waiver for partial color blindness to red and green" landed on a closed runway that was marked with orange crosses in the dirt 50 ft (15 m) beyond each end. The pilot's "limited ability to detect the orange-colored marking" was cited as a contributing factor, along with his anxiety following a near-midair collision that preceded the landing. The other incident involved a Navy F4J lost on Aug. 5, 1980, "when a severely color deficient pilot failed to interpret correctly the colored navigation lights of other aircraft in the area, leading to the false impression of a collision."
10. NTSB. *Collision With Trees on Final Approach: Federal Express Flight 1478; Boeing 727-232, N497FE; Tallahassee, Florida; July 26, 2002*, Report NTSB/AAR-04/02.
11. JAA. *Manual of Civil Aviation Medicine*. Chapter 13 "Aviation Ophthalmology," Section 10 "Colour Vision." Feb. 1, 2005.

Innovations in avionics that help flight crews recognize unsafe situations emerged as a common thread of several presentations in the Joint Meeting of the Flight Safety Foundation 61st annual International Air Safety Seminar, International Federation of Airworthiness 38th International Conference and International Air Transport Association. How soon they might be adopted remains unclear, however, while governments and the aviation industry jointly resolve technology-policy issues and finalize regulations to require installation of automatic dependent surveillance-broadcast (ADS-B) avionics; encourage wider use of satellite-based navigation aids such as the global positioning system (GPS); and introduce avionics, automated charting and pilot training to encourage broader implementation of required navigation performance (RNP) area navigation (RNAV) flight operations.

Some of these innovations are prompting the U.S. government, for example, to reassess strategies being applied to difficult operational risks on airport surfaces, much as near-universal use of terrain awareness and warning system (TAWS) equipment already has done for in-flight risks. Scott Dunham, air traffic control investigator in the U.S. National Transportation Safety Board (NTSB) Operational Factors Division, said that both the NTSB and the U.S. Federal Aviation Administration (FAA) envision rapid and significant safety improvements, for

Flight deck upgrades, many via software, could unleash ADS-B, RNP RNAV and GPS on intractable aviation threats.

Repurposing AVIONICS

BY WAYNE ROSENKRANS | FROM HONOLULU

Wayne Rosenkrans

J.A. Donoghue

example, from airlines implementing advanced cockpit moving-map technology as soon as it fully meets industry expectations. "It looks like that is happening pretty quickly," Dunham said.

In recent months, Category A runway incursions, the most serious type, in Fresno, California, and Allentown and Reading, Pennsylvania — small U.S. airports unlikely to install advanced surface movement guidance and control systems (A-SMGCS) — underscored the lifesaving role that upgraded avionics could play for that threat alone. In Reading, a landing Cessna Citation collided with a tractor on a runway, without serious injuries. In the other two incursions, pilots perceived the imminent high-speed collisions and averted them by margins of 10 ft (3 m) and 30 ft (9 m), he said.

Decade-old NTSB recommendations for air traffic controller–centric warnings to pilots quickly are being overtaken by the avionics advances, particularly the cockpit moving map with ownship display — the term for the flight crew's aircraft — and new runway alerting systems, Dunham said. "We are big fans of ADS-B," he said. "The [NTSB] is on record saying we want to see ADS-B In [as well as ADS-B Out capability] … for position data from other aircraft to be available to the pilot in each aircraft [and] a data path into the aircraft that the industry can start using for things like conflict warnings and transmitting conflict data. When ADS-B gets a little more mature, that could become the communication path for traffic exchange with a lot of possibilities. But right now, we don't even have the path, so we need to get that done."

To implement ADS-B as the cornerstone of the Next Generation U.S. air traffic control (ATC) system, the FAA has to address dozens of issues that have cropped up, including cost-benefit objections and even competitive disadvantages raised by some aircraft operators, said Steve Brown, ADS-B co-chairman, FAA Aviation Regulatory Advisory Committee and senior vice president, operations, National Business Aviation Association. "ADS-B is a technology that is well proven — its technical capabilities and operational [safety] benefits are fairly well known and have proven to be very positive," Brown said. "But benefits barely exceed the costs, so one of the things that we have been working on is to strengthen the business case and identify ways for the FAA to provide more benefits at lower cost so that we have a more rapid transition to this technology."

Brown expects ADS-B to make significant contributions to U.S. airline safety. "It certainly helps to increase situational awareness, not only through the precision of the technology [in weather avoidance and surface movement] … but improved displays of aircraft position and [relative] position to other aircraft in the system," he said. "There also are position accuracy and terrain avoidance benefits … increasing separation assurance, and preventing collisions." The committee will continue advising the FAA in early 2009 on issues such as operator security, privacy and tracking with ADS-B technology, and public disclosure of information, he added.

The FAA has proposed a dual-link strategy for the United States that requires aircraft that operate at or above Flight Level 240 (about 24,000 ft) to broadcast data via the 1090 MHz

From top, Brown; Bateman; Henegar; and William R. Voss, FSF president and CEO.

All Photos: Wayne Rosenkrans

extended squitter (1090ES) data link, while aircraft that operate below that flight level would use the 978 MHz universal access transceiver (UAT) data link. "Most of the rest of the world is considering using 1090ES only, a single frequency, but there are some implications for the terrain-alert and collision avoidance system [TCAS] and some safety issues that may require the dual-link strategy [as] the preferred international standard," Brown said. "In very large urban areas — New York, Chicago, Tokyo — we could get to a saturation point, causing the system to degrade to an unacceptable point due to frequency congestion, with the anticipated growth in traffic. There are going to have to be some modifications to TCAS to deal with that saturation and the congestion of all of the radar signals and the ADS-B signals anticipated."

Transforming what originally were single-purpose avionics units into multi-purpose platforms, and/or creating safety-related synergies from discrete avionics units, makes possible additional safety-related capabilities at relatively low cost. "One of the great things that happened last year and early this year was the ability to change to moving-map display [applications in Class 2 electronic flight bags] in the cockpit," said Don Bateman, corporate fellow and chief engineer, flight safety technologies, Honeywell Aerospace. "[The Runway Awareness and Advisory System] was 'bolted on' the runway database that existed already so we would know the latitude and longitude of runway ends, and such things as displaced thresholds, runway widths and altitudes. We married that data with GPS data, and by putting in some aural/voice advisories, announced when pilots are entering a runway, when they are on a runway and so on. This requires no wiring, airlines just drop it into place. Coupling that with the moving map made a great combination."

Ongoing research and development seeks to deliver directly to pilots the automated collision warnings that U.S. air traffic controllers increasingly will receive as enhanced versions of airport surface detection equipment, model X (ASDE-X) are installed at more airports; this has been implemented outside the United States as an enhancement to A-SMGCS, Level 2.

"In spring 2008, we supplied two airplanes and modified their TCAS units so they would have [synthesized] voices that could talk to the pilots when the aircraft were converging," Bateman said. "At Boston Logan International Airport, we had instances where ATC was controlling opposite [traffic on] converging runways. We linked the ASDE-X aural warnings directly to each pilot to take care of the delay time that occurs between the ASDE-X warning to the controller and relaying it to a pilot."

In related research and development, using a simple two-frequency radio receiver, Bateman's engineers this year studied data currently being transmitted during high-volume airline operations at London Heathrow Airport. They used avionics simulators in a nearby hotel room for real-time display of aircraft takeoffs, landings and taxiing on digital maps by processing the data received from ADS-B Out avionics aboard large commercial jets. "We are not doing enough with this capability — and this is not something unique to my company, a lot of companies make equipment [that could exploit ADS-B data]," he said. "We need to get the ADS-B standards put to bed in a hurry."

Researchers also have merged new and existing avionics functions by creating software that places a "virtual ruled box" around a runway and adds TCAS algorithms that annunciate to the pilot — by aural alert and pictorially on the cockpit moving-map display — that a runway is occupied, except when the conflicting aircraft is exiting from this box.

With designers anticipating that GPS or equivalent position data will become common on airliners, other prototype software upgrades enable automatic monitoring of whether flight crews are conducting a stabilized approach per their airline's standard operating procedures, providing advance advisories of a deep landing or long landing, and capability to annunciate a go-around recommendation if the airline wants it. A crew that adheres to stabilized approach criteria gets no alerts from this stabilized approach advisory system.

"This software is dropped into existing hardware, such as an enhanced ground proximity warning system," Bateman said. "In the United States alone, however, we have 2,000 large airplanes without GPS. A lot of these technologies, such as moving map, require a GPS processing engine, which operators also need for ADS-B."

Other safety advantages in the context of satellite-based navigation and 21st century ATC services will emerge from avionics designed for RNP RNAV for approaches and departures that previously were not geographically, technologically or economically feasible, said Marc Henegar, director of RNP/RNAV initiatives, Air Line Pilots Association, International and a former technical pilot for Alaska Airlines. Nondirectional beacon and VHF omnidirectional range approaches are rendered obsolete when an airline implements an RNP RNAV approach offering a stabilized path with lateral and vertical guidance to the runway, including a precise missed approach path.

The level of precision alone strongly mitigates the risk of controlled flight into terrain (CFIT) in all phases of flight, Henegar said. "Instead of worrying about a visual procedure into a high-terrain environment, you have an RNP track that you can follow all the way to the airport," he said. This also helps pilots deal with frequent risk tradeoffs between conducting a nonprecision approach that adds significant time/distance to an arrival and conducting a visual approach with responsibility for terrain avoidance that could deteriorate with reduced visibility.

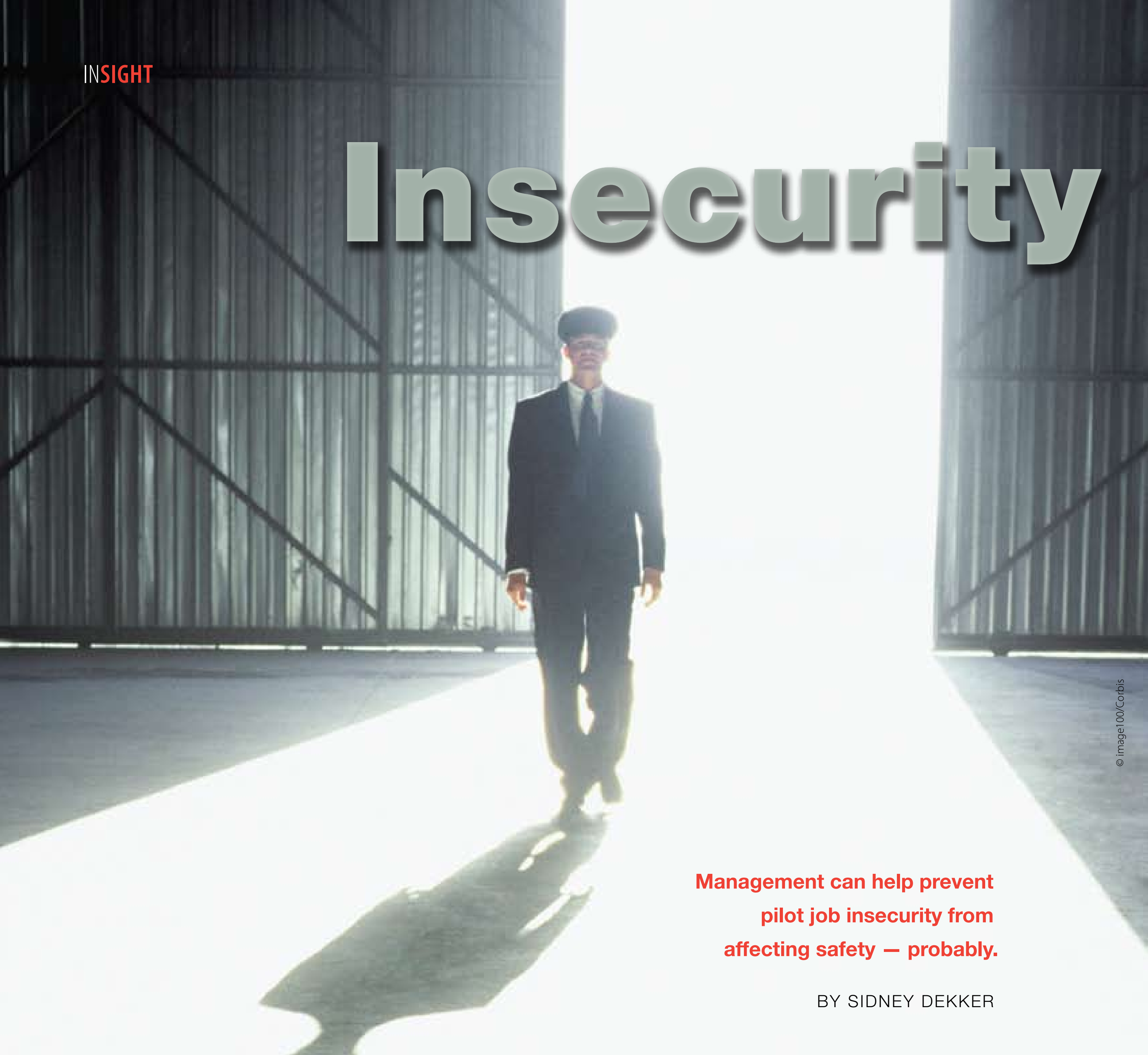
"We are getting to a tipping point where we have critical mass for RNP," Henegar said. "Using RNP RNAV procedures, each airplane takes less space and flies shorter, more efficient tracks and idle path descents; this allows less-restricted flying. When you use a vertical navigation path … you've got speed guidance [and] a repeatable lateral, vertical and time-based track."

Alaska Airlines has used RNP RNAV avionics on Boeing 737 airplanes for about 12 years for increased airport access during adverse weather and "tens of thousands of pounds" of extra passenger/cargo lift, Henegar said. Increased access to Juneau, for example, resulted from discontinuing use of a Runway 8 approach that has a minimum descent altitude of 3,000 ft and visibility of 4.0 mi (6.4 km), replacing it with an RNP RNAV approach providing minimums of 700 ft and 1.0 mi (1.6 km).

"On Runway 26, down a windy fjord, there was no approach; now there's an approach that goes down to 337 ft and 1.0 mi," he said. "[RNP RNAV] makes the difference between doing a night circling approach in a driving rainstorm to a 6,000-ft [1,829-m] runway that is wet, slick and with no overrun protection while providing my own glide path information, and simply following a flight director with an autopilot down to the runway in a controlled environment." Six other U.S. airlines are adopting some of the FAA's public RNP SAAAR (special aircraft and aircrew authorization required) approach procedures or internally developed special RNP approach procedures. Three non-U.S airlines are conducting special RNP approaches and departures, he said.

Entering 2009, avionics upgrades designed to target the persistent risks of CFIT, runway incursions and excursions, and runway collisions seem timely following a year when only loss of control displaced CFIT as the accident data category with the most fatalities in large commercial jets worldwide. James M. Burin, FSF director of technical programs, citing preliminary tallies of the number of accidents from Jan. 1 to Oct. 24, said, "We have already had 16 major accidents in 2008 in Eastern-built and Western-built commercial jets. Only six of these have been approach and landing accidents; this is quite unusual, a very low number, which is good. There have been two CFIT accidents, and five loss of control accidents. Four of these accidents have been runway excursions." Seven of 27 major accidents involving Eastern-built and Western-built commercial turboprop airplanes also have been CFIT accidents, yet a CFIT accident has yet to involve any commercial jet or turboprop equipped with properly updated and operating TAWS on the flight deck, he said.

Insecurity



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Management can help prevent pilot job insecurity from affecting safety — probably.

BY SIDNEY DEKKER

Last week my airline went bankrupt. I say "my" airline, but I wasn't actually employed by them. I flew as a first officer one day a week to stay current and have firsthand insight into practices on the sharp end.

So I still have my "real" job, that of university professor. But today, 300 pilots — and 900 other airline workers — don't. As disruptive and devastating as the effects of such a sudden collapse and the resulting layoffs are, they won't threaten flight safety at this airline, because flying promptly stopped.

But that's just one airline. As a global economic contraction accelerates, airlines around the world are grounding hundreds of planes. Singapore Airlines announced that it would reduce flights in Asia, and British Airways reported its traffic fell almost 5 percent in September alone. In the United States, airlines are cutting as much as 20 percent of their domestic flying schedules. You would think that would make for a lot of worried pilots.

I remember flying with one captain not long ago, who, for three hours during cruise, was

RISK

engaged in a heated soliloquy, lobbing questions my way every now and again about the multiple potential futures of the airline and, by extension, his own professional outlook. The questions were mostly about possible management actions — finding new investors, being taken over, having the current owners pump in more cash, trying intercontinental routes, merging with another airline in the same straits, or worse, declaring bankruptcy.

I could not answer any of the questions; I knew just as little as he. But the point of his monologue was perhaps for him to air his fears rather than for me to reply. Of course, the cruise portion gave us plenty of time to reflect on such matters. Though, some would say, you never did really check up on the minimum safe altitudes along your route, now did you? We were too distracted with matters of job insecurity. Others would probably say that the captain had flown these routes so often that he had the topographical map of the entire continent firmly in his head, knew the safe altitude numbers per waypoint by heart and could have recited them in his sleep.

How does job insecurity affect airline safety? My experiences and anecdotes count for little, I suppose, so let's turn to the scientific literature instead.

Which is, well … rather silent on the issue.

There are starting points, however, which, by inference, can lead us to interesting if speculative conclusions. Perhaps more important, the literature suggests what management and others could do to help bridge periods of intense job insecurity to prevent it from affecting safety.

In the early '90s, I was working with a transportation company in Australia which faced cutbacks, redundancies and layoffs. Having been employed initially as public service workers, nobody in the company had any idea that this could happen to them, and they were dismayed to find that they were not immune to economic contraction and organizational retrenchment. The workers almost universally showed the two predictable psychological effects that the literature has long since agreed on.[1]

The first is that uncertainty is almost always worse than certainty. Even if certainty means the loss of your job, it's psychologically better to know than not know and be consumed by fear of what might happen.

This is an acute problem for many pilots in an airline that faces an uncertain future. During the time that I flew with the airline that did finally go bankrupt, a number of pilots told me about their plans to jump ship. Some were considering the Middle East, Asia or business aviation. Others were contemplating leaving the industry altogether, still others were eyeing management slots as a way of cushioning the more volatile life as pilot on the line. But in most cases, these were just vague plans because all of these pilots were aware of the benefits of their seniority and the incomplete information and uncertainty on which they would have to base a decision to leave.

Colleagues who did leave were talked about with great admiration for their courage, particularly if they had landed good jobs elsewhere, or derided for the folly in giving up so early and trading their still-existing jobs and benefits for something perhaps less attractive. Not surprisingly, younger pilots found it easier to deal with the uncertainty because they generally had invested less, if they hadn't paid for their own type rating, that is. This is consistent with the research on job insecurity. The older or more senior the employees — or, in general, the less mobile they are because of their sunk costs — the less frequently they tend to leave in times of downsizing, and the worse the psychological and even health consequences.

Today, there is no such uncertainty for the pilots of "my" airline. With the jobs gone, all the perks are gone too, and it becomes a lot easier to start doing something else, to look for work elsewhere. And it's easier to start coping. That is why all psychological research points to the benefits of certainty over the debilitating effects

Even if certainty means the loss of your job, it's psychologically better to know than not know and be consumed by fear of what might happen.

Research shows that workers threatened with layoffs violated more safety rules.

of uncertainty. Certainty allows people to cope. Uncertainty teaches them to be helpless.

The second effect is detachment. Psychologists see the same effects in families of terminally ill patients: an increasing mental disinvolvement with the emotional object, so as to make an eventual loss a bit easier to bear. With the strong possibility of losing an object, even if it's a job, people start borrowing some of the psychological strain of that loss from the future. They start disconnecting themselves earlier, amortizing the pain.

The disinvolvement syndrome, as it is sometimes known, can be characterized by a loss of interest in the particulars of the job. One experimental study showed that knowledge of safety rules, and thereby compliance with them, decreases in people threatened with layoffs.[2] This period of disinvolvement can be punctuated by spikes of great hope that the organization — or the job, the seniority — may survive after all, which inspires people to expend greater effort, put in more time, go the extra mile. The implication is that management must be careful with the potential volatility of the information it provides, and instead try to smooth it out. Of course, management can never get this right. Either employees find that managers say too much, giving them hope or despair, or too little, leaving them uninformed and in limbo.

Research shows that workers threatened with layoffs violated more safety rules. They also produced lower quality outputs. In this, there may be a trade-off, as threatened workers are also more productive. Possibly that's because they want to create value for the company, or do anything possible to try to stay on as long as there is any hope left. Trading safety against productivity is something that is worth considering as a particular risk in airline operations, of course. Think of a diversion decision, or other go/no-go calls in which one alternative is more costly for the airline's bottom line and reputation — both likely already under pressure. Given this finding, one can question the sort of encouraging e-mails or memos from management that exhort everyone to "keep up the great work for our great product," or something to that effect.

What little research there is suggests that such messages may reinforce the idea that employees have more power over their own fates and that of their company than they actually have, and that their future may be secured through "good work." The problem is that the definition of "good work" is negotiable. Does that mean *safe* work? Safe work, after all, can interfere with more productive work, faster work, more efficient work. Safe work can mean *expensive* work.

So does "good work" perhaps mean work that does not cost the company unnecessary money, that gets people to their destinations on time, and that says, for example, "Yes, let's take off with those tires that are bordering on excessive wear, which I would like to have had changed but I don't feel I have a choice, so let's go"?

For management, it is impossible to find a good communicative balance between encouragement and realism, between hope and giving up, between telling people to keep up the good work and telling them not to take any unnecessary risks. Perhaps the only thing management can do is think twice about the meaning of such underspecified phrases as "good work," and consider the illusions they may put in people's heads about the supposed control such encouraged efforts may give them over their employment destinies. Indeed, follow-up research showed that a positive company safety climate, with top-level commitment to safety and safety communication, in addition to safety training and safety management systems, can moderate the negative effects of job insecurity and slow its corrosion of people's safety knowledge and safety compliance, and even keep incidents down in times of retrenchment, threatened layoffs and cutbacks.[3]

So what to do? For management: Keep the time of uncertainty to a minimum. Uncertainty means people suffer, their health can suffer and, indeed, safety can suffer. What about communication? When facing uncertainty, saying more is probably better than saying less. At least it shows an effort to keep everybody in the loop.

Think carefully about the choice of words in your communication, even if you know that you will never be able to find the right words until you can announce something like "we're bankrupt" or "we've found a buyer."

Never stop talking about safety, especially when the economic screws on your airline tighten and things look really gloomy. Go out of your way to celebrate people who put their foot down and courageously say "no" when others would have said, "Okay, we'll fly with those tires."

Regulators may have a rather hands-off approach during periods of downsizing and economic trouble.[4] They may be extra vigilant about a particular airline, if they have the resources, but do they know exactly what signs of trouble to look for compared with signs of trouble in boom times? In some countries, legislation forces employers to identify hazards and conduct a risk assessment whenever they consider downsizing or or some other significant reorganization. Of course this can lead, in some cases, to unnecessary paperwork and nonsensical bureaucratic accountability requirements.

Nonetheless, it is one model that could be followed. However, it would ask an airline to invest in an assessment of safety consequences when it could least afford the resources to conduct such an assessment. In a number of airlines which constantly operate on the brink of economic failure, this would mean that they would have to conduct such risk assessments during their entire existence. Nonetheless, there is merit in reminding management of the potential safety consequences of downsizing and in asking safety regulators to consider such consequences along the same lines.

The least a regulator could do is produce guidance on downsizing and organizational restructuring. Alternatively, if a regulator does not want to clutter the administrative load of a beleaguered airline in economic duress, it could make sure that its inspectors have a protocol or checklist that reminds them of what particularly to look for. Is the discussion about safety and risk alive in this airline, given its changing and probably deteriorating circumstances, and the pressures it feels to become faster and cheaper and better than all the other players in the market? What messages are being sent from management to the line? How long has the period of uncertainty lasted? Which groups are the most threatened, do they fall into certain age or seniority brackets and what does that say about their particular risks?

In these immediate post-bankruptcy days, I often think about the pilot who kept himself, and me, occupied during cruise with his inquisitive rantings about the possible futures of our airline. Today, there is no more future. Images of eerily quiet crewrooms, empty offices, stranded airplanes, abandoned buildings and mothballed uniforms in closets come readily to mind. Even the e-mail addresses stopped working, so I have no immediate way of contacting the captain to find out how he's doing. Yet when I picture him at home now, I feel physically affected.

If I believe the literature, though, he is better off today than he was during the weeks of uncertainty. That uncertainty has been replaced with certainty, and at least he can now start coping and looking for a new job — of which there are precious few, by the way. It somehow offers me small consolation.

Sidney Dekker, Ph.D., is professor of human factors and systems safety and director of research at the Center for Complexity and Systems Thinking, Lund University, Sweden. His books include The Field Guide to Understanding Human Error (ASW, *9/06*) *and* Just Culture: Balancing Safety and Accountability (ASW, *4/08*).

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2007 Accident Totals Improve for EASA Member State Aircraft

Fatal cargo flight accidents have decreased in recent years.

BY RICK DARBY

The accident rate for large commercial air transport aircraft registered in European Aviation Safety Agency (EASA) member states decreased from an average of four accidents per 10 million flights to an average of three per 10 million flights during the past decade, EASA reports.[1,2] But runway excursions have been involved in an increasing percentage of accidents, the agency says, based on data supplied by member states as required by International Civil Aviation Organization (ICAO) Annex 13, *Aircraft Accident and Incident Investigation*.

There were 34 accidents involving EASA member state–registered aircraft in 2007, 10 percent more than the annual average for the 1996–2005 period but fewer than the 39 in 2006 (Table 1). Fatal accidents in 2007, though, were half the number recorded in 2006 and half the 1996–2005 average. The 25 on-board fatalities in 2007 were 17 percent of the corresponding number for the previous year and 32 percent of the average for the 1996–2005 period.

Accidents and Fatal Accidents, EASA Member State Aircraft

Period	Number of Accidents	Fatal Accidents	On-Board Fatalities	Ground Fatalities
1996–2005 (average)	31	6	79	1
2006 (total)	39	6	146	0
2007 (total)	34	3	25	1

EASA = European Aviation Safety Agency

Source: European Aviation Safety Agency

Table 1

The rate of fatal accidents per 10 million flights for EASA member state aircraft in scheduled passenger operations was lower than that of non-EASA aircraft in all years of the 1998–2007 period (Figure 1).

"It is observed that during 2001, the rate of fatal accidents increased significantly above the decade average," the report says. "During that single year, six accidents — involving scheduled passenger operations — occurred which represent more than a quarter of all accidents in the decade. These accidents [involved] a Britten-Norman Islander with eight fatalities, a de Havilland DHC-6-300 with 20 fatalities, an Avro RJ100 with 24 fatalities, an Antonov An-28 with two fatalities, a CASA CN-235 with four fatalities and a Boeing 777-200 with one fatality."

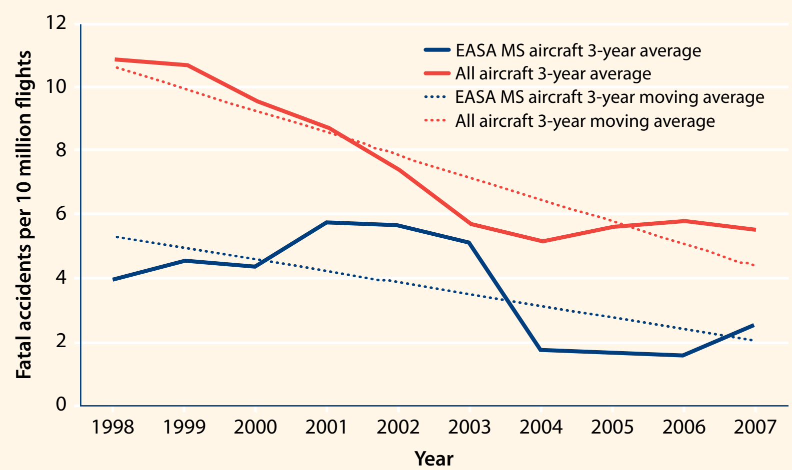
The three 2007 fatal accidents involved a Fokker 100 with one ground fatality, a de Havilland DHC-6-300 with 20 fatalities and a Beech 90 King Air with five fatalities. The latter two accidents occurred outside the European Union, in French Polynesia and Ukraine, respectively.

Although the small number of fatal accidents means that caution should be used in drawing conclusions about trends, the analysis of fatal accidents by type of operation shows a decline in cargo fatal accidents in recent years — one in the 2004–2007 period, compared with three in 1998, five in 1999 and four in 2002 involving EASA member state aircraft (Figure 2).

The report analyzed accidents involving EASA member state aircraft according to categories established by the Commercial Aviation Safety Team/ICAO Common Taxonomy Team (CICTT) to facilitate uniform accident and incident reporting (Figure 3, p. 52).[3] The categories with the highest number of fatal accidents are controlled flight into terrain (CFIT); loss of control in flight; and system or component failure or malfunction, related to the engine/powerplant (SCF-PP). Among nonfatal accidents, the most prevalent categories are abnormal runway contact; system or component failure or malfunction, non-powerplant (SCF-NP); and runway excursion.[4] A single accident can be assigned to more than one category if multiple causal factors are present.

"To further analyze accident category trends over the most recent years, SCF-PP and SCF-NP were combined into one category related to technical problems," the report says. The categories with the greatest number

Fatal Accident Rate, Scheduled Passenger Operations, All Aircraft

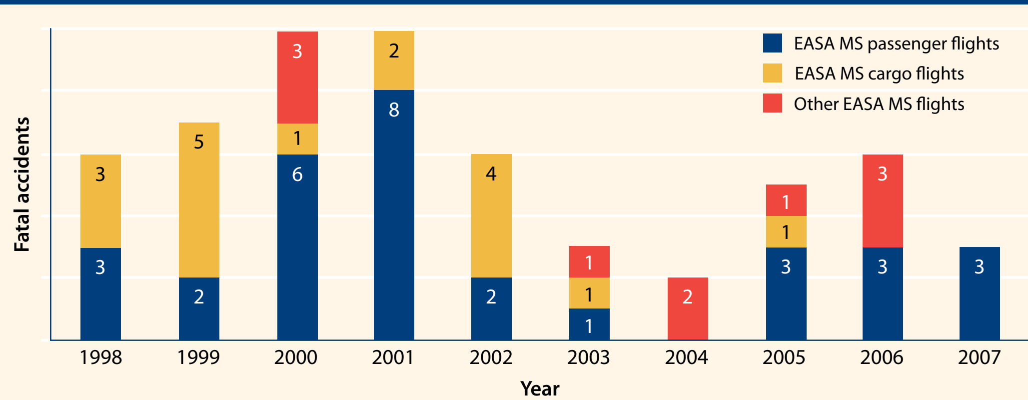


EASA = European Aviation Safety Agency; MS = member state

Source: European Aviation Safety Agency

Figure 1

Fatal Accidents by Type of Operation, EASA Member State Aircraft

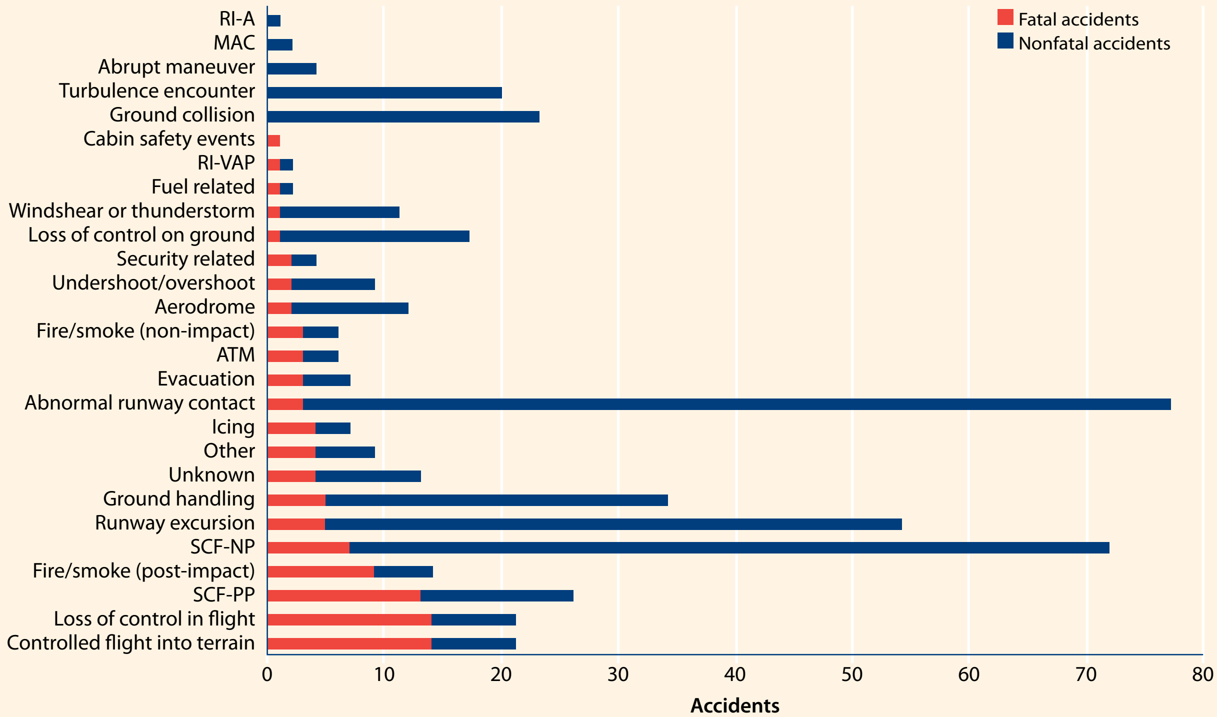


EASA = European Aviation Safety Agency; MS = member state

Source: European Aviation Safety Agency

Figure 2

Accident Categories, EASA Member State Aircraft



ATM = air traffic management/communication, navigation and surveillance; EASA = European Aviation Safety Agency; MAC = airprox/terrain avoidance and warning system alert/loss of separation/near-midair collision/midair collision; RI-A = runway incursion — animal; RI-VAP = runway incursion — vehicle, aircraft or person; SCF-NP = system/component failure or malfunction (non-powerplant); SCF-PP = system/component failure or malfunction (powerplant)

Note: An accident could be assigned to more than one category.

Source: European Aviation Safety Agency

Figure 3

of accidents assigned are runway excursion, system or component failure or malfunction, abnormal runway contact, and ground handling, with the CFIT percentage shown for comparison (Figure 4).

"Although accidents categorized under CFIT overall have a declining trend, they are presented in this review due to related safety actions taken in recent decades," the report says. Runway excursions show an overall upward trend. An accident could be assigned to multiple categories, so a runway excursion might be more a result than the main causal factor in an accident, but that was true throughout the study period, so the trend has face validity.

The report looked at helicopter accidents separately (Table 2). The number of accidents in 2007 was 53 percent less than in 2006, although it matched the 1996–2005 average.

Fatal accident numbers in the most recent year were a fourth of those in 2006 and a third of the average in 1996 through 2005. Between 1998 and 2007, there were 26 fatal accidents

Accidents, EASA Member State Helicopters

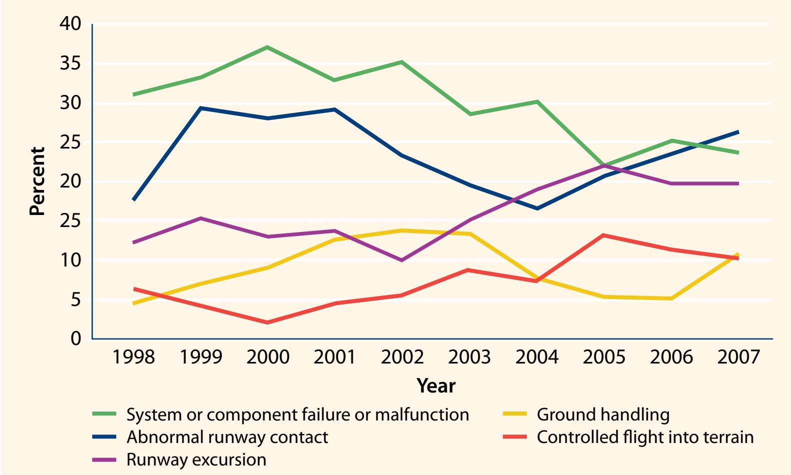
Period	Number of Accidents	Fatal Accidents	On-Board Fatalities	Ground Fatalities
1996–2005 (average)	7	3	11	0
2006 (total)	15	4	13	0
2007 (total)	7	1	7	0

EASA = European Aviation Safety Agency

Source: European Aviation Safety Agency

Table 2

Percentage of Accidents in Top Four Categories and CFIT Category, EASA Member State Aircraft, 1998–2007



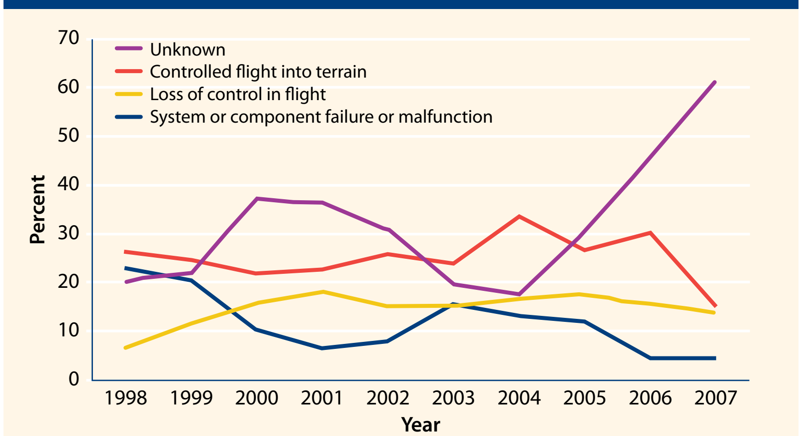
EASA = European Aviation Safety Agency

Note: An accident could be assigned to more than one category.

Source: European Aviation Safety Agency

Figure 4

Top Four Helicopter Fatal Accident Categories, Worldwide, 1998–2007



Source: European Aviation Safety Agency

Figure 5

involving an EASA state–registered helicopter, the report said, adding, "When looking at the three-year moving average, it appears that the number of fatal accidents has increased in the second half of the decade."

The greatest number of fatal accidents — 16 of the 26, or 62 percent — involving EASA state–registered helicopters was in emergency medical services (EMS) operations. That was a higher percentage of fatal accidents than for passenger, ferry/positioning and other operations. Worldwide, the percentage of EMS fatal accidents was considerably less. No flight hours data were available, however, so it is possible that EMS flights in EASA state–registered aircraft had greater exposure than those from many other areas.

Among helicopter fatal accidents to which categories have been assigned, CFIT ranked highest, followed by loss of control in flight. In recent years, CFIT has trended slightly downward (Figure 5). The sharp rise in the "unknown" category for 2004–2007 is probably a reflection of uncompleted accident investigations, the report says.

"Work with the data shows that the CICTT occurrence category taxonomy has limited usefulness when applied to helicopters," the report says. "New approaches will need to be developed to better trace the safety concerns in this segment of the aviation system. Consideration must be given to develop specific categories for such operations." Although the data are complete insofar as states have reported accidents to ICAO in accordance with Annex 13, "checks have revealed that not all states report in full and in time to ICAO," the report says.

Notes

1. The report, *Annual Safety Review 2007*, is available via the Internet at <easa.europa.eu/ws_prod/g/doc/COMMS/Annual%20Safety%20Review%202007_EN.pdf>.
2. EASA member states are the 27 European Union states plus Iceland, Liechtenstein, Norway and Switzerland. Data in this article concern aircraft with a maximum certified takeoff weight of more than 2,250 kg/5,000 lb.
3. The period from which data were drawn is presumably 1998–2007, although the report does not specifically say so.
4. Recent *ASW* articles about the Runway Safety Initiative and runway excursions include "Safety on the Straight and Narrow," "Margin for Error" and "Never Cross Red" (8/08) and "Snowed" (9/08).

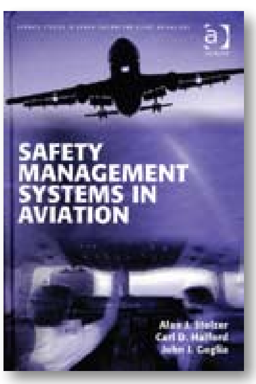
Designing Failure Out

Safety management systems offer a powerful combination of concepts, tools and methods.

BOOKS

Safety Management Systems in Aviation

Stolzer, Alan J.; Halford, Carl D.; Goglia, John J. Aldershot, England, and Burlington, Vermont, U.S.: Ashgate. 321 pp. Figures, tables, index.



It is now widely recognized that for the aviation industry to move beyond its already generally remarkable safety record, and seek the Holy Grail — *zero* serious accidents — the new paradigm will need to be based on foresight rather than reaction and on systemic rather than case-by-case risk reduction. Accordingly, thinkers and practitioners have turned to development of the safety management system (SMS) concept.

The term has become almost ubiquitous in aviation safety circles. Yet, SMS principles and processes are complex — this thorough book leaves no doubt on that score — and not always easy to grasp intuitively or intellectually.

The authors sum up the underlying idea: "SMSs provide organizations with a powerful framework of safety philosophy, tools and methodologies that improve their ability to understand, construct and manage proactive safety systems."

In contrast to what they call the "fly-crash-fix-fly approach" that dominated the safety improvement environment for most of the industry's history, the authors say, "Today we realize that it is much more productive to engineer a system in which, to the extent possible, causes of failure have been *designed out*." Accomplishing that requires "a working understanding of hazard identification, risk management, system theory, human factors engineering, organizational culture, quality engineering and management, quantitative methods, and decision theory." No wonder SMS doesn't yield up its meanings quickly.

The complexity of SMS can be gleaned from the authors' discussion of risk management systems. Noting that traditionally, risk was defined as the severity of an event multiplied by its likelihood, they say:

"Even the best safety analyses a few decades ago were forensic in nature. Note that [the traditional] definition of risk is also. The two measures on which this traditional calculation of risk is based both depend on an analysis of undesired events. Moreover, the data from which these calculations are drawn are historical. For example, suppose a hard landing occurs. A forensic approach to risk analysis would have the safety department look into the various safety databases maintained by the airline, and review the 'hard landing' reports on file."

From there, the safety specialists would create a matrix of the likelihood of such occurrences correlated with their severity. Based on that, most operators would determine appropriate mitigation and allowable time lines for corrective and preventive action, as well as assigning priorities based on relative risks of different kinds of occurrences.

"This analytic approach applied to understanding undesired events is a great improvement over that utilized in the past," the authors say. "However, this traditional 'severity *x* likelihood = risk' calculation is by its very nature backward-looking, and does not by itself capture the essence of SMS. An SMS also accomplishes risk analysis at the *constituent element* level of a system, where hazards are identified. In its most sophisticated form, risk analysis is based on model building, in which estimates of the range of potential severities, possible likelihoods and measures of the effectiveness of those controls put in place to mitigate hazards are allowed to interact with each other over and over in scenario-modeling software, with the result being a prediction of the most probable outcome of events."

The "four pillars" of SMS are designated by the U.S. Federal Aviation Administration in Advisory Circular 120-92, *Introduction to Safety Management Systems for Air Operators*, as policy, risk management, safety assurance and safety promotion. While this "orthodox disquisition" is conceptually sound, the authors say, "the SMS practitioner needs an in-depth understanding of the fundamentals, a comprehension deep enough to be able to enter any organization, at any level, and recognize the elements of a successful SMS as they might exist, in many different forms. Throughout this book, we will use every opportunity we can to take apart SMS and lay the components out on the table in front of us — examining those pieces in detail, and then putting it all back together only to take it apart in a different way. … Just as any complex system can be viewed from a variety of perspectives, each contributing to our understanding of the whole, deconstruction of the components of SMS can help us assure that we have a solid grasp of the discipline."

Conceptualizing and diagramming the SMS process, which the book aims to accomplish, doesn't exhaust the subject, however. There is still room for intuitive understanding.

"Recognizing a vibrant SMS is similar to distinguishing great art — you know it when you see it," the authors say. "Verification of the existence of an SMS is not presently accomplished (nor probably should it ever be) by merely the achievement of having eight of 10 boxes checked on the 'Is There an SMS Here?' form. SMS is far more organic and integral to the fabric of an organization … . But once you are an SMS practitioner yourself, spend a short time visiting an organization with a mature program, and you'll know, because safety management is everywhere you look."

REPORTS

Analyzing Vehicle Operator Deviations

Scarborough, Alfretia; Bailey, Larry; Pounds, Julia. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-08/17. Final report. July 2008. 40 pp. Figures, tables, references, appendixes. Available via the Internet at <www.faa.gov/library/reports/medical/oamtechreports/2000s/media/200817.pdf> or from the National Technical Information Service.*

Runway incursions involve not only aircraft, but ground vehicles as well. A vehicle operator deviation (VOD) occurs when a vehicle operator crosses an airport movement area — a taxiway or runway — without authorization from air traffic control.

"In this report, we present the results of an analytical study that examined the types of VODs that occur and recommend a process for improving the manner in which VOD investigations are conducted," the report says.

VODs can be analyzed according to a taxonomy called JANUS-GRO. "The goals of JANUS-GRO were to provide a common human factors framework for identifying human factors trends through better VOD reporting, designing VOD mitigation strategies and evaluating the success of VOD reduction efforts," the report says. JANUS-GRO consists of two broad error categories: factors directly related to vehicle operator performance and factors that contribute indirectly to vehicle operator performance. The first category consists of the task being performed, the mental processes involved and the vehicle operator's compliance with procedures; the second includes factors such as airport configuration, the amount of ground traffic, weather and noise.

VODs are supposed to be reported on FAA Form 8020-24, which records facts such as what happened, the location, the vehicle and aircraft, environmental conditions, information about the ground vehicle operator and pilots, and how the incident was detected. "Based on the information provided in Form 8020-24, we developed a directed model depicting the causal sequence of human factors associated with committing a VOD," the authors say. "We wished to move beyond simply describing VODs to forming predictive models that could serve as exemplars for designing improved VOD mitigation strategies."

A number of hypotheses were developed for testing, such as: "VOD types associated with the failure to follow signals, signs, markings and lighting are more likely related to maintenance and environmental contextual conditions compared to any other VOD type." The hypotheses were correlated with items from the reporting forms for 229 VODs.

Using logistic regression and other statistical analysis techniques, researchers found that "a lack of knowledge associated with the airport layout was instrumental in vehicle operators who completed driver training but became lost and/or were unable to locate the route they were instructed to follow. Knowing this, an airport operations manager could evaluate the airport's vehicle operator training program to determine whether improvements need to be made in how vehicle operators learn the airport layout and/or how they develop driving competencies for operating on and off the movement area."

The researchers found that vehicle operators are not always contacted to learn why they committed a VOD. "Instead, the causal factors are sometimes inferred by reviewing and/or interpreting the vehicle operator's behavior," the report says. "For example, if a vehicle operator committed a VOD as a result of a failure to follow movement area procedures, it may have been inferred that the vehicle operator lacked the knowledge about movement area procedures. However, the VOD may instead have occurred because the vehicle operator was distracted due to thinking about the task that he/she was going to perform after arriving at the destination. Without conducting an interview with the vehicle operator, there is no way to know for certain why the vehicle operator did not follow movement area procedures."

Lack of pertinent information seriously hampers efforts to reduce VODs, according to the researchers. "Our results illustrated that of all the information recorded on the current VOD reporting forms, less than 4 percent [was] associated with the vehicle operator's performance, such as task descriptions, noncompliance issues and mental processes," the report says. It suggests that the JANUS-GRO framework can be a step forward in improving reporting and investigation.

WEB SITES

Aircraft Icing Research Alliance, <icingalliance.org>

Aircraft Icing Research Alliance (AIRA), a partnership of Canadian and U.S. government agencies, says, "Aircraft icing is the most critical natural hazard affecting the safe operation of aircraft in the northern hemisphere." The Web site says that AIRA's mission is "to coordinate among the parties the conduct of collaborative aircraft icing research activities that improve the safety of aircraft operations in icing conditions."

Full-text icing presentations given at previous AIRA research implementation forums and AIRA sessions of the American Society of Mechanical Engineers conferences are available online at no cost. Presenters representing industry and government address icing aspects such as propulsion system icing, the physics of ice adhesion, airframe and engine company perspectives on icing challenges and opportunities, weather forecasting, and icing research.

Membership and collaboration efforts have expanded to include other countries. Collaborative icing research programs, ongoing and in development, are identified. Some listed programs link to presentations, training materials and images.

Source

* National Technical Information Service
Internet: <www.ntis.gov>

— Rick Darby and Patricia Setze

Wrong Direction

The pilots realized something was not right when they saw a mountain where there should have been water.

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

Faulty IRU Leads Aircraft Astray

Boeing 737-300. No damage. No injuries.

Investigators were unable to determine why on-board navigation displays showed the 737 correctly tracking east toward Makassar, on the southwest coast of Sulawesi, Indonesia, when the aircraft actually was on a curving course to the south. The flight crew did not notice the error until they saw a mountain while descending over what should have been the Java Sea.

The Feb. 11, 2006, incident was caused by a malfunctioning inertial reference unit (IRU) and concluded with an uneventful landing at Tambolaka Airport on Sumba, an island about 255 nm (472 km) south of Makassar, according to the final report published recently by the Indonesian National Transportation Safety Committee.

The pilot-in-command (PIC) was an inspector for Indonesia's civil aviation authority and occasionally flew for the operator to maintain proficiency in the 737-300. While preparing for the scheduled flight to Makassar from Jakarta at 2300 coordinated universal time (0600 local time), he found that the no. 2 IRU, a major component of the 737's inertial reference system (IRS), had failed. "The failed IRU was replaced by line maintenance engineers with a serviceable unit," the report said. "They tested and aligned the IRUs on the ground and found them to be functioning normally."

The PIC told investigators that he completed the alignment of the IRUs and initialized the IRS before departing from Jakarta at 2320. There were 146 passengers, six crewmembers and three flight attendant trainees aboard the aircraft.

The aircraft's flight management computer (FMC) normally receives data from the no. 1 IRU but automatically switches to the no. 2 IRU if a fault is detected. "The PIC reported that the takeoff, climb and heading changes on track were normal," the report said. "At 0025, the FMC changed, uncommanded, to [the no. 2] IRU, and the aircraft commenced a slow right turn. The PIC reported that he saw the caution 'IRS NAV ONLY' appear on the FMC, but the copilot cleared the message." The message indicated that the FMC was receiving only IRU data; the aircraft apparently was out of range of ground-based navigational aids.

Flight data recorder (FDR) data showed that the aircraft increasingly diverged south of the planned and programmed track. "The PIC reported that the divergence was not noticed because cockpit instruments showed [the aircraft] tracking toward Makassar," the report said. "This was confirmed by FDR data. … The reason for the aircraft diverging to the right when the FMC showed that it was maintaining the flight-plan track could not be determined using the available data."

"The pilots then referred to the standby compass and found that the aircraft's heading was 230 degrees."

The course deviation was not noticed by air traffic controllers. The report said that the controllers had not received training on a recently installed air traffic control (ATC) radar system, had not correctly programmed the new radar system's route-adherence-monitoring function, lacked "appropriate coordination [and] had a degraded awareness of their areas of responsibility."

The 737's transponder signal became weak as the aircraft flew south, and at 0041 the ATC radar track defaulted to the flight-plan track; thus, the 737 was depicted on the controllers' displays as following the correct path to Makassar.

During this time, the PIC — the pilot flying — administered oral quizzes separately to two flight attendant trainees; the quizzes lasted 20 minutes and 15 minutes, respectively. The report said that the PIC was not authorized to conduct the checks and that they diverted his attention from flying the aircraft.

The report also noted that "while in the cockpit, [the second flight attendant trainee] noticed that the sun was from the left side of the PIC seat, about 10 o'clock to the nose of the aircraft" and that "the PIC subsequently covered the left cockpit window with paper." The position of the sun indicated that the aircraft was heading south-southeast. "That should have been an indicator to the pilots that they had diverged significantly from the flight-planned track even though the navigation displays were indicating that they were tracking as planned to [Makassar]," the report said.

Believing they were 115 nm (213 km) from Makassar, as indicated by their electronic flight instruments, the crew received clearance from ATC to begin the descent from 33,000 ft. "When approaching 28,000 feet, the PIC saw a mountain on the right side of their track," the report said. "That topography was not expected because the flight to Makassar does not pass a mountain. The pilots then opened a map to find their position. … The pilots then referred to the standby compass and found that the aircraft's heading was 230 degrees."

The report said that the pilots consulted the quick reference handbook (QRH) but were unsuccessful in resolving the navigation problem because they did not complete all the actions prescribed by the QRH.

The crew solicited help from ATC and from pilots of other aircraft to identify geographical features in the area but were unable to fix their position. At 0214, the PIC told the copilot that one hour of fuel remained and that they might have to prepare for a ditching. The copilot then said, "There is a runway down there." The PIC decided to land at the unidentified airport.

"For the next 12 minutes while descending, the crew attempted to verify their position," the report said. "The PIC told the senior flight attendant that they would shortly be landing somewhere on Sulawesi island." After landing on the 1,920-m (6,300-ft) runway at 0240, the pilots found that they were on Sumba.

Investigators determined that both IRUs had malfunctioned during the flight. "The IRUs, when used by the flight management system, provided erroneous global position location to the FMC and flight instruments," the report said.

The investigation found evidence of repeated, unresolved IRU malfunctions in the operator's 737 fleet, including 18 in the two months preceding the incident. Nearly a year after the incident, the pilots of one of the operator's 737-400s were distracted by an IRU malfunction when the autopilot disengaged while en route to Sulawesi in bad weather. They became spatially disoriented and were not able to recover from the subsequent upset; all 102 people aboard were killed (*ASW*, 6/08, p. 36).

Service, Checklist Blamed for Gear Mishap

Embraer 170. Substantial damage. One serious injury.

After departing from Houston with 56 passengers and two flight attendants on May 30, 2006, the pilots were unable to raise the control lever to retract the landing gear. "The flight crew discussed the situation and did not believe they had a landing gear malfunction, as they did not receive an engine indicating and crew alerting system (EICAS) message [as shown on the checklist]," said the report by the U.S. National Transportation Safety Board (NTSB). "They decided to press the 'Downlock Release' button to raise the gear; the landing gear subsequently retracted, and the flight continued to the destination airport."

The nosegear did not extend when the crew prepared to land at Washington Dulles International Airport. The crew cycled the gear several times and performed checklist procedures, but the nosegear would not extend. "They continued in the traffic pattern while they briefed the flight attendants and passengers of the landing gear problem and instructed them to prepare for an emergency landing," the report said. "The flight crew flew an extended traffic pattern for Runway 19L and touched down normally on the main landing gear. The captain held the nose up until the airplane lost elevator effectiveness, and then the nose slowly settled to the runway."

After stopping on the runway, the crew initiated an emergency evacuation using the rear door slides. One passenger sustained a broken ankle while exiting the airplane.

Investigators found that routine nosegear service had been performed three days before the accident. The following day, a pilot reported that the nosegear was "low" and "sounded like it was bottoming out." The nosegear strut was checked by maintenance personnel and found to be within limits. The day prior to the accident, a pilot reported that the landing gear did not retract after takeoff. "Maintenance personnel believed the problem to be the landing gear control lever and replaced it," the report said.

Examination of the airplane after the accident revealed that the nosegear system contained only two-fifths of the normal hydraulic fluid quantity. Investigators found that, contrary to the airplane maintenance manual, the operator's maintenance job card did not include a procedure to complete nosegear servicing by filling the shock strut with hydraulic fluid.

Investigators also found that the "Gear Lever Cannot Be Moved Up" checklist used by the flight crew differed from the manufacturer's checklist and was not appropriate for the accident airplane. The checklist was appropriate for airplanes equipped with newer sensors that generate an EICAS message when the nosegear fails to retract or extend. The report said that the accident airplane did not have the newer sensors, and the crew incorrectly believed that the absence of the EICAS message indicated that there was no landing gear problem.

Camera-Battery Fire Forces Diversion

Airbus A320-200. Minor damage. No injuries.

The airplane was departing from New York's Kennedy International Airport with 130 passengers and six crewmembers the afternoon of Feb. 10, 2007, when a flight attendant responded to a call by passengers who saw smoke emerging from an overhead bin. The flight attendant found that the smoke was coming from a camera-equipment bag. After spraying the bag with a fire extinguisher, she removed it from the overhead bin, placed it in the aisle and continued spraying the bag until the smoke stopped, the NTSB report said.

After being notified of the situation, the flight crew declared an emergency, returned to the departure airport and landed the A320 without further incident.

Examination of the camera bag revealed that a 9-volt lithium battery had failed catastrophically. "Other batteries located in the same pocket of the equipment bag as the 9-volt battery had unprotected contacts," the report said. "[A] 14-volt [rechargeable lithium] battery pack displayed significant exterior thermal damage, consistent with damage from coming in contact with another battery."

The report said that battery fires typically result from short circuits when a battery comes in contact with other metal objects (*ASW*, 3/08, p. 42). "Batteries are generally not designed to be able to contain catastrophic failures," the report said. "When they go into thermal runaway, they often explode and expel their contents into the environment, potentially causing ignition in areas well beyond the initiating battery cell."

"Batteries are generally not designed to be able to contain catastrophic failures."

Guidance Lacking in Ground Accident

Boeing 747-200F. Substantial damage. No injuries.

A misunderstanding about the time at which the longest runway at Stockholm/Arlanda Airport would be closed for maintenance was among several factors that delayed the flight crew's preparations for the freighter's departure for a flight to Dubai the night of June 25, 2007, said the report by the Swedish Accident Investigation Board (SHK).

The flight crew started the engines as the 747 was pushed back from the cargo ramp. "After termination of the pushback, the parking brakes were set, and a [ground service] technician told the pilots that the pushback vehicle should be disconnected and removed," the report said.

The "After Start" checklist did not include a requirement for the flight crew to ensure that they received a thumbs-up "all-clear" signal from ground personnel before beginning to taxi. "About 45 seconds after the message from the technician that the pushback vehicle should be disconnected, the aircraft started to taxi without any clear signal," the report said. "The vehicle had been disconnected from the nosewheel and backed a bit so that the driver could change to the forward driving position. The vehicle was not backed far enough to get into the pilot's field of vision."

The technician and the driver of the pushback vehicle ran to safety before the 747's no. 2 engine struck the vehicle. The flight crew was making a right turn when the collision occurred. They heard a slight thud and felt a "juddering" that they attributed to the nosewheel skidding on the ground during the tight turn. About 30 seconds later, the no. 2 engine stopped producing power. The crew conducted the "Engine Failure" checklist and taxied the freighter back to the ramp.

"It was only while taxiing back in and parking the aircraft that the flight crew became aware that there had been an accident," the report said. The damaged engine leaked fuel, but there was no fire.

SHK determined that the accident was caused by "inadequate checklists for the pilots in respect of checking that an all-clear signal had been received" and that "stress and fatigue factors [likely] limited the concentration abilities of the pilots." The report noted that the pilots had been awake for 18 to 20 hours when the accident occurred at 0333 local time.

Two Out of Three Not Good

Cessna Citation 560. Substantial damage. No injuries.

The Citation was en route with three passengers on a charter flight from Teterboro, New Jersey, U.S., to Akron, Ohio, the evening of Dec. 17, 2006, when the pilots saw annunciator lights indicating that hydraulic fluid quantity and flow were low. Normal landing gear extension procedures failed, and activation of the emergency system resulted in extension of only the left main gear and nosegear.

"The flight crew then attempted to extend the right main landing gear by yawing and turning the airplane, and performing several g-loading maneuvers," the NTSB report said. However, airport traffic controllers confirmed that the right main gear was still retracted. The hydraulic system failure also prevented operation of the airplane's flaps, spoilers and thrust reversers. The right wing and fuselage were damaged when the Citation was landed on the 7,601-ft (2,317-m) runway.

Examination of the airplane revealed that a hydraulic pressure hose had ruptured because of internal wear between the hose's fire sleeve and stainless steel braid. "The installation position of the hose was such that it contacted an adjacent structure and was not restrained along its intermediate length," the report said. "The hoses had been manufactured in 1990 and accumulated a total time in service of 8,356.9 hours and 8,077 cycles. There is no life limit in place relating to the hose. … Following the accident, the airplane manufacturer was in the process of amending the airplane maintenance manual rigging procedures for the landing gear system and placing service time limits on hydraulic hoses."

TURBOPROPS

Double Jeopardy on Gravel Airstrip

Shorts SC-7 Skyvan. Destroyed. One fatality.

The 15,000-hour airline transport pilot had flown several aircraft, including a de Havilland Otter, to and from the airstrip at a remote lodge near McGrath, Alaska, U.S., but was performing his first landing there in a Skyvan during a cargo flight from Fairbanks on Sept. 1, 2007, the NTSB report said.

The pilot escaped injury, but the airplane was substantially damaged when the nosegear collapsed while rolling out on the gravel strip, which was 1,000 ft (305 m) long and 40 ft (12 m) wide. "Temporary repairs were made to the airframe, and a new nosegear assembly was installed by company maintenance personnel," the report said.

On Sept. 20, the pilot attempted to depart from the airstrip to ferry the Skyvan to the company's maintenance facility in Anchorage. "The lodge owner reported that the pilot started both engines and taxied the length of the airstrip, stopping momentarily several times. The pilot ran the engines for about 20 minutes and then began a takeoff. The airplane appeared to accelerate … but did not lift off until the very end of the airstrip."

The lodge owner said that he did not hear any unusual engine noises. After becoming airborne, the airplane struck treetops, veered right and crashed in a shallow lake. "The entire cockpit area forward of the wings was torn off the airframe," the report said. The pilot was unconscious when he was pulled from the wreckage and transported by helicopter to a hospital, where he died of his injuries five days later.

"Performance calculations indicated that the airplane's takeoff distance would have been about 950 ft [290 m], although the lodge owner said that, in his experience, the accident airplane was capable of lifting off about halfway down the airstrip without difficulty," the report said.

Rainwater Causes Short Circuits

Beech Super King Air 350. Minor damage. No injuries.

The King Air was at Flight Level (FL) 330 (about 33,000 ft), en route from Galway, Ireland, to Paris with eight passengers on Dec. 9, 2007, when the flight crew detected the odor of burning electrical insulation. "A mayday was transmitted to ATC, and an emergency descent to FL 120 was performed," said the report by the U.K. Air Accidents Investigation Branch.

Although no smoke was visible in the cockpit, the crew conducted the "Smoke Removal" checklist. "Shortly thereafter, the acrid smell returned, accompanied by smoke, prompting the crew to divert to Cardiff [Wales] Airport, where an uneventful emergency landing was performed," the report said. "Subsequent investigation revealed that the burning smell had been caused by electrical shorting due to moisture ingress into the right circuit breaker panel."

"The acrid smell returned, accompanied by smoke."

Before departing from Galway, the King Air had been parked outside in the rain for two days. The report said that rainwater had entered the circuit breaker panel after seeping through the right-window seal.

Company Collision on a Taxiway

Beech 99, Cessna 402B. Substantial damage. One minor injury.

The airplanes, operated by the same company, were en route on cargo flights to Milwaukee's General Mitchell International Airport in nighttime visual meteorological conditions on Jan. 24, 2007. The pilot of the Cessna 402, a twin-piston airplane, initially was cleared to land on Runway 25L but then was told to side-step and land on Runway 25R due to traffic.

After landing, the Cessna 402 pilot had a relatively long taxi route to the cargo ramp on the southwest side of the airport; the airport ground controller did not include any "hold short" instructions in the taxi clearance. Meanwhile, the pilot of the Beech 99 was cleared to land on Runway 25L. "The pilot acknowledged the landing instructions and reported that, due to traffic arriving and departing on Runway 25L, he decided he would try to 'land and exit quickly to expedite traffic flow,'" the NTSB report said.

The Cessna 402 pilot was in radio contact with the ground traffic controller when the Beech 99 pilot told the local traffic controller that he would exit Runway 25L on Taxiway A2, a high-speed stub taxiway at the intersection of Taxiway A, the taxiway that leads to the cargo ramp. "Neither controller had advised either pilot that another aircraft would be approaching the same taxiway intersection," the report said.

The Cessna 402 pilot was taxiing west on Taxiway B, a parallel taxiway north of Taxiway A, when the Beech 99 landed. The 402 pilot then was turning onto Taxiway A at an oblique angle when the Beech 99 exited the runway on Taxiway A2. Neither pilot saw the other airplane. "The Beech 99 pilot stated that as he turned onto Taxiway A2, he turned off the strobes, landing light and deicing equipment, and then reached for the radio to tune the ground control frequency," the report said.

Recorded airport surface detection equipment (ASDE-X) data showed that both airplanes were being taxied at 20 kt when they collided at 0200 local time. "The [airport] air traffic manager reported that the ASDE-X did not have conflict detection on taxiways [and] did not [provide an] alarm," the report said.

"The Cessna 402 pilot stated that … he was 'hit by a company Beech 99 from behind' [and] that the propeller on the Beech 99 ruptured the Cessna 402's wing tip fuel tank, creating a fireball," the report said. "The Beech 99 pilot stated that he 'heard a thump, looked up to my right and saw the engine engulfed in flame.'"

Radar data showed that the airplanes traveled more than 100 ft (30 m) before stopping. Both pilots shut down their engines and exited the airplanes. The Beech 99 pilot received minor injuries.

PISTON AIRPLANES

EMS Airplane Stalls on Go-Around

Cessna 414. Destroyed. Two fatalities.

The airplane was on an emergency medical services (EMS) positioning flight from Morgantown, West Virginia, U.S., to pick up a patient in Teterboro, New Jersey, the afternoon of Dec. 26, 2006. The 414, which had anti-icing and deicing equipment, was cruising at 9,000 ft when the pilot told ATC "we're getting iced up pretty bad here" and requested and received clearance to climb to 13,000 ft. Two minutes later, the pilot told ATC "I can't climb any farther" and requested clearance to descend to 7,000 ft.

The air route traffic controller cleared the pilot to descend to 5,000 ft and said, "If you want to level off on descent, that's approved." The pilot initially leveled off at 7,000 ft but then said "we're just barely keeping up with it" and requested and received clearance to descend to 5,000 ft.

A few minutes later, the pilot told the controller "I may get to a point where I can't hold my altitude" and that she would request clearance for an instrument approach "just to get me down to, like, twenty-five hundred feet to shed the ice off and go missed and then continue on my way."

The controller replied, "Right now, you're pretty much lined up for the localizer at Johnstown [Pennsylvania], so if you need to do that, just let me know." About a minute later, the pilot requested vectors for the instrument landing system approach to Runway 33 at Johnstown. The controller said that the airport's weather conditions included surface winds from 300 degrees at 15 kt, gusting to 20 kt, 7 mi (11 km) visibility and a 300-ft overcast with the ceiling varying from 200 to 600 ft. The pilot acknowledged the information and said, "If our ice comes off, we intend to go missed."

As the 414 neared the airport, the controller told the pilot that the ceiling was at 500 ft and visibility was 4 mi (6 km). The airplane was established on the localizer when the controller terminated radar services and told the pilot to contact the airport traffic control tower.

When the tower controller asked the pilot if she planned to land or conduct a missed approach, the pilot said, "It depends if my ice comes off or not. If the ice does not come off, we're going to land."

The tower controller saw the 414 break out of the clouds to the right of course at about 300 ft and believed that the pilot was conducting a missed approach. The controller then saw the airplane make a rapid left turn toward the runway and "drop like a rock." The tower supervisor saw that the landing gear was not extended and told the pilot, "Check wheels down." A few seconds later, the supervisor told the pilot to go around.

The landing gear was partially extended when the 414 touched down hard on the runway. "The pilot then attempted to abort the landing," the NTSB report said. "The damaged airplane became airborne, climbed to the right, stalled and nosed straight down into the ground." The pilot and flight nurse were killed.

Fuel Tanks Unport on Takeoff

Piper Chieftain. Substantial damage. One serious injury.

The pilot planned to fly the airplane from Columbus, Georgia, U.S., to Eufala, Alabama, about 30 nm (56 km) away, to refuel on Feb. 20, 2007. Refueling records indicated that on takeoff, 22 gal (83 L) of usable fuel remained in the Chieftain's inboard (main) tanks, which have a maximum capacity of 112 gal (424 L), the NTSB report said.

The airplane was about 800 ft above ground level (AGL) when both engines began to misfire. The engines then lost power as the pilot began a 180-degree turn back to the departure airport. The pilot realized that he could not reach the airport and attempted to land on a road. The Chieftain overshot the road and crashed into an embankment.

The report noted that the airplane operating manual says that when the inboard tanks are less than one-quarter full, turns on takeoff must be avoided to prevent fuel from moving away from the outlet ports. The manual states: "If the outlet is uncovered, the fuel flow will be interrupted and a temporary loss of power may result."

HELICOPTERS

Training Involved 'Dangerous Flying Activity'

Eurocopter EC135. Destroyed. One fatality, three serious injuries.

The helicopter was being used in police-training exercises in Sisjön, Sweden, on April 24, 2007. "The final part of the exercise consisted of so-called environmental training in which the [trainees] were to be given experience in feeling the violent effects of tactical helicopter flying," the SHK report said.

After performing several steep turns, the pilot flew at treetop level and began an abrupt climb. At about 300 ft AGL, the helicopter lost speed in a steep nose-up attitude before yawing left and beginning a steep dive. "At the conclusion of this maneuver, with high forward speed, the helicopter impacted the ground, the underside of the tail boom first and then the undercarriage skids," the report said. "It then capsized and rolled several times before coming to rest in a water-filled ditch. During the rolling, the cabin disintegrated and the passengers were ejected, fastened in their seats. The pilot [who was killed] remained sitting in the wreck and partly underwater."

SHK said that the accident was caused by the civil aviation authority permitting a "dangerous flying activity [and] the pilot's performance of the flight in combination with the possibility that the snow skids [plate-like devices] mounted on the helicopter's undercarriage may have affected the flight properties of the helicopter under extreme flying conditions."

Turbine Shaft Failure Forces Ditching

Bell 407. Substantial damage. One minor injury.

Soon after departing from a platform in the Gulf of Mexico on Aug. 16, 2007, the engine chip light illuminated. The pilot was turning back to the platform when he heard a high-pitched grinding noise and a pop before the engine lost power. "The pilot landed the helicopter safely on the water with the floats fully inflated," the NTSB report said. "Shortly thereafter, a large wave broke out the right windshield and rolled the helicopter inverted."

The pilot, who sustained minor injuries, and the passenger exited the helicopter and deployed a life raft. They were rescued by the crew of a shrimp boat. The power loss was traced to fatigue failure of the engine's power turbine outer shaft.

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Oct. 1, 2008	Kaliningrad, Russia	Boeing 737-300	substantial	144 none
The flight crew was unable to extend the landing gear and performed a gear-up landing at Kaliningrad-Khabrovo Airport.				
Oct. 2, 2008	Bangkok, Thailand	Boeing 747-400	none	1 serious, 13 minor, 151 none
En route from Hong Kong, the 747 was 128 nm (237 km) from Bangkok when it encountered severe turbulence at 40,000 ft. One passenger sustained a spinal injury.				
Oct. 5, 2008	Westerland, Germany	Cessna Citation 551	minor	2 none
During a positioning flight from Hamburg, the Citation was being landed at Westerland when the right main landing gear collapsed.				
Oct. 5, 2008	Nelspruit, South Africa	Britten-Norman Islander	destroyed	9 fatal
The Islander crashed near the summit of a mountain shortly after taking off for a visual flight rules (VFR) flight in marginal weather conditions.				
Oct. 6, 2008	Oaxaca, Mexico	Cessna 421	destroyed	2 fatal
The pilot was attempting to return to the airport after an apparent failure of the right engine on takeoff. The 421 was in a steep left turn when it crashed on the runway.				
Oct. 7, 2008	Indian Ocean	Airbus A330-300	minor	14 serious, 26 minor, 273 none
An inertial reference unit malfunction is suspected of having caused the A330's autoflight system to command an abrupt nose-down pitch change that resulted in a 650-ft dive from 37,000 ft while en route from Singapore to Perth, Australia.				
Oct. 8, 2008	Lukla, Nepal	de Havilland Canada DHC-6	destroyed	18 fatal, 1 serious
Visibility was reduced by fog when the Twin Otter struck a cliff short of the 1,600-ft (488-m) runway on approach to the airport, which is at 9,380 ft. The captain was the only survivor.				
Oct. 10, 2008	Longview, Washington, U.S.	Bell 206B	substantial	1 serious
The 206 was transporting an external load of tree limbs when the engine lost power. The helicopter rolled over during the forced landing in a ravine.				
Oct. 12, 2008	Bauru, Brazil	Beech King Air 100	destroyed	1 fatal
The King Air descended and struck terrain shortly after taking off for a cargo flight.				
Oct. 13, 2008	Sedona, Arizona, U.S.	Bell 407	none	1 fatal, 3 none
The search-and-rescue crew was picking up two hikers stranded on a mountain when the paramedic was struck by the main rotor blades while escorting a hiker to the helicopter.				
Oct. 14, 2008	Portland, Oregon, U.S.	Piper Chieftain	substantial	1 none
The pilot returned to the airport after the left engine caught fire during departure for a cargo flight. An exhaust-system clamp was found broken.				
Oct. 15, 2008	Aurora, Illinois, U.S.	Bell 222	destroyed	4 fatal
Night visual meteorological conditions prevailed when the emergency medical services (EMS) helicopter struck a lighted, 734-ft radio antenna, killing the three crewmembers and the patient.				
Oct. 17, 2008	San Pedro Garza García, Mexico	Cessna 402C	destroyed	3 fatal
The 402 crashed into a mountain at 5,700 ft after departing from Monterrey for a VFR flight to La Paz, Baja California Sur. Weather conditions included a 3,000-ft broken ceiling.				
Oct. 21, 2008	St. Martin, Netherlands Antilles	Robinson R44	destroyed	2 fatal
The EMS helicopter crashed at sea after departing from St. Martin to pick up a patient on Saba.				
Oct. 26, 2008	Kazan, Russia	MIL Mi-8	destroyed	4 fatal, 1 NA
The helicopter crashed between two houses during a test flight.				
Oct. 29, 2008	Jugiana, India	Beech King Air C90	destroyed	2 fatal
The King Air crashed shortly after departing from Chandigarh for a post-maintenance test flight.				
Oct. 31, 2008	Lanzarote, Canary Islands, Spain	Boeing 737	minor	80 none
The 737 overran the runway during a charter flight from Glasgow, Scotland.				

NA = not available

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