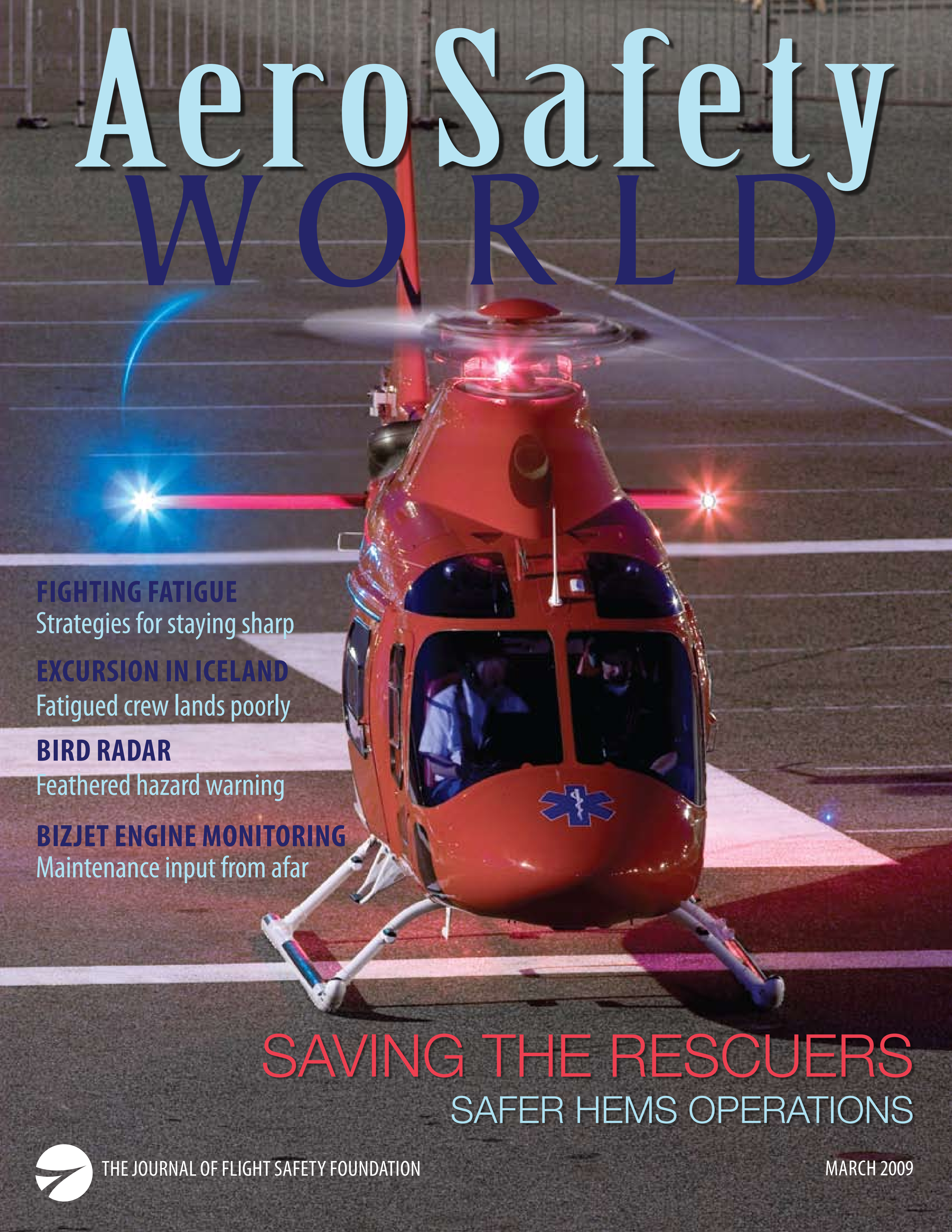
AeroSafety WORLD



FIGHTING FATIGUE
Strategies for staying sharp

EXCURSION IN ICELAND
Fatigued crew lands poorly

BIRD RADAR
Feathered hazard warning

BIZJET ENGINE MONITORING
Maintenance input from afar

SAVING THE RESCUERS
SAFER HEMS OPERATIONS

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

MARCH 2009

HIGH Expectations

During the last few weeks, I have been asked countless times to comment on what has been known as the "Miracle on the Hudson," the immediately famous ditching of US Airways Flight 1549, an Airbus A320, in New York City's frigid Hudson River. After being quoted on this event in a few hundred news outlets around the world, I want to say just three things about this accident.

First, I find it amazing that the ditching is the fourth in a series of major airline accidents where the aircraft was destroyed but everyone escaped with relatively minor injuries. I am thinking of the Air France Airbus A340 at Toronto, the British Airways Boeing 777 at Heathrow, and the Continental Boeing 737NG at Denver. At first everyone talked about how "luck" got everyone off the Air France aircraft, but now that there have been three more major nonfatal accidents, people are realizing, I think, that there is more to it than luck. Clearly, manufacturers are doing something right regarding the crashworthiness of the airframes, and the airlines have to take some credit for the extraordinary performance of the cabin crews.

Second, the US Airways accident is important because it reminds us that despite our best efforts, there will always be some residual risk. According to Bird Strike Committee USA, "a 12-lb Canada goose struck by a 150-mph aircraft at lift-off generates the force of a 1,000-lb [454 kg] weight dropped from a height of 10 ft. [3 m]." There is nothing we are ever going to do that will make it easy at 300 mph to avoid, or to safely fly through, a flock of geese. I have been trying to explain to the public that flying in a commercial airliner is one of the safest things they will ever do in their life, but it will never be without risk — and that is OK. That seems to make their heads hurt, but it needs to be said.

Finally, I was surprised at how emotional it was for me to listen to recordings of air traffic control (ATC) communications with Flight 1549. In less than a minute, the flight crew and ATC dealt with a normal departure, an emergency return, four runway options at two different airports and a ditching, handling the situation in a crisp and professional manner. The public seems amazed, but those of us who have dealt with emergencies in the cockpit and in ATC heard exactly what we expected to hear. *That is just what we do.*

We all grew up thinking about how we would handle a crisis like that, hoping that if the time came we would get it right. The thought of living up to that expectation is what made most of us fall in love with this business and stay with it. The desire to perform brilliantly at a critical moment is something that we all have in common.

So, take a second. Put aside the data, the crew schedules and the reporting systems, and have a quick listen to those ATC recordings on your computer. You undoubtedly will smile, remembering for a second how good it feels to be part of an industry where such high performance standards are just the way we do things.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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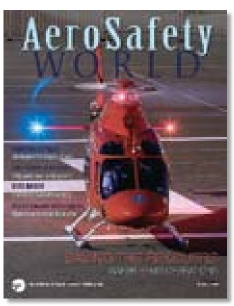

About the Cover
Report from NTSB's hearing on HEMS safety.
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Sales Contacts

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

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

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

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

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telephone: +1 703.739.6700

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

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

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

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

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

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

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

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

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

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

FIGHTING Fatigue

The growing body of evidence that we in the aviation industry are not defending adequately against the dangerous consequences of fatigue is reaching, from my point of view, critical mass. I have been of this opinion before (*ASW*, 11/06), but I have been wrong in assuming that changes would be made to adjust current practices to take into account the new information. Maybe this is the time.

In this edition of *AeroSafety World,* we have stories on several fatigue studies and a first-person description of air traffic controller shift scheduling, all calling into question the way we do things. And the way we do things is to largely ignore what we know very well about fatigue, choosing for the most part to stick with strategies that date to the 1930s or, beyond that, to simply ignore it, pretending, for example, that flying late into the night is no different than ending a flight sequence in mid-afternoon.

To say that this is a complicated matter with roots entwined deep in the history of aviation labor-management relationships and leave it at that is simply irresponsible, yet that is how the issue has been handled — or not handled — for decades.

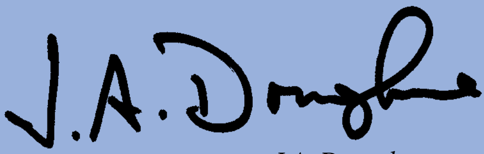
At the heart of this failure is the unfortunate fact that both sides are responsible to some degree for the development and persistence of poor practices. Labor, in the cases of controller schedules and other shift practices, seeks to maximize blocks of time off at the expense of rational work routines, and management tries to minimize staff sizes and travel expenses by condensing flight sequences into neat little packets that meet the letter of the rule but do violence to its spirit and ignore what we have learned about fatigue since those rules were established.

The insidious nature of how fatigue debilitates personal performance is another part of the problem. Despite the fact that fatigue repeatedly is cited as a causal factor in reports of accident investigations — as it is in the report in this issue of *ASW* on the landing incident in Reykjavik International Airport, Keflavík, Iceland — it is easy to dismiss this and other more serious events as simply poor piloting. But science shows that the problem with fatigue is not simply that someone is on the verge of sleep. Rather, it also manifests in a wakeful state in which performance is unknowingly degraded to a level equal to what is produced by drinking alcoholic beverages for quite a while, accompanied by an inability to detect that degradation.

Both sides of the labor-management divide must surrender ground to solve this problem. However, that doesn't mean that solutions must come with a high cost.

Several years ago at Flight Safety Foundation's International Air Safety Seminar in Paris, I was struck by the presentation of an innovative program launched by easyJet, with the approval of the U. K. Civil Aviation Authority, to experiment with different pilot scheduling sequences. The degree of a schedule's success was judged not by survey ("How do you feel?"), but by flight data analysis, closely tracking exactly how crews performed. Improved schedules, it turned out, were not hugely expensive to management or invasive of crew time.

The good science on this matter must no longer be ignored, and further science must be developed, if new rules are to be effective. Hopefully, the European Aviation Safety Agency's ongoing effort to update its pilot fatigue rules will establish an enlightened benchmark that others will follow.



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

Talking senses about cockpit alerts

The many issues raised in "Autoflight Audit" (*ASW*, 6/08, p. 30), related to the pilot-automation interface, reminded me of one thing I've lost transitioning from the old "mechanical" cockpit to the "glass" version, and that was the *click*.

Although not contemplated in the flight manuals, old cockpits actually signaled the flight mode annunciator changes with the audible click of a flipping flag, which caught a pilot's attention. Glass cockpits, friendly though they are, have grown silent; audible cues are categorized as cautions and warnings; and awareness has come to rely entirely on visual monitoring. The sole remaining discrete aural cue is the triple-click warning for landing capability degradation.

I think that modern cockpit design is wasting some resources in human input ability — the aural and tactile inputs. In high-workload flight phases, the use of cues other than visual optimizes the human interface. The click announcing a flight mode change is an extra that can capture a pilot's attention at the right moment, gaining seconds compared to the routine visual scan.

A moving throttle lever informs the pilot of the autothrottle system performance via his hand, while a static lever may require a visual confirmation of the commanded thrust indexes in the center panel at a critical heads-up moment. I believe modern cockpit design should try to use all available physiological capability as well as it uses all available technology.

Manuel Chagas
Airline pilot (A310), Portugal

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>.

MARCH 10–11 ➤ From JARs to IRs: Air Operations. European Aviation Safety Agency. Cologne, Germany. Elizabeth Schöffmann, <IR-workshops@easa.europa.eu>, <www.easa.europa.eu/ws_prod/g/g_events.php>, +49 221.89990.2025.

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

MARCH 15–18 ➤ Operations and Technical Affairs Conference. Airports Council International–North America. San Diego. <meetings@aci-na.org>, <www.aci-na.org/conferences/detail?eventId=141>, +1 202.293.8500.

MARCH 16–20 ➤ Aviation Safety Management Course. ScandiAvia. Stockholm. Morten Kjellesvig, <morten@scandiavia.net>, <www.scandiavia.net/index.php/web/artikkel_kurs/management_sto_2009_01>, +47 91.18.41.82.

MARCH 16–18 ➤ 21st annual European Aviation Safety Seminar (EASS). Flight Safety Foundation, European Regions Airline Association and Eurocontrol. Nicosia, Cyprus. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org/seminars.html#eass>, +1 703.739.6700, ext. 101.

MARCH 17–18 ➤ Managing Human Error in Complex Systems: An Introduction to HFACS and HFIX. Wiegmann, Shappell, & Associates. Atlanta. Dan McCune, <dnlmccn@yahoo.com>, <www.hfacs.com/services_hfacs.html>, +1 386.295.2263.

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 20–24 ➤ 64th IFALPA Conference. International Federation of Air Line Pilots' Associations. Auckland, New Zealand. Heather Price, <heatherprice@ifalpa.org>, <www.ifalpa.org/conference>, +44 1932 571711.

MARCH 23–27 ➤ Safety Management System Principles Course. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Page McCanless, <mpthomps@mitre.org>, +1 703.983.6799.

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 23–27 ➤ Safety Management Systems in Aviation Short Course. Cranfield University. Bedford, England. Graham Braithwaite, <g.r.braithwaite@cranfield.ac.uk>, <www.cranfield.ac.uk/soe/shortcourses/atm/page10263.jsp>, +44 (0)1234 754252.

MARCH 26–27 ➤ ADS-B Management Forum. *Aviation Week*. Washington. Alexander Moore, <Alexander_moore@aviationweek.com>, <www.aviationnow.com/forums/adsbmain.htm>, +1 212.904.2997.

MARCH 26–28 ➤ Annual Repair Symposium. Aeronautical Repair Station Association. Pentagon City, Virginia, U.S. Keith Mendenhall, <keith@arsa.org>, <www.arsa.org/2009SymposiumInfo>, +1 703.739.9488.

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

MARCH 30–31 ➤ SAR 2009: Search and Rescue Conference and Exhibition. The Shephard Group. Washington. Kathy Burwood, <kb@shephard.co.uk>, <www.shephard.co.uk/events>, +44 1753 727019.

MARCH 30–APRIL 2 ➤ International Operators Conference. National Business Aviation Association. San Diego. Dina Green, <dgreen@nbaa.org>, <www.nbaa.org/events/ioc/2009>, +1 202.783.9000.

MARCH 31–APRIL 1 ➤ Aviation Human Factors Conference: Real-World Flight Operations and Research Progress. Curt Lewis, Flight Safety Information; U.S. Federal Aviation Administration Safety Team, Southwest Region, and Fort Worth Flight Services District Office; International Society of Air Safety Investigators. Dallas/Fort Worth. Kent Lewis, <lewis.kent@gmail.com>, <www.signalcharlie.net/Conference>, +1 817.692.1971.

APRIL 20–21 ➤ Regional Air Safety Seminar: Air Accident Investigation in the European Environment. European Society of Air Safety Investigators. Hamburg, Germany. Anne Evans, <aevans@aaib.gov.uk>, +44 1252 510300.

APRIL 20–MAY 1 ➤ Advanced Accident Prevention and Investigation Course. Southern California Safety Institute and Czech Republic Ministry of Transport. Prague. Sharon Morphew, <registrar@scsi-inc.com>, < www.scsi-inc.com/Prague%20Announcements.html>, 800.545.3766, ext. 104; +1 310.517.8844, ext. 104.

APRIL 21–23 54th annual Corporate Aviation Safety Seminar (CASS). Orlando, Florida, U.S. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org/seminars.html#cass>, +1 703.739.6700, ext. 101.

APRIL 25–26 ➤ Regional Advanced Airport Safety and Operations Specialist School. American Association of Airport Executives. Buffalo, New York, U.S. Stacey Renfroe, <stacy.renfroe@aaae.org>, <www.aaae.org/meetings/meetings_calendar/mtgdetails.cfm?MtgID=090416>, +1 703.824.0500.

APRIL 28–30 ➤ World Aviation Training Conference and Tradeshow. Halldale Media Group. Orlando, Florida, U.S. Fiona Greenyer, <fiona@halldale.com>, <www.halldale.com/WRATS.aspx>, +44 (0)1252 532000.

APRIL 30 ➤ Annual Dinner/Meeting. International Society of Air Safety Investigators, Mid-Atlantic Region. Herndon, Virginia, U.S. Ron Schleede, <ronschleede@cox.net>, +1 703.455.3766.

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 4–7 ➤ Aging Aircraft 2009. Universal Technology Corp. Kansas City, Missouri, U.S. Jill Jennewine, <jjennewine@utcdayton.com>, <www.agingaircraft2009.com/index.html>, +1 937.426.2808.

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.

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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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Flight Safety Foundation
601 Madison St., Suite 300, Alexandria, VA, 22314-1756 USA
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Safety News

Communications Cleanup

Helicopter operators in the Gulf of Mexico should be evaluated after hurricanes and other events that might disrupt communications to ensure that the operators remain in compliance with their own communication contingency plans, the U.S. National Transportation Safety Board (NTSB) says.

The NTSB issued the recommendation to the U.S. Federal Aviation Administration (FAA), citing the Sept. 6, 2005, forced landing of a Houston Helicopters Inc. (HHI) Sikorsky S-76A in Gulf waters after both engines lost power about 24 mi (44 km) southeast of Sabine Pass, Texas. All 10 passengers and both pilots exited the helicopter before it sank; the pilots and three passengers had serious injuries, and the seven remaining passengers received minor injuries. All were rescued after about 7 ½ hours in the water.

The NTSB's final report on the accident said the probable cause was "the pilots' delayed response to the no. 1 engine fire warning and the loss of power to both engines, which occurred for undetermined reasons."

The report said that the pilots had not contacted base operations when they departed on the accident flight, or when they departed and arrived on the previous flight, as required by HHI's FAA-approved operations specification. The pilots said that, before Hurricane Katrina in August 2005, they had been able to make most of their calls on the company's communications network. When the accident occurred, the company's network and cellular towers in the area were still out of operation because of storm damage.

"Although other Gulf offshore helicopter operators secured alternate means for their pilots to communicate with their base operations … HHI did not take similar action," the report said. "Rather than provide a formal communications plan, HHI management suggested that its pilots use their own cellular phones or request assistance from oil platform personnel to relay flight departure information to base operations."

The report said that the accident pilots did not ask platform personnel to relay messages and did not contact a flight service station for assistance.

U.S. National Oceanic and Atmospheric Administration

"Each pilot reported in post-accident interviews that he assumed the other pilot made efforts to contact the company," the report said.

The NTSB said that search and rescue operations were delayed because of "the pilots' incomplete mayday call, the pilots' and HHI's noncompliance with company and FAA flight-following requirements and HHI's inadequate communications contingencies and procedures for reporting overdue flights."

The NTSB also cited the FAA's "inadequate surveillance of previously identified company deficiencies, including HHI's lack of adequate flight-following procedures," and said that the lack of surveillance "allowed HHI's corporate culture to remain lax with regard to safety."

Australia Increases Safety Oversight

Australian transportation officials have asked lawmakers to consider new legislation aimed at strengthening two aviation safety agencies and their oversight of airlines.

One proposal before the Australian Parliament calls for creation of a five-member board within the Civil Aviation Safety Authority (CASA) to "provide high-level direction to the organization's regulatory and safety oversight role," said Anthony Albanese, minister for infrastructure, transport, regional development and local government.

The measure also would improve CASA's ability to oversee foreign carriers operating in Australia, strengthen provisions for "preventing operators from continuing to operate services where CASA considers it unsafe for them to continue," and make it an offense to negligently carry dangerous goods on an airplane, Albanese said.

The second proposal would re-establish the Australian Transport Safety Bureau (ATSB) as an independent statutory agency outside the government's Infrastructure Department. The measure also would give the ATSB new authority to "compel agencies and operators within the aviation industry to respond to its formal recommendations within 90 days" — a provision that Albanese said would increase public confidence "that the lessons from past accidents will be acted upon in a timely manner."

He added that additional measures to strengthen aviation safety would be outlined in an aviation white paper expected to be finalized later this year.

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Charges Filed in Teterboro Crash


U.S. National Transportation Safety Board

Five officials of the company that operated the Bombardier Challenger 600 that crashed on takeoff from Teterboro Airport in New Jersey, U.S., on Feb. 2, 2005, and a company pilot — who was not one of the crewmembers on the accident flight — have been charged in a 23-count indictment in connection with the crash (*ASW*, 3/07, p. 30).

The U.S. Attorney's Office in New Jersey said that the charges against the officials of Platinum Jet Management of Fort Lauderdale, Florida, included conspiracy to commit continuous willful violations of regulatory requirements for the operation of commercial charter aircraft.

The indictment accused the men of "routinely undertaking and concealing dangerous fueling and weight distribution practices" on the airplane, which overran a runway, crashed through an airport perimeter fence and onto a six-lane highway and struck a warehouse before coming to a stop. Nine people in the airplane and one person in the building received minor injuries in the crash, which destroyed the airplane.

The U.S. Attorney's Office said that the airplane had been "over-fueled in a manner that caused the plane's center of gravity to exceed its forward weight limit for takeoff, contributing to the crash." The office said that the over-fueling practice was commonly used by Platinum Jet to increase company profits.

Acting U.S. Attorney Ralph J. Marra Jr. added, "The fuel loading was the primary contributing factor in the crash. It is astounding — and criminal — that owners and operators of jet aircraft would repeatedly engage in such a dangerous game with passengers and airplanes loaded to the brim with jet fuel. What this indictment alleges is an anything-goes attitude by the defendants to get their planes in the air and maximize profits without regard to passenger safety or compliance with basic regulations."

Marra's office said that the six men "joined a conspiracy to defraud charter flight customers, jet charter brokers and the Federal Aviation Administration (FAA) through interstate wire communications, and to defraud the United States by impeding and obstructing the FAA's regulation of commercial aircraft."

Laser Warnings

Pilots are being warned of increasingly common incidents involving laser illumination of aircraft, which — especially at low altitudes — can cause glare, flash blindness and other visual disturbances.

The International Federation of Air Line Pilots' Associations (IFALPA) says that although laser illuminations can result from outdoor laser light shows, most recent incidents have resulted from deliberate action by a person with a hand-held laser pointer.

"This is either because the perpetrator has a lack of understanding of the consequences or, of more concern, the perpetrator understands the hazards of lasers and illuminates aircraft with the intent of doing harm," IFALPA says in a *Medical Briefing Leaflet* for pilots. "The problem has become more pronounced with the easy availability of powerful lasers, often purchased via the Internet."


Wikimedia.org

As an example of recent incidents, IFALPA cites the laser illuminations of at least four aircraft on approach to Sydney Airport in Australia in March 2008. The green laser beams came from four locations, IFALPA says, noting that in response to the illuminations, air traffic control (ATC) changed the runways in use.

Exposure to laser beams has resulted in burning of the cornea, the surface layer of the eye — a temporary condition made worse by rubbing the eye — but has rarely been associated with more serious, lasting damage.

IFALPA advises pilots, in the event of laser illumination, to look away from the laser, shield their eyes, engage the autopilot and, if possible, turn over control of the aircraft to a crewmember who was not exposed. Turning up cockpit lights can minimize the effects of further illuminations. The crew should inform ATC and later file a more detailed report with authorities, IFALPA said.

Airport Turf

Synthetic turf designed to improve airport safety has been installed at the edges of one runway at Paris Charles de Gaulle International Airport.

FieldTurf Tarkett, the turf manufacturer, says the synthetic turf is designed to improve visibility by creating a visual contrast that makes the edge of the runway more conspicuous; reduce dust and debris on the runway; eliminate sources of food, water and shelter for wildlife in the area; and improve drainage.

Similar airport synthetic turf systems are in place at several other airports, including those in Boston, Hong Kong, New York and San Francisco, the manufacturer said.

U.S. Federal Aviation Administration

Infrastructure Upgrade Urged

The aviation infrastructure in the Middle East is not keeping pace with the industry's growth and must be upgraded to improve efficiency and capacity, an official of the International Air Transport Association (IATA) says.

Majdi Sabri, IATA regional vice president for the Middle East and North Africa, told a Civil Air Navigation Services Organisation conference in January that governments, air navigation service providers and other aviation groups must address the inefficiencies in air traffic that are threatening expansion of the industry.

Wikimedia.org

"That means looking beyond national borders to the regionwide implementation of en route airspace and terminal control areas based on performance-based navigation," Sabri said. "It calls for investment in improved aeronautical information management and communications infrastructure. And it means making better use of aircraft and air traffic management technology to achieve an airspace structure that is based on user-preferred flight paths."

Air travel in the Middle East makes up 10 percent of international traffic, up from 5 percent seven years ago, IATA said.

Next Phase for NextGen

The U.S. Federal Aviation Administration (FAA) is ready for a new phase of its Next Generation Air Transportation System (NextGen) — the plan to transform the national airspace system with an infusion of advanced technologies to meet future safety, capacity and environmental needs.

The next phase of the program focuses on the avionics that will support NextGen operational capabilities expected to be in place by 2018.

"NextGen investment requires more than FAA investment, it requires industry investment," said Michael Romanowski, FAA director of NextGen integration and implementation, adding that the agency needs more input to determine exactly how NextGen will develop in the next few years and how aircraft should be equipped.

"The FAA cannot completely answer these questions on our own," he said. "We can't gain the traction we need to move forward unless we have the guidance, support and cooperation of the aviation community as full partners in this area, particularly in the area of equipage."

To provide this guidance, RTCA, an industry association that functions as an advisory committee to the government, has established a task force to develop recommendations on "how to get the most benefits from the NextGen mid-term operational capabilities," the FAA said.

U.S. Federal Aviation Administration

RTCA said its task force will "recommend when, where and how the FAA and operators should implement the needed infrastructure, aircraft equipage, policies, procedures, training and other actions" for NextGen operations.

NVG Training

U.S. Air Force

A 17-month trial of night vision goggles (NVGs) has ended in Australia, and approved operators are continuing to use the devices in designated operations and in training.

The Australian Civil Aviation Safety Authority (CASA) has approved the use of NVGs for operators conducting flights for emergency medical services, law enforcement, search and rescue, marine pilot transfer, aerial fire fighting and NVG training. Their use has not been approved in private flight operations, except for training.

CASA plans to evaluate applications for NVG operations throughout 2009, and to oversee the safety of NVG use in operations that already have been approved.

Single Sky

Eurocontrol says it has taken a big step toward integrating all major groups involved in air traffic management with the first meeting of the Air Navigation Services Board, a 15-member panel designed to help shape Eurocontrol's work in support of the Single European Sky.

The new board represents air navigation services providers, airspace users, airports and the military.

Board Chairman Dieter Kaden said after the February meeting that the board's primary objective is to develop a consensus on priorities and "enhance the efficiency of the overall [air traffic management] supply chain."

In Other News …

The ANA Group plans to extend the **line operations safety audit** (LOSA) — in which trained observers record flight crew actions during a flight — to all six member airlines. In 2006, ANA became the first Japanese airline to implement LOSA. … A new **surface surveillance** system to improve visibility from aircraft and ground vehicles on runways and the apron (ramp) is being installed at Montreal-Pierre Elliott Trudeau International Airport. Sensis Corp.'s Multistatic Dependent Surveillance technology uses airport sensors and aircraft transponder signals to triangulate aircraft locations and provide the information to air traffic controllers. … For the first time, the European Aviation Safety Agency has granted a **type certificate** to a transport aircraft from the Commonwealth of Independent States. The certificate was issued for the Tupolev Tu 204-120CE, a cargo version of the Tu 204.

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Fire fighters look at the wreckage of a Colgan Air turboprop that crashed into a home in suburban Buffalo, New York, U.S., on Feb. 12, during an approach to Buffalo Niagara International Airport. The crash killed all 49 people in the Bombardier Q400 and one on the ground; the airplane was destroyed. The U.S National Transportation Safety Board is investigating.

Compiled and edited by Linda Werfelman.

Flight Safety Foundation and Me

BY SID BAKER

The sudden death of Sid Baker, vice chairman of Flight Safety Foundation's Corporate Advisory Committee, just a few days after he sent us the following column, was a sad shock to everyone who knew Sid. Recently retired as head of Kodak's flight department, Sid, 63, was already eager to take on new challenges. He will be missed by all who knew him and worked with him.

Since you are reading this magazine, you and I have something in common — a passion for safety, particularly aviation safety. I was bitten by the safety "bug" not long after I started flying. I can still remember the importance placed on maintaining a safe environment and the expectation that all of us would operate safely. Granted, that was in a military flight school, but the same principles and consequences apply to every situation we encounter today. Those who are corporate aviation safety managers all have the same purpose — to achieve predictable outcomes based on proven procedures and practices that enhance the opportunity for our companies to become more successful.

Most of us began our careers thinking we were the center of the operation. As we matured, we realized that the reason there is an aviation department is to facilitate the success of the company — not so we could fly airplanes! We cannot guarantee the company's success, but we can certainly enhance the chances of success by providing a rapid response to travel needs with the flexibility to modify schedules while also operating safely and securely into many varied locations not served by our airline counterparts.

We eventually realized that we are part of a system larger than our individual companies, and that we can impact that system either positively or negatively. Flight Safety Foundation helps to make that impact favorable.

No other organization views aviation as a global operation involving manufacturing, operations, maintenance, air traffic control and regulation with a regional — as well as a universal — outlook on safety. The Foundation recognizes that not all aviation efforts are equal, with vast differences among regions, among operators and among controlling agencies. The Foundation offers a forum to address these varied safety issues in a nonpartisan manner, appealing to government agencies in all countries and offering suggestions, support and advice to those concerned with maintaining a safe air transportation system.

The Foundation offers a venue to meet and trade information with other aviation professionals. The Foundation represents our safety interests to government agencies around the world. The Foundation represents you and me on safety matters in venues we cannot access, and that absolutely affect how we do our jobs and how we can contribute to the success of our companies. The Foundation has taken the leading role in dealing with fatigue issues, preventing approach and landing accidents and controlled flight into terrain accidents, checklist construction, corporate flight operational quality assurance programs, explaining the advantages of safety management systems, and petitioning governments to prevent the criminalization of the accident investigation process. The Foundation likely will lead future projects that will identify risks and formulate responses to enhance safety, which facilitates our companies' drive to succeed.

The Foundation is important to me and to you. It is important to our companies, it is important to our nations, and it is important to our global economy.

We are the Foundation; it works through us and for us. I am proud to be associated with the Foundation and look forward to all we can accomplish in the future.

Closing the LOOP

BY LINDA WERFELMAN

Alarmed by a surge in fatal accidents in 2008, the NTSB is spearheading an effort to identify new safety measures for helicopter EMS operations.

Helicopter emergency medical services (HEMS) missions in the United States have among the highest fatal accident rates in the aviation industry, and their pilots and medical crews are more likely to be killed in crashes, a medical data specialist has told a federal panel probing the recent surge in HEMS accidents.

"You can't manage what you can't measure," Dr. Ira Blumen, program and medical director of the University of Chicago Aeromedical Network, said, telling a U.S. National Transportation Safety Board (NTSB) public hearing on HEMS safety issues that efforts to prevent HEMS accidents have suffered because of incomplete accident data.

Blumen said that a detailed analysis found that 146 HEMS accidents, including 50 fatal accidents, occurred between 1998 and 2008. Of the 430 people in the accident helicopters, 131 were killed, including 111 crewmembers, 16 patients and four others.

In 2008 — the most deadly year on record for HEMS in the United States, with 13 crashes, nine of them fatal, and 29 fatalities — the fatal accident rate was 2 per 100,000 flight hours, he said (Figure 1, p. 17, and Figure 2, p.17). In 2007, according to calculations based on a 10-year average, the fatality rate was 113 per 100,000 HEMS crewmembers. In comparison, according to U.S. government data for 2007, workers in what typically is the highest-risk occupation in government statistics — fishing — were killed at a rate of 111.8 per 100,000. A study of data from 1980 through 2008 showed that HEMS patients died at a rate of 0.76 per 100,000 patients flown, Blumen said.

"We've crunched a lot of numbers," he added. "I truly believe that we have the ability to save lives, but unfortunately, we also have the ability to take them."

NTSB member Robert Sumwalt, who headed the four-day hearing in early February, called the recent accident record "alarming and unacceptable," and added, "The safety board is concerned that these types of accidents will continue if a concerted effort is not made to improve the safety of emergency medical flights."

The motivation for the hearing, Sumwalt said, was "to find innovative ways to improve HEMS safety." He said the hearing might lead to an updated study of HEMS operations, issuance of new safety recommendations or development of a "white paper" that addresses HEMS safety issues and provides guidelines for resolving them.

In recent years, the NTSB has issued numerous recommendations aimed at improving HEMS safety, many of them calling for regulatory action by the U.S. Federal Aviation Administration (FAA). Several of those recommendations currently are included in the NTSB's list of "Most Wanted" safety improvements:

- Conduct all flights in which medical personnel are on board in accordance with Federal Aviation Regulations Part 135, which governs charter aircraft operations — not general aviation operations, which are subject to more lenient weather and visibility restrictions;

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- Develop and implement programs to evaluate the safety risks of each flight;
- Require formalized procedures for dispatch and flight-following, including the use of current weather information; and,
- Install terrain awareness and warning systems (TAWS) on all EMS aircraft.

These recommendations were issued previously, in a 2006 special investigation report by the NTSB on airplane and helicopter EMS operations.[1] The report analyzed the crashes of 55 EMS aircraft, concluding that 29 of the 55 could have been prevented if the four safety actions recommended had already been in place.

Nineteen other recommendations were issued in 1988, after a safety study that evaluated 59 earlier HEMS crashes.[2]

John Allen, director of the FAA Flight Standards Service, said that the FAA is "working with the NTSB to close the loop on an industry that is safe but not as safe as it could be." Allen noted that most of the nation's more than 830 EMS helicopters have flown for years without a fatal crash — and many have never experienced any type of accident.

Nevertheless, he cited accident statistics — especially the increases recorded in 2008 in HEMS accidents and fatalities — as proof that intensified safety efforts are needed. Allen credited an earlier round of safety initiatives with a reduction in HEMS accidents in the years preceding 2008 and said that, because of the decrease, the FAA had not implemented new regulations.

"We believe the existing regulatory structure is safe; the numbers prove it," Allen said. "However, the upward trend in 2008 has prompted a more aggressive response to this problem."

FSF Endowment Will Aid HEMS Research

Flight Safety Foundation has received a $1 million gift, part of which will be used to develop ways to improve the safety of helicopter emergency medical services (HEMS) operations, and the remainder to endow the Foundation's new Manuel S. Maciel Chair for Aviation Safety Research.

The gift was from the estate of Maciel, the founder of Manny's Sonoma Aviation, a full-service fixed base operator at the Charles M. Schulz Sonoma County Airport in Santa Rosa, California, U.S. Maciel died in 2005.

"The research he has funded will drive safety improvements in HEMS for years to come," said Foundation President and CEO William R. Voss.

— LW

The FAA's efforts have included not only regulations but also the establishment of a task force responsible for implementing safety initiatives, revised operations specifications for increased weather minimums and the development of incentives for operators to equip their EMS helicopters with night vision goggles (NVGs) and helicopter-TAWS (H-TAWS), designed especially for the low-altitude flight paths typically flown by helicopters, Allen said.

"Technology alone does not and cannot solve the problem," he said. "We routinely seek voluntary compliance on safety advances while we are considering rule making as a dual-prong approach to safety enhancement."

'Zero Tolerance'

In a joint statement delivered to the NTSB hearing, three industry associations —the Association of Air Medical Services (AAMS), Helicopter Association International (HAI) and the Air Medical Operators Association (AMOA) — said that they "maintain a position of zero tolerance for accidents." Nevertheless, the associations said, a review of HEMS accidents during 2007 and 2008 showed that "no service model, category of operator (for-profit, not-for-profit, civilian or government) or geographic area is immune to accidents.

"We must establish effective safety solutions that allow for the continuance of this necessary service — a service that has become an integral part of the health care system," they said, asking the NTSB to consider a series of recommendations, including a requirement that all night EMS flights be conducted either with NVGs or another form of enhanced vision system, or under instrument flight rules (IFR).

Other recommendations called for use of automated weather observation systems and instrument approaches at hospital helipads and airports used for air medical transport, establishment of a "dedicated low-altitude helicopter IFR infrastructure," accelerated implementation of automatic dependent surveillance–broadcast infrastructure in HEMS operating environments, a study of fatigue in HEMS operations and establishment of flight operational quality assurance programs for HEMS operators.

In addition, the associations endorsed recommendations to apply the same federal safety standards and oversight provisions to commercial HEMS operators and government, or public-use, operators; to eliminate response time requirements, which promise a response to calls within a prescribed time period; to increase management oversight of crew performance; and to address "helicopter shopping," the practice in which one HEMS operator after another is contacted — typically in instrument meteorological conditions (IMC) — until one accepts a mission.

The associations said that a recent AMOA survey found that eight Part 135 operators, whose 700 helicopters account for more than 90 percent of those involved in HEMS operations nationwide, have equipped 35 percent of their aircraft with NVGs. The survey also found that operators planned to equip 90 percent of their aircraft with NVGs by 2011.

A separate survey submitted to the NTSB by the National EMS Pilots Association (NEMSPA) showed that of 380 HEMS pilots questioned, 334 (88 percent) said they agreed with a statement that the use of NVGs "has improved the safety of HEMS night operations."

NEMSPA President Gary Sizemore said that the survey respondents did not recommend H-TAWS as a viable alternative to NVGs, noting, "Although these systems may well have a role in improving the safety of HEMS night operations, they only warn the pilot of hazards that he cannot see. With NVGs, the pilot can see, identify and avoid hazards in much the same manner that he does during daylight flight."

T.K. Kallenback, vice president of marketing and product management at Honeywell Aerospace, said that the Helicopter-Enhanced Ground Proximity Warning System (H-EGPWS) — one of Honeywell's TAWS products — was developed from the EGPWS used for several years in airplanes and designed specifically for helicopters operating very near terrain and obstacles.

FAA documents presented to the NTSB panel said that because H-TAWS is sensitive not only to the proximity of terrain but also to excessive sink rate, it is especially effective against controlled flight into terrain and against some approach and landing accidents. "Because the accident scenarios against which H-TAWS would be effective tend to have severe outcomes, it would reduce the risk of fatal accident by 20 percent," the FAA said.

Matthew Zuccaro, president of HAI and co-chairman of the International Helicopter Safety Team, told the NTSB panel that his organization promotes not only the use of NVGs but also H-TAWS, and other technological advances, as well as development of a strong safety culture and other related human factors advances.

"But there is no magic bullet," he said, noting that previous HEMS fatal accidents have involved helicopters with advanced cockpits and two-pilot, IFR-qualified crews, and have occurred during visual flight rules (VFR) operations as well as in IMC.

VFR vs. IFR

Larry Buehler, an aviation safety inspector in the FAA Flight Standards Service, said that night flights and inadvertent entry into IMC are among the greatest challenges facing HEMS pilots and that conducting a flight in accordance with instrument flight rules is the best countermeasure for the risk of controlled flight into terrain.

One-third of HEMS operators are authorized to conduct IFR flights, he said; for those that must fly under VFR, compliance with regulations and proper preflight planning — with special attention to establishing a minimum safe altitude — are crucial, he added.

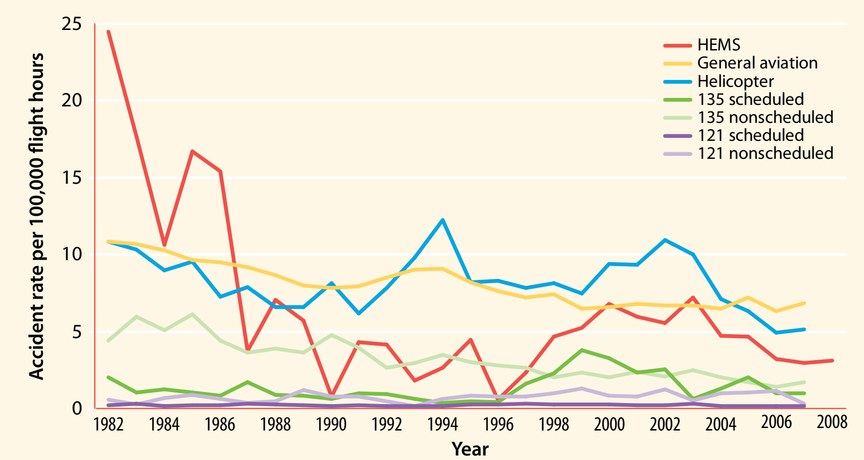
Tony Bonham, chief pilot for Air Evac EMS, which conducts VFR flights from 84 bases in 14 states, said that VFR and IFR flight are both safe for HEMS.

"Our first mission is to follow the rules and regulations and procedures for safe flight," Bonham said, adding that Air Evac EMS operates under Part 135, equips all helicopters for recovery from inadvertent entry into IMC and plans to install NVGs in helicopters at all its bases.

More, and Better, Training

Several of the 40 witnesses testifying before the NTSB panel identified crew training — including crew resource management (CRM) training for pilots

U.S. Aviation Accident Rates, 1982–2008



HEMS = helicopter emergency medical services

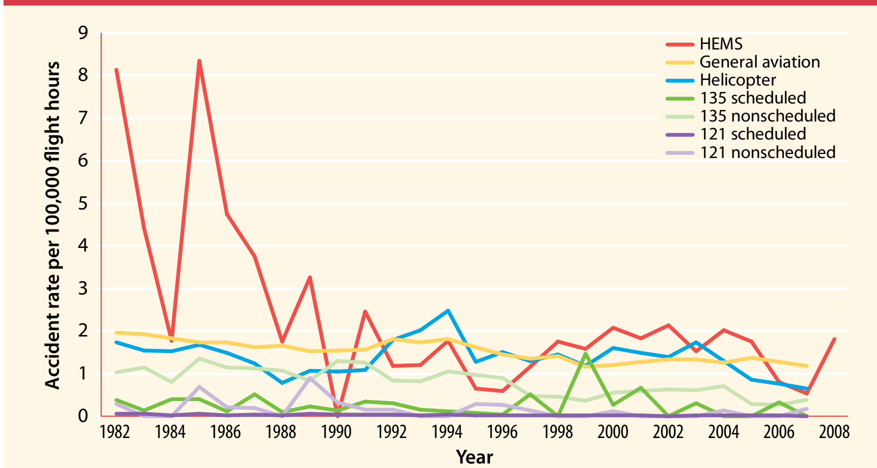
Part 121 = U.S. Federal Aviation Regulations Part 121, "Air Carriers and Commercial Operators"

Part 135 = U.S. Federal Aviation Regulations Part 135, "Commuter and On-Demand Operations"

Source: Ira Blumen, M.D.

Figure 1

U.S. Aviation Fatal Accident Rates , 1982–2008



HEMS = helicopter emergency medical services

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Part 135 = U.S. Federal Aviation Regulations Part 135, "Commuter and On-Demand Operations"

Source: Ira Blumen, M.D.

Figure 2

and medical crewmembers — as crucial in improving HEMS safety.

Bruce A. Webb, Eurocopter's chief flight instructor, described himself as "certainly an advocate of technology" but added that technology alone is not the solution to the problem. "That's training," Webb said.

Training requirements vary, depending in part on the complexity of the helicopter and the operator's weather minimums, Webb said, adding that an annual training session probably is adequate for pilots of basic VFR helicopters who comply with conservative weather minimums. "But twice a year is better," he said. For pilots of technologically advanced helicopters, he recommended quarterly training.

"Scenario-based training is where we must go to stop accidents from occurring," Webb said. "Most people think their IFR recovery skills are better than they really are."

Terry Palmer, an instructor and manager of rotorcraft programs for FlightSafety International, agreed that "training is key. These are perishable skills that need to be reinforced. The best way to do that is with scenario-based training in a simulator."

Kevin High, a registered nurse and president of the Air/Surface Transport Nurses Association, cited mandatory CRM training as one of the HEMS community's most pressing needs.

"The culture has improved a lot" in recent years, with the advent of the notion that there must be agreement among the pilot, flight nurse and flight paramedic that conditions are right for any particular flight, High said, noting the popularization of the phrase "three to go, one to say no."

Nevertheless, High and James P. Riley, a paramedic and president of the International Association of Flight Paramedics (IAFP), said that many medical crewmembers are reluctant to be the sole crewmember to suggest refusing a mission because of safety concerns.

Riley also voiced concern that, in a July 2008 survey of IAFP membership, 30 percent of respondents reported that pilots were well aware of the nature of the request for each flight.

"This opens the door for human factors to be taken into account when deciding whether it is safe to fly," he said, noting that pilots who are told about the critical condition of a patient may feel pressure to accept a flight in bad weather.

"We can try not to consider that the patient is a sick child or we are the last chance for the survival for the patient," Riley said. "However, with over 70 percent of the air medical crashes being human-factor related, the IAFP is not comfortable with this process of informing the pilot of patient information."

'Helicopter Shopping'

Dan Manz of the National Association of State EMS Officials (NASEMSO) and state director of EMS in Vermont, described "slow but steady growth" in HEMS operations from the 1970s, when operations began, until 2000, when the Centers for Medicare and Medicaid Services developed a new formula to reimburse operators. The growth period that followed the centers' action resulted in a doubling of the number of EMS helicopters from fewer than 400 in 2000 to about 830 today. Many of the new programs are private, for-profit operations, instead of the non-profit hospital-based programs that predominated before 2000, Manz said.

His organization told the NTSB panel that the influx of helicopter and airplane EMS programs has resulted in "coordination and confusion issues" in some areas, with more aircraft than are needed to transport patients. The states should work with the federal government to coordinate oversight of EMS operations, NASEMSO said.

Dr. David Thompson of AAMS, who also is the national medical adviser for PHI Air Medical, said that HEMS operations often function as backup medical care in small communities that lack hospital services, medical specialists or ambulances to provide ground transportation to distant medical facilities.

He denounced the concept of helicopter shopping, suggesting that patients and operators alike would benefit from increased cooperation; for example, a VFR operator that rejected a flight because visibility was below minimums might refer the job to an IFR operator.

Indispensable

Regardless of what other steps are implemented, a number of participants told the NTSB panel, establishment of a strong safety culture within each operation is crucial.

"A safety culture is the indispensable context for enabling technology," said the FAA's Allen. "When a management team establishes a corporate culture that supports the decision-making skills of the pilots and treats each flight as safe passenger transportation and not as an emergency evacuation mission, the risk of an accident is reduced dramatically."

Notes

1. NTSB. *Special Investigation Report: Emergency Medical Services (EMS) Operations*, SIR-06/01. Jan. 25, 2006.
2. NTSB. *Commercial Emergency Medical Service Helicopter Operations*, SS—88-01. Jan. 28, 1988.

BY THOMAS ANTHONY

Wake Me When My Shift Is Over

On the "rattler" shift, it's a toss-up who will crash first.

"The rattler" is the nickname for a work schedule used in U.S. air traffic control (ATC) facilities. I used to work the rattler shift as a controller in the 1980s. I learned that this shift earned its reputation for doubling back and biting those who worked it.

My first reaction to learning about the rattler shift was, "Does anybody know we are doing this?" I figured the answer had to be "no," since no one would intentionally schedule a controller to work live traffic with only three or four hours of sleep. I found out I was wrong. Not only was it done intentionally, but it occurred regularly in

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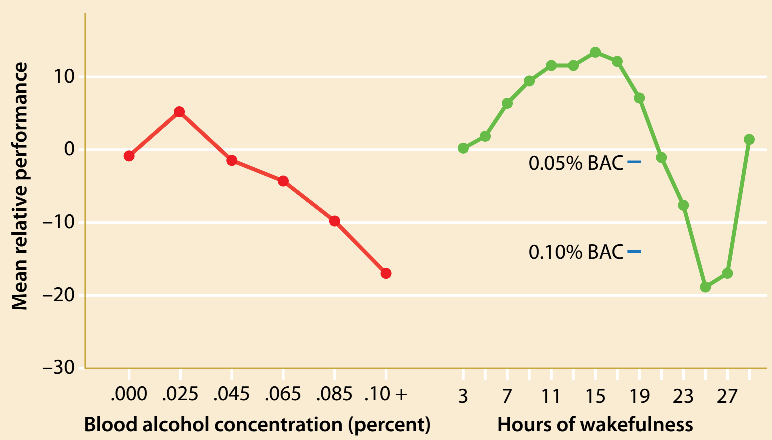
facilities around the Federal Aviation Administration (FAA) ATC system. Imagine my reaction after reading about the Comair Flight 5191 accident at Lexington, Kentucky — they're *still* working the rattler.

The idea behind the rattler is to compress your five eight-hour shifts closely together to maximize the time in your days off. Here is how it works: The first day of your workweek — we'll call it Monday, but it could be any day — you start work at 4 p.m. and are off at midnight. Your second day, you work from 2 p.m. to 10 p.m. Your third day, Wednesday, is from 8 a.m. to 4 p.m. Your fourth day, Thursday, is from 6 a.m. to 2 p.m. For your fifth day, you begin at either 10 p.m. or midnight on your fourth day, late Thursday night. You are off at either 6 a.m. or 8 a.m. Friday. Then you have until 4 p.m. on Monday before you have to come back. For someone wanting to maximize time away from work, this is an ideal shift. From the perspective of a responsible individual wanting to ensure air safety, it is irresponsible.

Alcohol Intoxication vs. Sleep Loss



Source: Accident Investigation Board of Norway/Susan Reed

Figure 1

In the days following the Comair accident, the news media made a big deal of the fact that *the controller only had two hours of sleep*. My thought at the time was that the controller was fortunate that he had gotten that much sleep between a day shift and a midnight shift (mid). Two hours of sleep is not an anomaly when working the mid; it is a normal fact of life. The media failed to ask *why* the controller only got two hours.

At the University of Southern California Aviation Safety and Security Program, among the topics we cover is human factors that contribute to aircraft accidents. In one course, Flight Surgeon Gregg Bendrick of the U.S. National Aeronautics and Space Administration (NASA) Dryden Flight Research Center presents the science behind the decrease in function associated with sleep loss and fatigue. This includes loss of focus, attention and ability to perform complex tasks.

Bendrick teaches that there are three aspects to fatigue: circadian rhythm, acute sleep loss and chronic sleep loss. Circadian rhythm means that people have "low points" in their day in terms of alertness and functionality. A mild low point is normally in the mid- to late afternoon, whereas the other, more significant major low point is in the early morning — when one normally is sleeping.

Moreover, circadian rhythm physiology makes it easier for humans to *lengthen* their day rather than to *shorten* it. Indeed, personal experience tells us it is easier to fly from the East Coast to the West Coast of the United States, rather than vice versa. But with the rattler, one is trying to force the body to do just the opposite — shorten the physiological day.

Acute sleep loss refers to how many hours one has been continuously awake. The real problem comes in when the acute sleep loss overlaps the major low point in the circadian rhythm. At that point, performance deteriorates to the point of being identical to someone who is legally drunk. Admittedly, some of this effect can be counteracted with caffeine, cold air and auditory stimulation. However, chronic sleep loss — the difference between the number of hours slept and the number of hours of sleep required — over the preceding two weeks lessens the effects of the usual countermeasures. Hence, the triple whammy of circadian rhythm, plus acute and chronic sleep

loss leads to a several-hour "valley of fatigue" during which one's performance is really poor, whether or not the person realizes it. As the individual climbs out of the valley with the progression of the circadian rhythm, he or she may actually feel pretty good, as if having caught a "second wind." It is possible to be lulled into a false sense of security.

The effects of fatigue are shown in two graphs that compare performance degradation from hours of wakefulness and performance degradation associated with blood alcohol concentration (Figure 1). The two curves are strikingly similar.[1]

My perspective on workplace fatigue is entirely more personal. It comes from years of working the rattler shift. I can remember lying in bed in the summer at 5 p.m. with all the shutters closed, trying my hardest to get some sleep before I had to get up and go to work at 9 p.m. Several of the neighbors had gathered on the sidewalk outside my bedroom window to talk, and their kids played up and down the sidewalk. It was not an environment conducive to sleep. If I got an hour's real sleep I felt lucky. And the urgency of knowing that I had to get some sleep, but not being able to sleep, is something I will never forget. Of course, the harder I tried to sleep, the more difficult it became.

There is a flip side to the phenomenon. Amazingly, with an hour or two of quasi-sleep you feel pretty good and alert for the first two or three hours of your shift. Then there is about a three- to four-hour period when the air traffic demands are low, and you get into a "low and slow cruise" mode. You are able to handle about an hour of increased activity from 5 a.m. to 6 a.m. — or at least you think you can — but the last two hours of the shift are very hard. You hope there is enough staffing so that the supervisor can "bury" you on a low-activity position. Even at that, I remember that the effort to stay awake sometimes bordered on pain.

The drive home after the last day of a rattler shift was no better. I would drive with the windows down, blasting the radio and biting my tongue to stay awake. I consider myself lucky that I got into only one wreck coming home from a rattler shift; the car was a total loss. At the time, I made no connection between the wreck and coming off a rattler shift.

So what is the answer? Air traffic managers must staff the midnight shift. Controllers cannot work a permanent midnight shift because their skills would erode. The U.S. Air Force in Vietnam was faced with a similar challenge of scheduling crews that would fly missions during the hours around midnight. They did so by scheduling three straight midnight shifts separated by days off on either side. This kind of schedule avoids the "double back" feature of the rattler shift. Alternatively, a schedule employing a week of straight mids every two months would be an option. The options may not be popular with the unions because they result in less regular time off between shifts. Either option would, however, be the responsible choice.

The science is clear. As Bendrick demonstrates in his course, one cannot change human physiology. When one tries, the result is truly impaired performance and myriad excuses to justify the current practice, with a search for a target of blame when something bad happens. But for me, it goes beyond science. It is a memory of being so sleep-impaired that at times it verged on pain. This is not a safety mindset, and it is not a characteristic of a safety culture. I must ask again: Isn't it time to get rid of the rattler?

Note

1. Dawson, D.; Reid, K. "Fatigue, Alcohol and Performance Impairment." *Nature* Volume 388, July–August 1997.

Acknowledgment

Special thanks to Gregg A. Bendrick, M.D., M.P.H., chief medical officer and flight surgeon at the NASA Dryden Flight Research Center for his contributions to this article.

Thomas Anthony is director, Aviation Safety and Security Program, Viterbi School of Engineering, University of Southern California.

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

Aeromedical experts expect fatigue-related problems to worsen with the advent of more ULR flights, unless reliable countermeasures are implemented.

Easing Fatigue

BY LINDA WERFELMAN

The aviation industry generally has failed to incorporate new knowledge of fatigue-fighting techniques into flight crew scheduling provisions and flight and duty time limitations, according to sleep experts who recommend ending prohibitions on cockpit naps and authorizing the use of certain sleep-inducing medications.

In a position paper adopted by the Aerospace Medical Association (AsMA),[1] the organization's fatigue countermeasures subcommittee wrote that few changes have been made in flight time limitations and flight crew scheduling since the first limits were adopted in the 1930s, despite numerous recommendations, including the 1997 publication by Flight Safety Foundation of duty and rest scheduling guidelines for corporate and business operators.[2]

"Although the scientific understanding of fatigue, sleep, shift work and circadian[3] physiology has advanced significantly over the past several decades, current regulations and industry practices have in large part failed to adequately incorporate the new knowledge," the fatigue panel said. "Thus the problem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of pilot fatigue has steadily increased along with fatigue-related concerns over air safety."

A separate fatigue study conducted for the European Aviation Safety Agency (EASA) concluded with a call for new limits on duty time (See "Study: EASA Needs Stricter Limits on Fatigue," p. 24).

The AsMA position paper said that accident statistics, pilot reports and operational flight studies all indicate that aviation operators are increasingly concerned about fatigue.

"Long-haul pilots frequently attribute their fatigue to sleep deprivation and circadian disturbances associated with time zone transitions," the fatigue panel wrote. "Short-haul (domestic) pilots most frequently blame their fatigue on sleep deprivation and high workload. Both long- and short-haul pilots commonly associate their fatigue with night flights, jet lag, early wakeups, time pressure, multiple flight legs and consecutive duty periods without sufficient recovery breaks. Corporate/executive pilots experience fatigue-related problems similar to those reported by their commercial counterparts."

Concerns about fatigue are likely to increase as ultra-long-range (ULR) flights — those of 16 hours or more — increase, the panel said.

"An important question for ULR operations is whether the strains imposed by the extension of flight duty hours beyond the limits commonly flown will effectively be mitigated by the standard fatigue countermeasures, which in part have been responsible for the acceptable safety record of existing flight operations," the panel said. "Without proper management, ULR operations may exacerbate the fatigue levels that have already been shown to impair safety, alertness and performance in existing flight operations."

Causes and Effects

Research has found that the causes of fatigue are similar in all types of aviation operations, as are the effects.

Studies conducted during flight and in simulators have found that fatigue interferes with the functions of the central nervous system, that pilots may experience "vigilance lapses" during periods of flight marked by low workloads, and that pilots are especially susceptible to microsleeps — periods of sleep that last only several seconds and often go unrecognized — in the middle-to-late segments of cruise flight during long-haul operations.

The fatigue panel cited a survey by the U.S. National Aeronautics and Space Administration in which 80 percent of 1,424 flight crewmembers from regional airlines said they had "nodded off" during a flight. A survey of 1,488 corporate/executive flight crewmembers found that 71 percent had fallen asleep during flight.

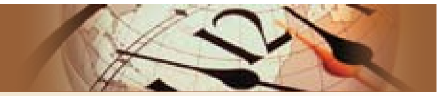
"Fatigue in aviation is a risk factor for occupational safety, performance effectiveness and personal well being," the panel said. "Humans simply were not equipped (or did not evolve) to operate effectively on the pressured 24-7 schedules that often define today's flight operations, whether these consist of short-haul commercial flights, long-range transoceanic operations or around-the-clock military missions. Because of this, well-planned, science-based fatigue management strategies are crucial for managing sleep loss/sleep debt, sustained periods of wakefulness and circadian factors that are primary contributors to fatigue-related flight mishaps."

Current Practices

The AsMA fatigue panel rejected the rule-making approach typically used by the U.S. Federal Aviation Administration (FAA) and other regulatory agencies to prescribe the limits on flight, duty and rest times (Table 1, p. 24). Such limits should be developed from scientific research on the effects of sleep and circadian rhythms on job performance, the panel said.

"The risks associated with non-science-based regulatory approaches may have been unknown in the 1930s, when flight and duty time limits were first addressed," the panel said. "At the time, research documenting the performance and alertness decrements associated with sleep loss and circadian disruption was limited, and it seemed sufficient to ensure safety via agreements between flight crew and management. However, with the demands of 24-7 aviation operations, it has become increasingly apparent that such prescriptive

Study: EASA Needs Stricter Stand on Fatigue



European Aviation Safety Agency (EASA) rules do too little to mitigate the effects of fatigue on pilots, according to a report by human factors researchers that was applauded by pilot organizations and faulted by airlines as "seriously lacking."

The report, made public in January after it was submitted to EASA by Moebus Aviation and the European Committee for Aircrew Scheduling and Safety (ECASS), said that a number of existing EASA rules and proposed rules changes conflict with scientifically developed principles of fatigue prevention.

"Our responses are based on the available scientific knowledge which, briefly, finds that fatigue is increased by extended time awake, reduced prior sleep, the window of circadian low and task load, and that these effects are modified by changes of time zones and rest provisions," the report said.

The researchers said they were especially concerned with provisions that allow "a large number of duty hours in a short time. … The permissible maximum of 180 duty hours in three consecutive weeks allows for a high density of work hours in a short period of time and should be limited through an additional provision for a maximum of 100 duty hours in 14 consecutive days."

Their report also said that the maximum daily flight duty time of 13 to 14 hours "exceeds reasonable limits, especially under exacerbating circumstances (e.g., high workload, night flying …) and should be reduced."

The Association of European Airlines denounced the report as "seriously lacking in substantive scientific and medical content" and said it "arrives at conclusions which are oblivious to the evidence of decades of safe operation."

The European Cockpit Association welcomed the researchers' findings, noting that fatigue has been cited as a contributing factor in 15 to 20 percent of fatal aviation accidents associated with pilot error.

The results of the study were not included in a proposed revision of regulations governing air operations that were published in late January, EASA said. Instead, the study will be the subject of a regulatory impact assessment to consider the potential safety benefits of its recommendations, as well as their social, economic and environmental aspects, EASA said.

—LW

Note

1. Moebus Aviation and ECASS. "Consensus Report Prepared by ECASS: Scientific and Medical Evaluation of Flight Time Limitations," TS.EASA.207.OP.08. 2008. <www.easa.europa.eu/ws_prod/r/doc/research/FTL%20Study%20Final%20Report.pdf>.

FAA Rest, Flight and Duty Time Limits

Type of Limit	Non-Augmented Crew[1]	Augmented Crew[2]
Minimum pre-duty rest period	10 hours	10 hours
Minimum post-duty rest period	10 hours	12 hours 18 hours for multiple time zones
Maximum flight time	10 hours	12 hours
Maximum duty time	14 hours	16 hours
Maximum duty time per week	30 hours	30 hours
Maximum duty time per month	100 hours	100 hours
Maximum duty time per year	1,400 hours	1,400 hours

FAA = U.S. Federal Aviation Administration

1. A non-augmented crew includes the minimum flight crew required to conduct a flight.
2. An augmented crew includes more than the minimum number of crewmembers to conduct a flight.

Source: *Aviation, Space and Environmental Medicine*

Table 1

approaches do not address inherent sleep and circadian challenges, nor do they provide operational flexibility."

For example, the panel said, current FAA regulations do not recognize any difference between eight hours of duty time during the day and eight hours at night. A "scientifically informed" regulation would acknowledge a difference, based on time of day and circadian rhythms, the panel said.

In-Flight Strategies

The fatigue panel reviewed several in-flight fatigue countermeasures: napping on the flight deck, activity breaks, bunk sleep on long-haul and ULR flights, in-flight rostering — scheduling some flight crewmembers to assigned positions on the flight deck while freeing others for in-flight rest — on long-haul and ULR flights, and increased exposure to flight-deck lighting.

"All of [these] in-flight countermeasures … clearly have a place in sustaining the alertness and performance of aviation personnel," the panel said. "However, the manner in which these strategies are employed should be based on the currently available scientific knowledge and should be implemented only after thoughtful consideration."

Members of the panel said they "take exception to the current prohibition on in-seat cockpit napping in civil aviation," and described in-seat napping of up to 40 or 45 minutes as a "safe and effective" risk-management tool that could "significantly improve alertness … and help sustain aircrew performance during situations in which unexpected delays require the postponement of the next consolidated sleep opportunity."

In-seat naps should not, however, be used to replace in-flight bunk sleep during long-haul and ULR flights, the panel said, adding that bunk sleep — used along with in-flight rostering — should be considered a primary method of fatigue mitigation. Additional research is needed to determine the best timing for sleep to help crewmembers maintain maximum performance, AsMA said.

Research also has found that alertness is improved with breaks for mild physical activity and increased social interaction "or even just temporary disengagement from monotonous tasks," the panel said, recommending breaks of about 10 minutes each hour.

In addition, laboratory studies have shown that increasing the light level on the flight deck, especially at night, can temporarily improve alertness and performance, the panel said. This technique should be used only with an understanding of how light can affect circadian rhythms, however.

Off-duty naps that are intended to promote on-duty alertness should be "as long as possible, and whenever feasible, they should occur at the circadian time most conducive to natural sleep (i.e., early afternoon or early predawn hours, according to the body clock)," the panel said. "The principles outlined for good sleep hygiene should be followed to promote optimal nap quality and duration (Table 2).

"Upon awakening from a nap, there should be a wake-up period of at least 30 minutes prior to the performance of any safety-sensitive tasks."

Sleep-Inducing Medications

Because sleep often is difficult to obtain — if the environment is noisy, hot, uncomfortable,

Strategies for Better Sleep

Recommendations to optimize sleep opportunities

- Wake up and go to bed about the same time every day.
- Use the sleep area only for sleep — not for chores.
- Establish a consistent bedtime routine — for example, read and take a hot shower, then go to bed.
- Perform aerobic exercises every day but not within two hours of bedtime.
- Keep the sleep area dark, quiet, comfortable and relatively cool.
- Move the alarm clock out of sight.
- Avoid caffeine in the afternoon and evening.
- Avoid using alcohol to promote sleep.
- Avoid cigarettes, especially before bedtime.
- If you can't sleep, leave the sleep area and do something relaxing. When you become sleepy, go back to bed.

Recommendations for rotating shift schedules

- When rotating onto night duty, avoid morning sunlight.
- To promote daytime sleep, keep the sleep area dark and cool; use eye masks and either earplugs or a "masking noise" to limit interference from light and noise.
- Comply with the "Recommendations to optimize sleep opportunities," above, with adjustments for daytime sleep.
- Before night duty, take a short nap.
- After waking from daytime sleep, expose yourself to at least two hours of sunlight or artificial bright light in the late afternoon or early evening.

Recommendations for time zone adjustments

- Quickly switch to the new time zone schedule for sleep, meals and activities.
- Maximize sunlight exposure during mornings.
- Minimize sunlight exposure during afternoons.
- Avoid heavy meals at night.
- Comply with the "Recommendations to optimize sleep opportunities," above.
- Use relaxation techniques to promote sleep at night.
- If possible, take a hot bath before bed. Cooling off after the bath "may mimic the circadian-related temperature reduction that normally occurs during sleep."
- During the first few days of adjustment, use sleep medications, if authorized, to promote nighttime sleep and caffeine to promote daytime alertness.

Source: *Aviation, Space and Environmental Medicine*

Table 2

or otherwise not conducive to sleep; if the individual is excited or anxious; or if the sleep opportunity occurs at a time not biologically conducive to sleep — the fatigue panel recommended allowing the off-duty use of one specific type of sleep medication.

The panel said that zolpidem — sold under the brand names of Ambien, Myslee and Stilnox — should be authorized for use by civilian pilots up to four times a week, "in situations where natural sleep is difficult or impossible due to circadian or other reasons." The FAA currently allows its use no more than twice a week, and requires 24-hour grounding for any pilot who takes it (Table 2, page 25).

The panel outlined three conditions for use of zolpidem: The pilot must first determine, while off duty, that he or she has no unusual reactions to the medication; the dose must not exceed 10 mg in a 24-hour period; and at least 12 hours must pass between the time the pilot takes the medication and the time he or she returns to duty.

"Zolpidem should not be taken to promote any type of in-flight sleep," the panel said. "It should be noted that facilitating quality sleep with the use of a well-tested, safe pharmacological compound is far better than having pilots return to duty when sleep-deprived or having then return to duty following a sleep episode that has been induced with alcohol."

The panel's recommendation did not extend to other types of sleep-inducing medications.

Other sleep medications not yet on the market are likely to be more effective — and may improve sleep efficiency so much that fewer than eight hours of sleep a day will be required for "effective wakefulness," the panel said.

Like the FAA, AsMA's fatigue panel discourages the use of herbal substances such as valerian and kava and the synthetic hormone melatonin that sometimes are used to promote sleep.

Because the U.S. Food and Drug Administration does not regulate these substances, the quality of compounds that contain them is left up to individual manufacturers and cannot be assured, the panel said. Melatonin probably is the most frequently used of these substances, and studies indicate that it may be useful in some aspects of sleep-promotion, especially when it is taken outside the usual sleep period. In some countries other than the United States, melatonin is regulated, and laboratory tests have found pharmaceutical-grade melatonin effective.

'Tactical Caffeine Use'

Crewmembers also should understand how their intake of caffeine — in coffee, tea, soft drinks and some pain relievers — will affect their alertness, the panel said (Table 3).

"Numerous studies have shown that caffeine increases vigilance and improves performance in sleep-deprived individuals, especially those who do not consume high doses," the panel said. "Caffeine … is already used as an alertness-enhancing substance in a variety of civilian and military flight operations, and it has proven safe and effective."

Most people feel the effects of caffeine — including increased alertness, decreased sleepiness and a more rapid heartbeat — within 15 to 20 minutes, and these effects typically last four or five hours, longer in people who are especially sensitive.

Crewmembers who use caffeine for alertness should consume it in small quantities, "and save the arousal effect until they really need it," the panel said. "This is called 'tactical caffeine use.'"

Caffeine Content of Common Drinks and Over-The-Counter Medicines

Substance	Average Caffeine Content
1 cup Maxwell House coffee	100 mg
1 Starbucks short coffee	250 mg
1 Starbucks tall coffee	375 mg
1 Starbucks grande coffee	550 mg
1 Coke	50 mg
1 Mountain Dew	55 mg
1 cup tea	50 mg
2 Anacin	65 mg
2 Extra Strength Excedrin	130 mg
1 No Doz Maximum Strength	200 mg

Source: *Aviation, Space and Environmental Medicine*

Table 3

The panel endorsed the continued use of caffeine as a fatigue countermeasure and recommended that crewmembers avoid taking more then 1,000 mg of caffeine in any 24-hour period, take it only "when it is truly needed to reduce the impact of fatigue" and avoid it within four hours of bedtime.

"Here are some situations where using caffeine makes sense: leading into the predawn hours, mid-afternoon when the alertness dip is greater because of inadequate nocturnal sleep and prior to driving after night duty, but not within four hours of going to sleep," the panel said.

New Technologies

The panel cautioned against any over-reliance on fatigue-detection technologies and scheduling tools that rely on biomathematical models of alertness — such as monitoring an individual's brain waves, eye gaze, muscle tone or other characteristics.

Nevertheless, some of these tools can be incorporated into overall safety management, and some have great potential but have not yet been shown to meet practical, scientific and ethical standards, the panel said.

"None of the real-time fatigue-detection technologies have been sufficiently proven in an aviation environment (with the possible exception of the wrist-worn alertness device that triggers an alarm sound when wrist inactivity occurs for a preset amount of time) to warrant widespread implementation," the panel said.

The panel said that some crew scheduling tools based on fatigue-prediction models have proved "to a limited extent" worthwhile, especially those that are used to evaluate the fatigue associated with different schedules and design alternatives.

"Refinement of both the new fatigue monitoring technologies and scientifically based scheduling software must continue, and once they are validated for specific types of operations, they should be incorporated as part of an overall safety management approach supplementing regulatory duty limitations," the panel said.

No 'One-Size-Fits-All' Cure

To discourage overreliance on sleep medications, the panel said, "crewmembers should be educated about proper sleep hygiene, the benefits of aerobic exercise for promoting quality sleep and natural strategies designed to promote circadian readjustment."

Education must lead to an understanding of the dangers of fatigue, the causes of sleepiness and proper sleep habits, which can help ensure that crewmembers obtain about eight hours of sleep every night, the fatigue panel said.

"Ultimately, the individual pilot, schedulers and management must be convinced that sleep and circadian rhythms are important and that quality day-to-day sleep is the best possible protection against on-the-job fatigue," the panel said. "Recent studies have made it clear that as little as one to two hours of sleep restriction almost immediately degrades vigilance and performance in subsequent duty periods."

Educational efforts should emphasize five points, the panel said:

- "Fatigue is a physiological problem that cannot be overcome by motivation, training or willpower;
- "People cannot reliably self-judge their own level of fatigue-related impairment;
- "There are wide individual differences in fatigue susceptibility that must be taken into account but which presently cannot be reliably predicted;
- "There is no one-size-fits-all 'magic bullet' (other than adequate sleep) that can counter fatigue for every person in every situation; but,
- "There are valid counter-fatigue strategies that will enhance safety and productivity, but only when they are correctly applied."

Along with educational efforts, operators should implement a fatigue risk management system (FRMS) to develop flight and duty schedules based on physiological and operational needs rather than prescriptive hours-of-service limitations that do not take into consideration the effects of circadian rhythms, the panel said.

The panel characterized an FRMS as an "evidence-based system for the measurement, mitigation and management of fatigue risk" that often exists within an operator's safety management system.

"A multi-component FRMS program, with a scientific foundation, helps ensure that performance and safety levels are not compromised by offering an interactive way to safely schedule and conduct flight operations on a case-by-case basis," the panel said.

The development of fatigue countermeasures requires increased attention to individual differences in responding to sleep loss, sleep disruption and time zone transitions, the panel said.

"Many issues associated with flight operations remain unanswered and can only be answered by collecting data during carefully scientifically designed research," the panel said. "While fatigue represents a significant risk in aviation when left unaddressed, there are currently numerous countermeasures and strategies that can be employed to increase safety. Furthermore, new technologies and countermeasures are being developed that hold great promise for the future."

Notes

1. Caldwell, John A.; Mallis, Melissa M.; Caldwell, J. Lynn; Paul, Michel A.; Miller, James C.; Neri, David F.; AsMA Aerospace Fatigue Countermeasures Subcommittee of the Human Factors Committee. "Fatigue Countermeasures in Aviation." *Aviation, Space, and Environmental Medicine* Volume 80 (January 2009): 29–39.
2. Flight Safety Foundation Fatigue Countermeasures Task Force. "Principles and Guidelines for Duty and Rest Scheduling in Corporate and Business Aviation." *Flight Safety Digest* Volume 16 (February 1997).
3. A circadian rhythm is the human body's natural internal cycle — approximately 24 hours long — of periods of sleep and wakefulness.

Further Reading From FSF Publications

FSF Editorial Staff. "Lessons From the Dawn of Ultra-Long-Range Flight." *Flight Safety Digest* Volume 24 (August–September 2005).

Susan Reed

Too Long at the Wheel

BY MARK LACAGNINA

Fatigue factors in a runway excursion.

The augmented flight crew elected to take their rest breaks in the cockpit of the Boeing 737-800 rather than in the on-board rest facility that had been provided for the round-trip flight between Iceland and Turkey — a journey that was prolonged by delays and the unexpected need for an en route fuel stop. The cockpit provided an unsuitable environment for rest, and the pilots likely were tired when they conducted the last approach and landing of the long day, according to the Aircraft Accident Investigation Board (AAIB) of Iceland.

The board's final report on the incident said that fatigue was reflected in the crew's performance during the approach and landing at Keflavik. With little or no flare, the aircraft bounced on touchdown. The wheel brakes were applied late, and reverse thrust was not used to its full effectiveness. The surface conditions at the end of the

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Nearing Keflavik, the pilots of this 737 commented on how long the day had been and how tired they were.

runway were worse than expected, and the crew turned the 737 onto the final taxiway to avoid an overrun.

"The aircraft skidded off the taxiway and came to rest parallel to the taxiway with the nose landing gear and the right main landing gear off the paved surface," the report said. No one was hurt, and damage was minor.

Pointing to the fatigue-related errors identified during the investigation, the board called on authorities to ensure that operators provide adequate crew rest facilities when required and to develop guidance for implementing fatigue management systems.

The incident flight was conducted on Oct. 28, 2007, by JetX under a wet-lease agreement with Astraeus. The flight plan called for the 737 to depart from Keflavik at 1005 coordinated universal time (1005 local time) for the positioning flight to Antalya, arriving at 1600 (1800 local time) and departing at 1700 for a 2320 arrival in Keflavik.

The estimated duty period was 14 hours and 15 minutes, which necessitated the augmented flight crew. The commander, 39, had 6,132 flight hours, including 976 hours in type. The "augmented" (relief) commander, 41, had 5,850 flight hours, with 1,590 hours in type. The first officer, 28, had 2,949 flight hours, including 365 hours in type.

The pilots reported for duty at 0905. They received a message from a duty officer for ScanOps, the contracted flight-planning service for JetX, that 189 passengers were expected for the 2,616-nm (4,845-km) flight from Antalya to Keflavik. "Due to strong headwinds, the duty officer advised that carrying all the luggage could pose a problem," the report said. "If so, and if flight and duty time limitations allowed, he suggested that a fuel stop would be preferable to offloading luggage."

The JetX flight operations manual set a 16-hour duty limit for an augmented flight crew. Two landings were allowed during the duty period; a third landing could be conducted only with permission by the Icelandic Civil Aviation Administration (CAA). Among the requirements for permitting a third landing was the *availability* of approved crew rest facilities aboard the aircraft.

At the crew's request, ScanOps developed another flight plan for the return flight, with a fuel stop in Edinburgh, Scotland, and obtained permission from the CAA for the third landing.

Behind Schedule

The 737 departed from Keflavik at 1056 — 51 minutes late. "During preparations for departure, the crew was delayed because the auxiliary power

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Groundspeed was 35 kt when the pilots turned left off of Runway 02 onto the final taxiway.

unit was inoperative and they had to have the engines airstarted," the report said. "During startup an igniter failed, causing further delays."

The designated crew rest facility comprised a row of three adjacent seats at the rear of the cabin, partitioned by a curtain. The relief commander did not use the facility while the commander and first officer conducted the positioning flight to Antalya. He remained in the cockpit and participated in planning the return flight.

The 737 arrived in Antalya at 1634 — 34 minutes later than planned. The crew was informed that filing the new flight plan with Turkish authorities might take up to four hours. "Upon consultation with a duty officer at ScanOps, the flight crew decided to take off with their original flight plan and, once en route, divert to Edinburgh to make a fuel stop, to avoid further delays," the report said.

The actual passenger count was 187 plus one infant — or one passenger more than can be accommodated with three seats reserved for crew rest. "The commander made the decision to carry the extra passenger and made a note that the passenger would have to sit in a cabin crew seat during cruise," the report said. "In fact, the passenger sat in the crew rest area from Antalya to Keflavik."

The aircraft departed from Antalya at 1810 — one hour and 10 minutes late. The relief commander and the first officer were at the controls. The commander took his rest break in the cockpit.

The 737 arrived at Edinburgh at 2313 and departed for the final leg to Keflavik at 2345. The standby commander was the pilot flying (PF), and the commander was the pilot monitoring. The first officer remained in the cockpit.

Inadequate Facility

The pilots told investigators that they considered the crew rest facility to be inadequate. "The crew felt that the cockpit provided a more suitable resting environment," the report said. "The crew could recline in their seats, stretch out and were separated from passengers by a door rather than a simple curtain."

About 40 minutes from Keflavik, the senior cabin crewmember entered the cockpit and asked the pilots how they were doing. "The flight crew answered that they were really tired and commented on how long the day had been and how tired they were," the report said.

The commander listened to the Keflavik automatic terminal information service broadcast, which said that weather conditions at 0100 included surface winds from 270 degrees at 5 kt, visibility greater than 10 km (6 mi), a few clouds at 4,000 ft, temperature 0° C (32° F) and dew point minus 3° C (27° F). The following information was provided for Runway 11/29: "Braking action good, occasional ice patches. Braking action taxiways and apron medium/poor, sanded."

The pilots discussed the surface winds, and the PF said that they would request Runway 02 if the wind velocity remained less than 10 kt. The report noted that Runway 11/29 and Runway 02/20 are more than 3,000 m (9,843 ft) long but provided no information about the runway safety areas.

When the commander requested, and received, radar vectors from Reykjavik Control toward Runway 02, he did not ask for a braking action report for that runway. Keflavik Approach cleared the crew to conduct the instrument landing system (ILS) approach to Runway 02. "During the briefing for the approach, the PF mentioned that the taxiways to the terminal would be slippery but the runway would be good," the report said.

Callouts Omitted

The pilots omitted several required calls during the descent, including the callout at Flight Level 100. The PF did not respond to the commander's callout at 2,500 ft radio altitude and did not identify the radio frequency set for the ILS. "The reason for the missed callouts remains unexplained and could possibly be attributed to fatigue," the report said.

Noting that a cabin crewmember occupied a cockpit jump seat during the descent and approach, the report said that "there were distractions in the cockpit, and the mood was relaxed."

The crew flew the approach with the autopilot, autothrottles and auto speed brakes (ground spoilers) engaged, but they did not engage the autobrakes. Landing reference speed (VREF) was 148 kt.

The last friction measurement on Runway 02 was made at 2312. A SNOWTAM (snow warning to airmen) issued shortly thereafter indicated that the runway was contaminated with ice and that the measured friction values were 69 for the first third of the runway, 71 for the second third and 45 for the final third. (Lower values are associated with less effective braking action.)

When a Keflavik Tower controller cleared the crew to land on Runway 02, he said that the winds were from 320 degrees at 5 kt and that braking action was "good-good with the occasional ice patches." The controller told investigators that he had no explanation for using the term "good-good"; he said that he normally reports braking action using measured friction values, as required by the airport authority.

No Extra Precautions

"The information on the runway and taxiway conditions that the PF received led him to expect that no extra precautions would be necessary during the landing," the report said. The crew also had no indication that the surface conditions on the last third of the runway were deteriorating.

About 18 minutes before the 737 was landed, the airport surface condition analyzer generated a frost pavement condition warning because the dew point had increased above the runway surface temperature. "At the time of the frost warning, all the airfield services staff were outside the office working on runway maintenance, and the system was not being monitored," the report said.

The crew omitted the required callout when the aircraft crossed the outer marker. They disengaged the autopilot and autothrottles while descending through 575 ft above ground level. "On short final, the crew used the precision approach path indicator (PAPI) lights as a visual approach slope indicator as well as the runway lighting," the report said.

Surface winds were from 318 degrees at 7 to 10 kt at 0155 when the 737 touched down on Runway 02 at 150 kt. "The aircraft contacted the runway and then bounced up into the air again before full runway contact was made with the main landing gear tires followed by the nose landing gear tire," the report said.

Recorded vertical accelerations were 2.13 g — that is, 2.13 times standard gravitational acceleration — on the first touchdown and 2.01 g on the second touchdown. The report said that the flight crew "channelized into analyzing the reason behind the hard landing instead of focusing on the deceleration of the aircraft."

The ground spoilers had deployed after the first touchdown, and the crew engaged the thrust reversers after the second touchdown. "Reverse thrust was initially increased to 73 percent N_1 [engine fan speed] for approximately seven seconds, then reduced to idle thrust decelerating through a groundspeed of 110 kt and approximately 4,000 ft [1,219 m] down the runway," the report said. "Thrust reversers remained deployed and at idle power [until the 737 neared the end of the runway]."

The wheel brakes initially were applied about 46 seconds after the second touchdown, when the aircraft was about 1,500 ft (457 m) from the end of the runway with a groundspeed of 72 kt.

Groundspeed was 35 kt when the crew began to steer the aircraft left onto Taxiway N-4. They increased reverse thrust to 80 percent N_1 to help slow the 737. "The aircraft came to rest on a final heading of 288 degrees with the right main landing gear and nosewheel off the paved surface of Taxiway N-4," the report said.

The nosewheel had been slightly damaged during the excursion. The crew kept the left engine running until a ground power unit was connected. "There was no need to evacuate the aircraft immediately, and the passengers stayed on board until buses were brought by the airport authority to bring them to the terminal building," the report said.

The pilots were on duty for 17 hours and 20 minutes — more than three hours beyond the expected duty period. The report said that although current regulations allow an augmented flight crew to be on duty for as many as 19 hours under unforeseen circumstances, they "do not restrict the number of hours of wakefulness or prescribe a minimum number of hours of restorative sleep."

Based on the findings of the incident investigation, the AAIB called on the European Aviation Safety Agency to modify the flight and duty time regulations.

This article is based on AAIB Iceland "Report on Serious Incident, Runway Excursion, M-03707/AIG-19: JetX; Boeing 737-800, TF-JXF; Keflavik, Iceland; October 28, 2007."

Left Behind

BY MARK LACAGNINA

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The ATR 42 pilots were unaware of current procedures for recovering from an ice-induced upset.

The airline's failure to promptly update its standard operating procedures (SOPs) was among organizational deficiencies that contributed to the loss of control of an ATR 42-320 during an encounter with severe icing conditions the morning of Sept. 14, 2005, said the Accident Investigation Board of Norway (AIBN).

In its final report on the serious incident, the board said that the airline, Coast Air, had only recently distributed revisions to severe-icing emergency procedures that had been issued two years earlier by the aircraft manufacturer. "The pilots received this [information] close to the time at which the incident occurred and had not had time to become familiar with its content," the report said.

The flight crew struggled to regain control of this ATR 42 after an ice-induced stall.

Coast Air operated two ATR 42s and six British Aerospace Jetstream 31s and 32s on scheduled flights between nine airports in Norway. The airline issued SOPs for the ATR 42 when it received its air operator certificate early in 2000; the last revision was dated Sept. 13, 2002.

In October 2003, the manufacturer revised the ATR 42 airplane flight manual to require pilots to memorize the following six actions on the "Severe Icing" emergency checklist:

- Increase the "red bug" minimum icing speed by 10 kt[1];
- Apply maximum continuous torque;
- Disengage the autopilot while firmly holding the control wheel;
- Escape from the severe icing conditions; and,
- Notify air traffic control (ATC).

A notation following these memory items says that if any unusual roll response or uncommanded roll control movement occurs, the control wheel must be pushed firmly forward and the flaps extended to 15 degrees. These actions, however, are not designated as memory items. ATR told investigators that roll excursions will not occur if the actions that *are* designated as memory items are completed correctly upon encountering severe icing conditions.

The report said that shortly before the incident, a newly hired flight operations manager "discovered by coincidence" the two-year-old revisions and told the chief pilot to distribute the information. An "OPS INFO" document outlining the revised procedures was issued to the company's ATR 42 pilots the day before the incident. The airline did not have a system to monitor the receipt and review of OPS INFO documents. The pilots told investigators that they remembered retrieving the documents from their mailboxes either the day before, the same day or the day after the incident. "However, they had not picked up particularly on details of the content or reflected in any concrete way on what the changes meant," the report said.

Moreover, the OPS INFO document did not include the following notice that the manufacturer had added to the "Severe Icing" emergency checklist:

> *Severe icing may result from environmental conditions outside of those for which the airplane is certificated. Flight in freezing rain, freezing drizzle or mixed icing conditions (supercooled liquid water and ice crystals) may result in ice buildup on unprotected surfaces exceeding the capability of the ice protection system or may result in ice forming aft on the protected surfaces. This ice may not be shed using the ice protection systems and may seriously degrade the performance and controllability of the airplane.*

"In *severe icing*, therefore, it is necessary to change course and/or altitude instantaneously since the aircraft's anti-ice and deice systems cannot handle these conditions," the report said. "A characteristic of severe icing is said to be ice formation on the side windows and/or an unexpected decrease in speed and climb rate. Water which splatters and streams on the front windshield and ice buildup at the back of the spinner and on the airframe in places where ice does not normally collect are given as secondary indications. In addition, it is stated that visible rain and large droplets with an outside temperature of around 0° C [32° F] could lead to severe icing."

Strong Cold Front

The aircraft was being operated as Flight 602 from Stord, an island off the southwestern coast of Norway, to Oslo, about 170 nm (315 km) east. The pilots and the flight attendant reported for duty at 0615 local time.

Noting that a strong cold front had passed through the area overnight, the report said, "The weather was the subject of conversation that morning. There had been a landslide in Bergen [north of Stord] during the night, and precipitation records had been set at several locations in the western part of Norway."

The three crewmembers visited the airport's flight information service facility to gather weather information and notices to airmen. "The weather forecast was a moderate risk of local icing in the western part of Norway up to Flight Level (FL) 180 (approximately 18,000 ft), which is normal for this time of year," the report said.

Before departing with 24 passengers at 0710, the flight crew activated the anti-ice systems for the probes and windshields (Figure 1). The first officer, 29, was the pilot flying. He had been employed by Coast Air in 2003 and earned an ATR 42 type rating the same year. He had 2,980 flight hours, including 1,350 hours in type.

The commander, 39, had been employed by Coast Air as a Jetstream pilot in 1999. He earned an ATR 42 type rating in 2000 and upgraded to commander in type the next year. He had 7,850 flight hours, including 2,800 hours in type.

The flight attendant, 29, had been employed by the company in 2001.

The aircraft entered icing conditions shortly after takeoff, and the crew activated the anti-icing systems for the aileron, elevator and rudder horns, propellers and side windows. Activation of the horn ice protection system also armed the stick shaker (stall warning) system to activate — and cause the autopilot to automatically disengage — at a lower-than-normal angle-of-attack: 11 degrees instead of 18 degrees with flaps retracted.

The flight proceeded east, toward the cold front and rising terrain. The crew did not use the weather radar system during the climb. "This may indicate that the crew had a low level of awareness of the importance of using the weather radar as an aid for avoiding severe icing," the report said, noting that the airline did not have a written policy about using the equipment. "Information from the weather radar could have made it possible for the crew to plan their route outside the cells with the heaviest precipitation at greatest hazard of severe icing."

'Impression of Complacency'

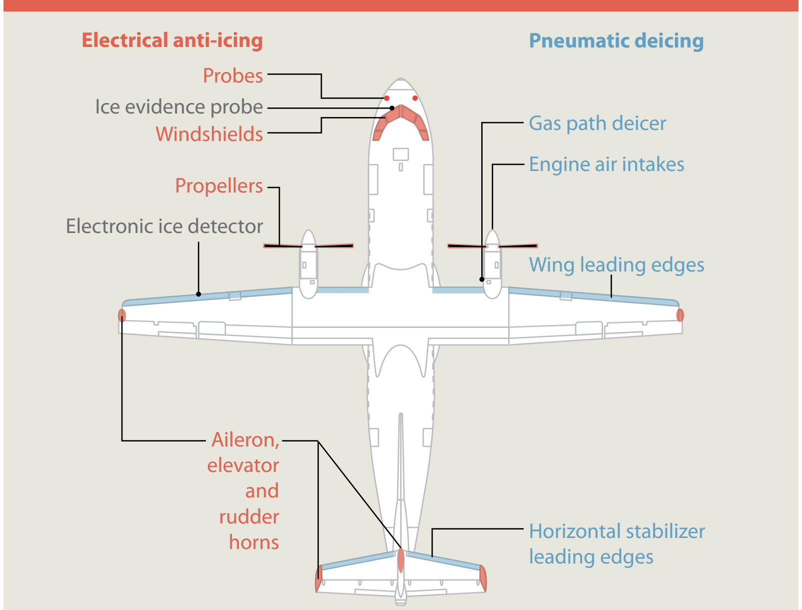
The aircraft was climbing through FL 100 when the "ICING" warning light illuminated. This indicated that the electronic ice detector sensed that ice was accumulating on the wing and that the appropriate ice protection systems had not been activated. In response, the crew activated the deicing systems for the wing and horizontal stabilizer leading edges, and the engine nacelles.

"The crew is certain that the systems were functioning as intended," the report said. However, ice continued to accumulate rapidly. Neither pilot realized that the aircraft had entered severe icing conditions.

"The commander has stated that they gradually went into heavy rain, with large drops that splattered on the front windshield while the outside temperature (static air temperature, SAT) was minus 10° C [14° F]," the report said. "He saw significant ice formation on the evidence probe outside his window and assessed the icing as more or less the same as the worst case he had experienced during the course of his six years of flying this aircraft type."

That "worst case" had been resolved when the aircraft exited the icing conditions. "It may appear that the flight crew also anticipated that the problems here would resolve themselves by their exiting the icing area in time, which is something that gives the impression of complacency," the report said. "Both pilots were experienced and had

ATR 42 Ice Protection Systems



Source: Accident Investigation Board of Norway/Susan Reed

Figure 1

flown the route between Stord and Oslo in icing conditions countless times with no problems. The pilots were used to the aircraft's systems handling moderate icing conditions. … Another important element is that the hazard of icing was not given particular emphasis in the company's program for training and flight safety."

Ice covered the cockpit side windows, but the pneumatic deice boots on the wings appeared to be shedding ice from the leading edges. "From the cockpit, it was not possible to see whether there was ice further back on the upper and lower sides of the wings," the report said. "Neither the commander nor the first officer remembered afterwards whether they saw ice on the propeller spinners."

The crew said that the aircraft climbed normally until reaching FL 120. Climb performance then decreased significantly. "When they approached FL 140, the climb was marginal," the report said. The first officer, who was flying the aircraft with the autopilot engaged in the airspeed-hold mode, adjusted the commanded airspeed from 160 kt to between 150 and 155 kt in an attempt to increase the climb rate.

The crew had set the red speed bugs on their airspeed indicators to 143 kt, the minimum airspeed specified for flight in "standard" icing conditions. "Both the commander and the first officer were of the opinion that they had sufficient margins when they were at least 7 kt above [minimum] icing speed," the report said. According to the emergency checklist, however, the correct speed bug setting for severe icing conditions was 153 kt. "The crew therefore did not have the safety margin they assumed since they had allowed the speed to drop to 150–155 kt," the report said.

The pilots discussed the possibility that the aircraft's performance was being affected by mountain wave activity, which indicates that they did not associate the performance deficiency with severe icing. The airspeed reduction did not result in the anticipated climb rate improvement; instead, it resulted in the contaminated wing nearing the critical — stall — angle-of-attack, the report said.

ATR 42-320

© Hans Olav Nyborg/Airliners.net

The Avions de Transport Régional (ATR) program was launched in 1981 when Aérospatiale and Alenia agreed to combine their efforts to design a twin-turboprop regional airplane. Deliveries of the first model, the ATR 42-300, began in 1985. The airplane has 1,342-kw (1,800-shp) Pratt & Whitney Canada PW120 engines. The ATR 42-320, introduced in 1987, has 1,566-kw (2,100-shp) PW121 engines, which improve performance at high altitude and with high ambient temperature.

Basic seating capacity is for 42 passengers. Maximum takeoff weight is 16,700 kg (36,817 lb). Maximum operating altitude is 25,000 ft. At a maximum cruising speed of 267 kt at 17,000 ft, range with reserves is 4,481 km (2,420 nm). Stall speeds are 104 kt with flaps up and 81 kt with flaps extended 30 degrees.

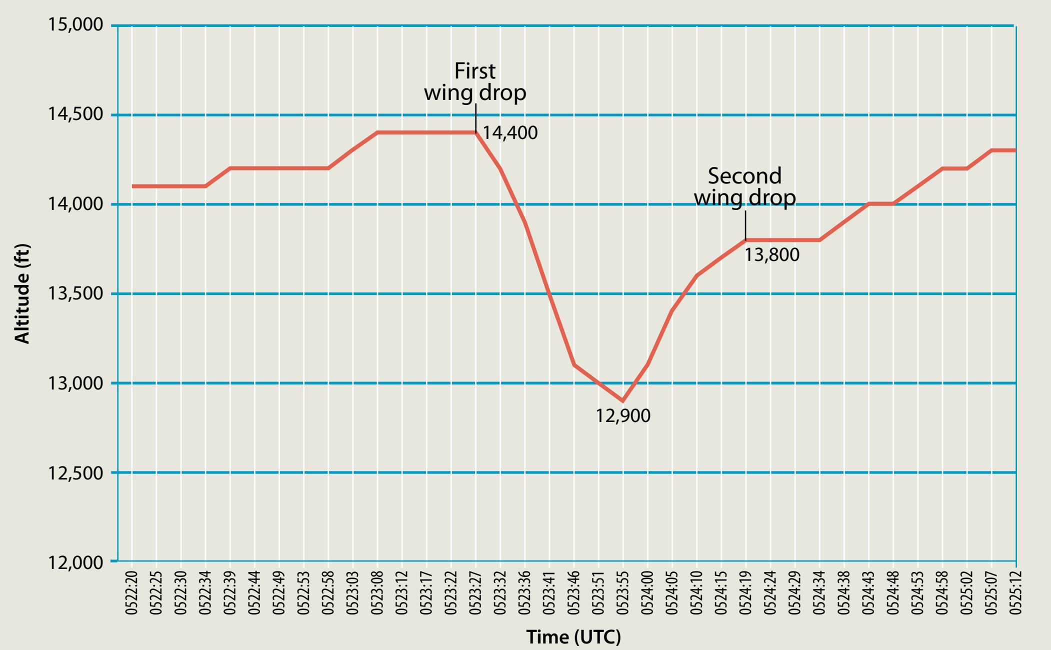
Production of the ATR 42-300 and -320 was phased out in 1996. ATR became a corporate entity in 2001 and currently produces the ATR 42-500 and the ATR 72-500.

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

Struggle for Control

The aircraft stopped climbing at 14,400 ft. The first officer placed his hand on the control column and felt the stick shaker activate. He was about to disengage the autopilot when it disengaged automatically. "A second or two after this, the aircraft suddenly rolled, uncommanded, approximately 45 degrees to the right at the same time the nose dropped to approximately 7–8 degrees below the horizon," the report said (Figure 2, p. 36).

Flight Profile



UTC = coordinated universal time

Source: Accident Investigation Board of Norway

Figure 2

The first officer said that he pushed the control column forward to keep the nose down while setting the engine controls to achieve maximum continuous torque. He did not extend the flaps 15 degrees. "He struggled to regain control of the aircraft and tried to rectify the bank angle," the report said. "The bank angle moved from the right straight over to the left before it gradually allowed itself to be straightened up."

The commander's decision not to take control when the upset occurred was not faulted. "The best the commander could have contributed in the critical situation … would probably have been to extend the flaps in time," the report said. "Control would have been regained more quickly. By only pushing the stick forward, the speed would have to increase more before the angle-of-attack dropped below the critical value."

Recorded ATC radar data indicated that the upset had begun at 0723 (0523 coordinated universal time) and that the aircraft had descended 1,500 ft before the first officer regained control. "It is equivalent to an average descent speed of approximately 3,200 fpm for the 28 seconds that passed before the aircraft again commenced climbing," the report said. "At its steepest, the descent was around 5,000 fpm."

Terrain clearance, however, was not a factor. The aircraft was over a glacier about 35 nm (65 km) east of Stord, where the minimum safe altitude was 7,000 ft. With the wings leveled and airspeed increasing to about 175 kt, the first officer pulled the control column back to stop the descent. The aircraft then entered a relatively steep climb. "According to the radar readings, it climbed 700 ft in the first 15 seconds, which corresponds to 2,800 fpm," the report said. "The fact that the crew did not register that the pull-out from the dive was excessive can be explained by the fact that they were shaken by the experience in addition to the fact that they were in cloud and had to correct a most abnormal aircraft attitude based on information from the aircraft's instruments," the report said.

Angle-of-attack again exceeded the critical value, and the aircraft stalled and rolled left. "This wing drop was almost as powerful as the first, and the first officer has stated that he used the same procedure to regain control," the report said. During this time, the aircraft had exited from the clouds.

After the first upset, the commander had set the red airspeed bug at 160 kt and told ATC that they were having icing problems and were requesting FL 150 as their final cruising altitude. After the second upset, he told ATC that they were unable to maintain FL 150 and requested, and received, clearance to fly within an altitude block between FL 130 and FL 150.

All the passengers had been seated during the upsets. The flight attendant, who was placing empty bottles in the cargo compartment at the rear of the aircraft, lost her balance and fell into the cargo compartment. Uninjured, she returned to the galley and held onto an unsecured service cart until the aircraft was returned to controlled flight.

The flight attendant then entered the cabin and found the passengers sitting still; none had been injured. "She spoke for a little while with a woman who, before takeoff, had told her she was afraid of flying," the report said. "The commander gave a passenger announcement, [stating] that they had moved into some bad weather involving turbulence and icing, but that this was now over, so the flight would continue to Oslo as normal."

The ATR 42 was flown between cloud layers and out of icing conditions, and was landed without further incident in Oslo at 0804.

Although AIBN requires prompt notification of a severe icing encounter involving a loss of altitude, Coast Air's manuals contained "extremely old" information about reporting requirements. The airline reported the incident to the Civil Aviation Authority of Norway (CAA) almost two weeks after it occurred. The CAA forwarded the report to the AIBN. By then, voice and flight data recorded in the aircraft during the incident no longer were available.

'Organizational Incident'

Coast Air had experienced major changes in its ownership, key personnel and route structure.[2] The report said that the CAA had found deficiencies in the airline's quality system and flight safety program but had not ensured that they were corrected. Chief among the persistent deficiencies were an unsatisfactory document-management system and inadequate collection and dissemination of information about hazards and preventive measures.

Among deficiencies that related directly to what the report characterized as an "organizational incident" was inadequate pilot training for flight in icing conditions. "Pressure to keep down cost levels within the company may have contributed to reducing the quality of flight crew training," the report said.

The airline had contracted with Finnair to use its ATR 42 flight simulator to train Coast Air pilots for type ratings and to conduct six-month proficiency checks. The training was performed by Coast Air instructors. The proficiency checks comprised four hours in the simulator. Among the procedures reviewed was stall recovery in various aircraft configurations.

"The first items in the procedure when the stick shaker actuated in a clean configuration (gear up, flaps zero degrees) was that the person flying should say, 'Stalling,' immediately advance power, level the aircraft's nose 2–3 degrees above the horizon and say, 'Set max power, flap 15,'" the report said. "The second pilot should do the manual actions and respond, 'Max power set, flaps 15 selected.' … The training manager has stated that it was common for the pilots to forget to extend the flaps in conjunction with this exercise."

Noting that the French accident-investigation bureau also has found that ATR 42 pilots generally are not familiar with the requirement to extend flaps to 15 degrees, the AIBN recommended that the action be designated as a memory item on the emergency checklist.

The report also said that the stall-recovery training in the flight simulator was not related to icing conditions. The airline's training manager was not aware that the flight simulator was programmed to provide four icing scenarios — two related to inadequate preflight deicing, and two related to encounters with standard icing conditions and severe icing conditions without the appropriate ice protection systems activated. "Coast Air first became aware of the opportunity to train on realistic icing scenarios in the simulator as a result of this incident," the report said.

The incident aircraft was not equipped with an aircraft performance monitoring (APM) system, which ATR introduced as an option in 2005. The system monitors icing intensity and its effect on aircraft performance, and generates several different visual and aural advisories and warnings. For example, an "INCREASE SPEED" warning light illuminates and a chime sounds if airspeed decreases below red bug speed plus 10 kt. The AIBN recommended that the APM system be required aboard all ATR 42s and 72s.

This article is based on AIBN Report SL 2009/02, "Report on the Serious Incident Over Glacier Folgefonna, Norway, on 14 September 2005 with ATR 42-320, LN-FAO, Operated by Coast Air AS."

Notes

1. The "red bug" is an adjustable marking on the airspeed indicator.
2. Coast Air filed for bankruptcy in January 2008.

Further Reading

Rosenkrans, Wayne. "Surveillance Without Surprises." *ASW* Volume 2 (April 2007): 42–46.

Dow, John P. Sr. "Understanding the Stall-Recovery Procedure for Turboprop Airplanes in Icing Conditions." *Flight Safety Digest* Volume 24 (April 2005): 1–17.

PARADIGM *Shift*

BY WAYNE ROSENKRANS

After the recent A320 bird strike and ditching, expectations soared for avian radar to warn airline pilots of real-time hazards.

When the U.S. National Transportation Safety Board (NTSB) convenes a public hearing in mid-2009 on a few aspects of the Jan. 15, 2009, ditching of a US Airways Airbus A320 into the Hudson River, attention to digital avian radar likely will be more intense than at any time since 2006. That year, a proposal for civilian-military and public-private collaboration — the *North American Bird Strike Advisory System: Strategic Plan* (NABSAS) prepared by the U.S. Federal Aviation Administration (FAA), the U.S. Air Force and Transport Canada[1]— was shelved, and the FAA decided to limit most subsequent avian radar research to performance assessments.

Aspiring to deploy a network of airport avian radars and real-time bird hazard alerting within 10 years, the NABSAS addressed issues that may resurface in the current NTSB investigation. But the plan may have been most prescient in expecting mitigation of bird strike risk to be impeded primarily by human, not avian, factors.

Preliminary NTSB factual information said that Flight 1549 was "ditched into the Hudson River shortly after the aircraft struck Canada geese, resulting in an immediate loss of thrust in both engines." Two people were seriously injured among the 155 passengers and crew. One of four focus areas planned

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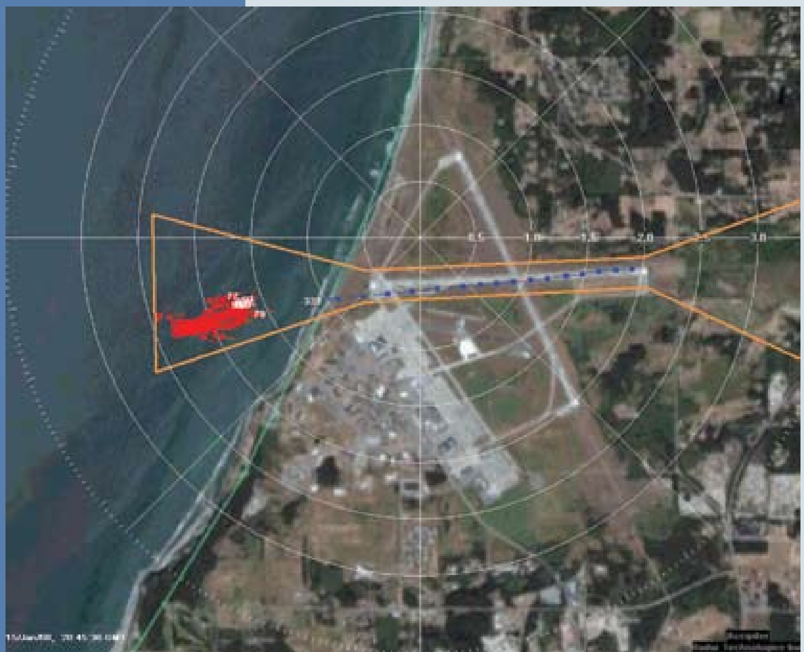


Avian radar captures a near-miss event at Naval Air Station Whidbey Island, Washington, U.S.

for the hearing is "new and developing technologies for detection of large groups of birds and procedures to avoid conflicts with birds in the general vicinity of airports," the NTSB said.

NTSB member Robert Sumwalt on Feb. 24 told a congressional committee hearing that the first officer, the pilot flying, "spotted a group of dark birds slightly to the right of the flight path" and an instant later, about 1.5 minutes after takeoff, the flock filled the windscreen and multiple bird strikes occurred at an altitude of about 2,750 ft. The captain took control of the airplane, and the aircraft touched down about 3.5 minutes after the bird strikes.

Margaret Gilligan, FAA associate administrator for aviation safety, characterized avian radar at the hearing as a limited technological solution so far. "Bird detection radar may have the most promise as tools to help airport operators manage their wildlife control programs," Gilligan said. "However, as many airports routinely have birds in the area, we do not yet know if this system would be capable of providing alerts that would be operationally suitable for making specific time-critical decisions on landing or takeoff."

In The Spotlight

The avian radar systems intended for civil or military airport use typically are designed from commercial off-the-shelf marine X-band, S-band or combined radar sensors; advanced digital radar signal processors; personal computers programmed with proprietary bird-tracking algorithms that process target data; geographical information system (GIS) mapping software; and network communication. Some are on mobile platforms, others have been installed in airport buildings with roof-mounted antennas.

In the wake of the Flight 1549 accident, some have asked the FAA and its Center of Excellence for Airport Technology (CEAT) at the University of Illinois–Urbana Champaign to explain what has impeded the development of real-time alerting for air traffic control (ATC) and pilots (see "Other Countermeasures," p. 40). The possible timing and relative safety of envisioned alerts to pilots have yet to be determined, however, in the context of the maneuverability limitations of transport jets, visibility restrictions from the flight deck and air traffic conflicts. Nevertheless, Edwin Herricks, a professor at the university and principal investigator on avian radar use at civil airports for CEAT, says that because of this accident "the paradigm has shifted — we are no longer working in obscurity" given new public expectations.

"Now that we have radars deployed and collecting data, the CEAT team is working on a group of reports," Herricks said. "One report on the deployment of avian radars hopefully will help people who are contemplating using them to have a realistic sense of what an avian radar can do. We then will produce a shorter technical publication on mapping clutter — the electronic background noise and the radar returns from buildings, trees, etc. Our third report will talk about our nearly two years of experience with three radar systems at Seattle-Tacoma [International Airport, Washington, U.S.] and discuss the operational applications and their utility from the perspective of a user … to promote realistic expectations rather than unrealistic ones." During the deployment phase, the FAA

Other Countermeasures

The Air Line Pilots Association, International (ALPA) in February expressed optimism about the safety contributions of digital avian radar and published a white paper titled "Wildlife Hazard Mitigation Strategies for Pilots."

"Being able to find birds, track them and project their position with quality radar is of great interest to us," said Rory Kay, a captain and ALPA's executive air safety chairman. "Pilots not only have to know the projected direction of flight but know at what altitude the birds are flying. If [the birds] are at 1,000 ft and 5 nm [9 km] from the airport, the birds are not an issue. If I can be made aware [of birds] I can pick a different runway to use for departure or arrival, or I can simply delay my departure or arrival while a clearly visible, large flight of birds transits the area. That would not always work, so ongoing wildlife hazard mitigation programs at each airport are important."

John Prater, a captain and president of ALPA, added, "What we are really looking for is separate air traffic control displays so they have a radar that is specifically tuned and pointing at the local area, a small radius for tracking and … a sophisticated communication system … so that if birds are being tracked, that information can be passed via radio to the pilots."

Airline training on flight deck countermeasures, and quickly funding and implementing the next generation air transportation system, NextGen, also were cited as important ways to reduce bird strike accident risk. "Some airlines provide a checklist that covers what to do following a bird strike, but ALPA is unaware of any airline that provides wildlife-avoidance training," Prater said. "We would suggest that wildlife-avoidance techniques and guidance, such as that included in the [U.S. Federal Aviation Administration] *Aeronautical Information Manual*, be provided in airline flight operations manuals, training materials and other company guidance for flight crews. … On arrivals and departures, [airline pilots] are held sometimes for hundreds of miles at low level because of the inadequacy of the ATC system. So NextGen is about capacity at airports, keeping us higher longer, saving fuel, reducing carbon emissions and certainly keeping us and the birds out of each other's path."

The ALPA white paper calls for high alertness to bird and mammal activity reports while taxiing; a final check of the runway for wildlife before commencing takeoff; waiting for wildlife hazard managers to clear birds from the runway environment; advance preparation to adjust an aircraft's vertical path to avoid birds; best rate of climb through any altitude band where birds have been anticipated; using extreme caution if accelerating above 250 kt below 10,000 ft; monitoring airport and en route radio frequencies for intelligence about bird activity; using higher rates of descent — without increasing speed — to descend through altitude bands where birds have been anticipated; and considering a go-around if an encounter with birds occurs on approach, subject to other precautions.

— WR

has required only letter reports and updates on progress, he said.

The current situation of inadequate validation of avian radar performance and little peer-reviewed literature on avian radar applications in airport settings will be rectified by studies that both CEAT and the U.S. Department of Defense have under way, Herricks said. Another issue has been inadequate basic engineering research that could lead to new bird-specific radar sensors to supersede today's marine sensors.

Sidelined Strategy

The NABSAS aimed to overcome problems in developing avian radar in 2000–2005. "The purpose of this strategic planning document is to fully integrate all the disparate systems currently under deployment, development or proposal," the plan said. "Many have argued that further and much greater advancement could be made if the current fragmented and competitive efforts could be consolidated in a single cooperative venture."

One phase of the plan would have integrated "small-scale mobile radars … available to monitor local bird movements in real time at select locations," the plan said, building on similar Canadian efforts to upgrade commercial airports. "At the airport or airfield level, dedicated radars must be able to detect birds in the critical airspace, defined as three-dimensional coverage out to 5 nm [9 km] and up to 3,000 feet above ground level," the plan said. "The goal is to provide effective bird strike warnings to pilots flying from one location to another. … Automated warnings [would] be issued when the system has identified potentially hazardous concentrations of birds. One example is heavy migration of large birds in critical airspace."

The decision was made around 2002 by the U.S. Air Force and the FAA to look at commercially available avian radar technologies, Herricks said. "Since these were untried and unproven in civil airport environments, this meant deploying these technologies to airports and conducting performance assessments so that the FAA could obtain technical information that would allow it to identify standards and requirements that could be used in an advisory circular," he said. "The advisory circular will be critical because it basically will define characteristics that technologies must meet to allow reimbursement from the FAA Airport Improvement Program for avian radar funding."

In 2006, the FAA shifted the focus of its airport-related avian radar research, as noted in the FAA 2008 *National Aviation Research Plan*. "The vision of the original [NABSAS] draft focused on providing near-real-time hazard advisory information to a variety of end users such as pilots, air traffic controllers, airport operators and wildlife control personnel. While that long-term objective is still viable, recent lessons learned and advances in technology have shifted the approach toward initially validating current avian radar capabilities, and providing risk assessments for key flight operational zones in the airport environment."[2]

In 2009, avian radar assessments by CEAT support the wildlife hazard manager's work at Seattle-Tacoma. The FAA's schedule calls for additional testing at Chicago O'Hare International Airport, Dallas/Fort Worth International Airport (DFW) and John F. Kennedy International Airport (JFK).

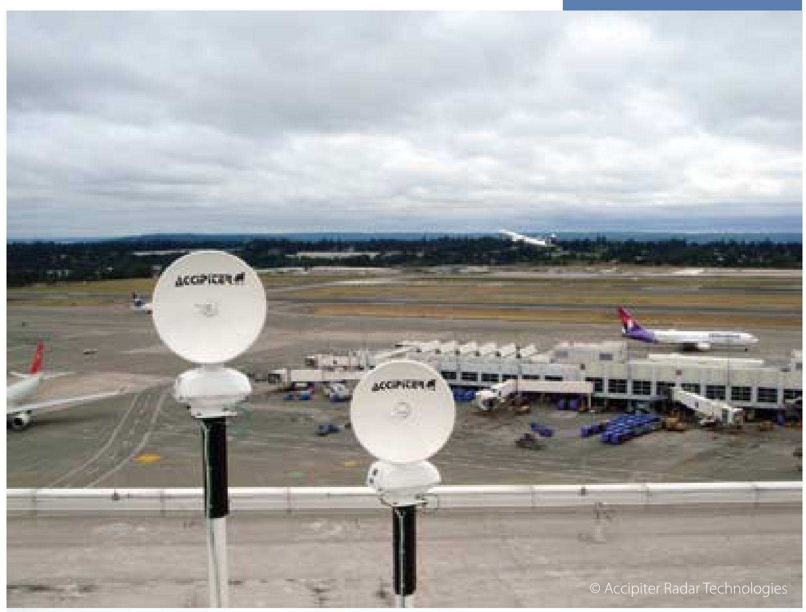
Seattle-Tacoma Experience

Assessment work at Seattle-Tacoma illustrates how details of avian radar can differ from aviation industry assumptions and public expectations. "In cooperation with researchers at [CEAT], we are exploring enhanced wildlife monitoring through the use of an avian radar system that was installed in August of 2007," said Mark Reis, the managing director of Seattle-Tacoma, in testimony at the hearing. "Are we able to accurately track the birds? Absolutely. … The question is, 'What can we do with that data?' At this point, we probably have too much data. The key thing for [future] operations is, 'How do we filter down to the critical data that would be important to air traffic controllers and to pilots?' Or long term, how could airports better understand the dynamics of the bird populations around the airport and what we can do about them?"

The safety factor of providing timely avian radar data to an airport wildlife hazard manager cannot be underestimated. "We are learning about bird population habits beyond what we already knew," Reis said. "We are learning them with greater accuracy, and we can learn 24 hours a day, 365 days a year as opposed to when people are able to observe [bird activity]." FAA and airline flight safety specialists will have to

Top: Performance of roof-mounted avian radar currently is being assessed by CEAT for the FAA at Seattle-Tacoma.

Bottom: Durban International Airport, South Africa, plans to install displays in its air traffic control tower linked to mobile avian radar.



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determine how real-time tactical use of the data by ATC and pilots would occur later, he said.

Herricks remains resolute that avian radar validation at large civilian airports and resultant requirements and standards have to precede any real-time applications. "I don't believe at this point that any avian radar is capable of operating within the complex environment of civil airport operations at even moderately busy commercial airports," he said. "It is not a turnkey situation where we turn these radars on and automatically we prevent bird strikes. I agree with the FAA that these systems are not ready for prime time. … All of the data that we have to date — including lots of experience at Seattle-Tacoma — indicate that we have still got a ways to go. But that doesn't mean that we can't provide quality information to the airport system to make things safer now."

Part of the reasoning behind this policy position is that avian radar is not just a matter of technology issues but concepts of operations, achieving buy-in of stakeholders, developing communications systems and deciding how to safely and reliably communicate alerts to ATC and pilots in time for them to take action, he said.

One example of a recurrent glitch seen in CEAT assessments is occasional disappearance of some bird targets on avian radar. "We see a big bird that shows up very well on the radar," Herricks said. "We see it flying, and then all of a sudden, that track disappears. It may be that we can pick up that track a little later. If the clutter environment is relatively intense, the signal associated with the bird will be lost in that background noise. … We are now mapping the clutter environments at O'Hare, JFK and DFW from multiple locations; we have done 23 sites at O'Hare. We also discovered at Seattle-Tacoma that if we put the radar in a ground depression, this actually improves the performance of the radar by a significant amount."

Outspoken Critic

DeTect, a U.S. manufacturer of avian radar systems, disputes the basis of the policy position at the FAA and CEAT. "Advanced bird radars from several manufacturers are in operational use by the U.S. Air Force, U.S. National Aeronautics and Space Administration (NASA), the U.K. Royal Air Force and several U.S. and foreign airports, airfields and ranges," said Gary Andrews, general manager and CEO. Unlike systems assessed by CEAT at Seattle-Tacoma and elsewhere, "the DeTect Merlin avian radar system has been and is being used tactically by the U.S. Air Force at five U.S. locations since 2003 and by NASA launch controllers at Kennedy Space Center since 2006 with real-time bird radar displays in the control towers/launch control center and data used to make tactical decisions," he said.

Most avian radars used at U.S. sites in this decade have been made by Accipiter Radar Technologies, DeTect and Geo-Marine. "Much of the current level of technology is limited by what users will currently pay for a bird radar system," Andrews said. "In March 2009, DeTect will announce its next-generation bird radar, which will be a solid state, all-weather system that will detect and alert bird strike risk in wet fog and moderate rain." Merlin is not "blinded" by light rain or wet fog, he said. "We are also 'Dopplerizing' [adding Doppler marine radar sensors to] our first system and expect to introduce it in late 2009 or 2010. True three-dimensional systems will likely become available as the technology gains greater acceptance, return on investment is further demonstrated, and the additional cost for the system can be justified."

DeTect's tactical concepts of operation vary by site but generally include a specialized display — called Merlin ATC, designed with input from air traffic controllers and pilots in 2003 and 2004 — that provides "continuous, real-time display and monitoring of bird activity in the runway approach and departure corridors with the current 'bird strike' risk level displayed in color-coded text above each corridor with low risk as green, moderate risk as yellow and severe risk as red," he said. "Merlin ATC is currently used in the control tower only at military installations," Andrews said. "The Durban International Airport in South Africa will be the first use of Merlin ATC in the tower [of a civilian airport]."

The system is fully automated and does not require full-time monitoring because when the bird hazard risk level increases, an audible alert directs the controller's attention to the risk condition, risk location and precise altitude on the display, he said. Risk thresholds are defined and set in the software so that insects do not contaminate the data, and only birds that pose a risk to specific airframes are factored into the ATC displays and alerting. Military wildlife personnel also have real-time radar displays on mobile wireless devices to help them respond more quickly to hazardous bird activity.

CEAT has received funding to lease the DeTect Merlin system for assessment at DFW, Herricks said. The FAA hopes to broaden its knowledge from working with the Merlin system, he added. "We have been working madly for six to nine months to try to get the money out the door to go to DeTect," Herricks said.

CEAT and FAA recognize the need to use all available expertise, he said. "I don't think there is any company that has thought more about how to get information into the ATC-pilot decision-making framework than DeTect," Herricks said. "I also want DeTect in our performance assessment because nobody has the experience that they have with vertically spinning radars. They can provide information about altitude — the missing feature in virtually all our radar work to date. We get some altitude discrimination with dual four-degree radars — parabolic dish types — but it would be nicer to have greater discrimination."

Responding to Andrews' criticisms of assessment time spent by CEAT compared with military and NASA programs, Herricks said that these comparisons are not valid. CEAT's position is that avian radar research for civilian commercial hub airport environments is significantly different in character, scope and complexity from these military and NASA contracts.

Accipiter Perspective

Seattle-Tacoma and the other U.S. civilian airports deploying avian radar through CEAT — except DFW — use systems from Accipiter. Beyond the three mentioned, Accipiter's current military installations include Naval Base Ventura County in California and Elmendorf Air Force Base in Alaska.

"Eventually, bird advisories generated in real time in response to significant and risky bird movements identified by radar will find their way into ATC operations in a manner analogous to weather advisories," says Tim Nohara, president and CEO of Accipiter. "The public and news media may consider this the [ideal application] — which may in fact drive political support for federal funding — but I believe the more important application in improving flight safety is providing airport wildlife control personnel a greatly improved bird situational awareness."

Two of the CEAT research sites — Naval Air Station Whidbey Island, Washington; and Marine Corps Air Station Cherry Point in North Carolina — each have generated a year's worth of avian radar data, enabling for the first time retrospective overlays of bird tracks and aircraft flight paths on the same GIS map. "We are taking one month's data at both sites and refining the process of identifying/extracting near-miss events (NMEs)," Nohara said. "Once we've refined the procedure, we will apply it to the year's data sets. We will analyze NME patterns over time, compare them with reported bird strikes over the same time and confirm correlation," i.e., that they follow the same trend. "We are getting a measure of how tightly the airspace is packed with birds in the vicinity of an aircraft, rather than counting birds alone, or counting bird strikes alone, to provide a more sensitive indicator to a change in safety," he said.

Manufacturers typically enhance performance with their own system design innovations or by adopting newly invented radar sensors, antennas or other components. "We have developed the first dual-beam, height-finding avian radar prototype — with patents pending — and it is ready to undergo three-dimensional tests against remote-controlled aircraft in spring 2009," he said.

Each new generation of marine radar sensor can open possibilities of better avian radar performance at commercial hub airports. "Vendor literature suggests that improvement in bird detection in clutter will be achievable, but at a cost increase of about $100,000 per unit," Nohara said. "Multi-sensor integration in the past year has included integration [of marine radar] with a number of cameras. … Having the radar automatically classify birds into different species or groups is still in the research and development domain."

Staying The Course

Misunderstandings of what avian radar can do have the potential to set back CEAT's process of moving avian radar toward acceptance and utilization, Herricks fears. "We can't afford to have a tool that provides so much potential fall prey to that, so we have to have expectations that are realistic," he said. Realism about avian radar also means understanding policies and procedures required for safe insertion of this technology into the ATC decision-making framework, he added.

The Flight 1549 accident report and the forthcoming reports by CEAT on its avian radar assessments may quell the current controversy about avian radar by clarifying logical next steps. Better information about detectable bird hazards — possibly including real-time alerts to ATC and pilots — will require better collaboration among all stakeholders willing to take time to understand the complexity of avian radar systems, the civil airport environment and the ATC implications while assessing risk under safety management systems.

To read an enhanced version of this story, go to the FSF Web site <www.flightsafety.org/asw/mar09/avianradar.html>.

Notes

1. FAA; Transport Canada; U.S. Air Force. *North American Bird Strike Advisory System: Strategic Plan*. April 2005.
2. FAA. *2008 National Aviation Research Plan*. Feb. 4, 2008.

© Viktor Gmyria/Dreamstime; Honeywell Aerospace

Time Travel

Safety advantages seem understated as remote analysis of turbofan engine parameters helps business jet operators stay on schedule.

BY WAYNE ROSENKRANS

Engine condition monitoring (ECM) like that required for extended range operations (ETOPS) has begun to interest non-ETOPS business airplane operators.[1] Risk reduction, however, may not be what appeals most when they consider subscribing to several new services tailored for them. These services equip engine systems with wireless data-downloading capabilities used on the ground, remotely acquire the data, conduct in-depth analysis at a central facility and rapidly communicate safety-critical information and maintenance recommendations to operators and flight crews.

They take advantage of digital electronic engine controllers, advanced sensors, telematics[2] and remote diagnostics technology, analytical software that compares measured parameters to those of a master model, secure global network communications and handheld computers or mobile telephones with computer functions. Logically, the services could help reduce human factors errors such as failing to remember to manually download data from the aircraft, failing to manually upload data from a laptop computer to a remote database, unintentionally using outdated analysis models or losing critical engine data without backup copies off the aircraft.

The technology reflected, for example, in the Honeywell Aerospace Zing remote diagnostics service for TFE731 engines on the Hawker 750, 800, 800XP, 850XP and 900XP and the programs of Pratt & Whitney Engine Services–Advanced Diagnostics, a unit of Pratt & Whitney Canada (PWC), for the Dassault Falcon 2000EX and

7X have been embraced by a growing number of business jet operators. Honeywell this year has been expanding its service to the Falcon 50, Falcon 900 and Learjet 40/45 fleets.

In 2008, Honeywell published several early operator experiences. In one report, the flight crew of a Hawker observed an "ENGINE FAIL" light during descent, and one engine changed to manual mode. The crew landed in northern Minnesota, U.S., on a Saturday and called the director of maintenance, who instructed them to initiate a wireless data download from the engines to the Zing service. The director of maintenance then contacted the engine manufacturer's technical representative, who reviewed the data on a mobile phone. The review was completed in 15 minutes, and the director of maintenance grounded the aircraft. Within 30 minutes of the download, however, the correct parts had been shipped to the remote airport. Maintenance technicians were able to install them and release the airplane to service the following day.

Maintenance, repair and overhaul (MRO) paradigms are undergoing a significant shift as a result of the application of this new technology compared with relying on maintenance technicians at one shop acquiring knowledge of an engine through first-hand experience, said Maria Mandato, senior advisor–communications of PWC. "Today, any technician who has access to the Internet — from a remote location anywhere, anytime — can have 24x7 access to engine data, including both reports and alerts. They also can have access to watch lists for a visual summary of engine status."

When combined with the TFE731 engine trend monitoring services provided by partner Jet-Care International,[3] "Zing eliminates manual engine data downloads, improves proactive trend monitoring and reduces downtime during unscheduled engine events," said Donna Chase, vice president of Honeywell Business and General Aviation Customer and Product Support. Operators annually save hundreds of hours of downloading time with the wireless engine data download service, which provides fault code, event/exception alerting, automated trend data forwarding to Jet-Care and an Internet Web interface where remote diagnostics link directly to suggested tests, repairs and original equipment manufacturer manuals, she said.

Subscriber flight crews typically shut down the engines after each landing, engage the digital electronic engine controllers and press a green button on the Zing control panel. This action downloads data stored by the engine controllers, encrypts the data and sends it over a Global System for Mobile Communications (GSM) digital mobile phone network in about five minutes. Nine Hawker operators performed more than 500 downloads of engine data with the service at U.S. and international airports while logging 3,500 flight hours in 2008.

Some safety specialists see growing acceptance of this technology by operators but have yet to decide how it will influence their own programs. "We do not have a formal policy or position on this technology," said Eli Cotti, director,

The Internet brings engine data history and remote analysis within reach.

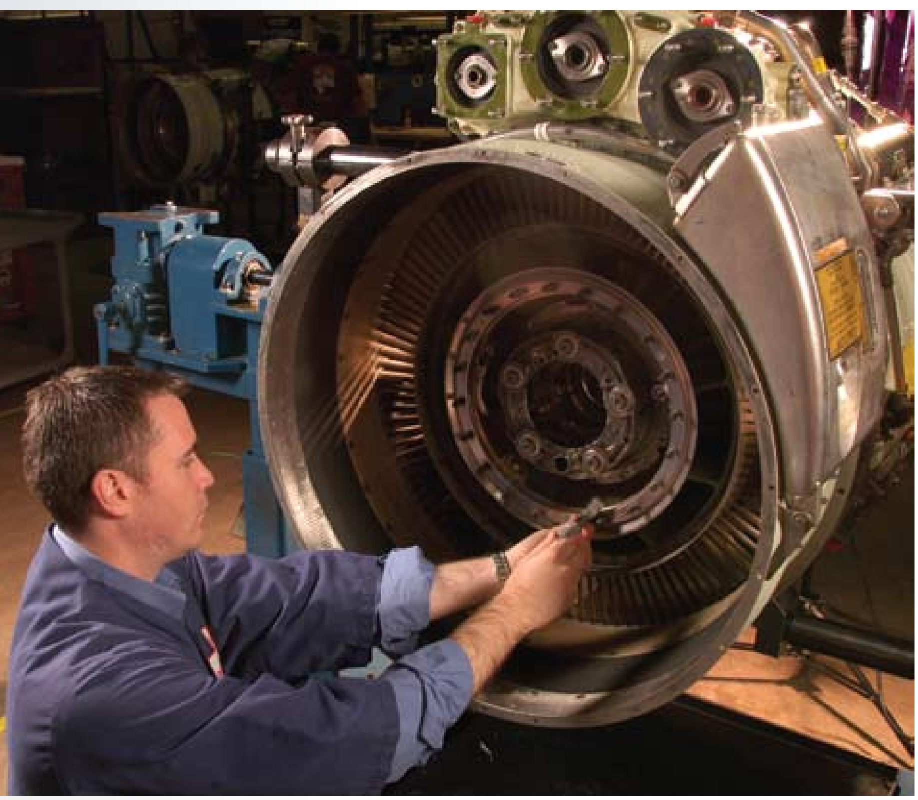
© Pratt & Whitney Canada

technical operations, of the National Business Aviation Association. "Many operators are taking advantage of this service because of the real-time response and logistic support it provides almost immediately upon landing.

"Once a discrepancy is noted in the aircraft records, the aircraft is out of service. The only way to continue operating is to perform corrective action. One of the underlying reasons for Zing, for example, is to allow operators to send their maintenance and support personnel [timely] information about events. Without Zing, the operator requires maintenance personnel attention to accomplish the task of engine data download, usually once every 50 flights."

More than targeting anomalies such as inflight engine shutdowns or rejected takeoffs, today's ECM services focus on subtle combinations of engine parameter exceedances and events, fault codes, trends and associated flight conditions. Services provide detailed guidance so that operators and pilots can respond appropriately before an issue affects any aspect of flight operations, including airworthiness. Some deviations from normal limits are safety critical.

Consistent, frequent data downloads accelerate work at MRO centers.



© Honeywell Aerospace

"An example of a typical unscheduled engine event would be intermediate turbine temperature (ITT) indication shifts," Cotti said. "This could be as a result of combustion chamber transition ducts or seal misalignment. Another example would be that, if and when exceedance events are recorded, they are typically accompanied by a [digital] date-time 'stamp' of all running parameters.

"Exceedances often have a cycle/limitation penalty — a reduction of total operating hours or a cycle limitation, useful hours or cycles for an hour-limited or life-limited component. Exceedances that go beyond the exceedance record — that is, a limit in the event-recording process — would be followed by an auto-commanded engine shutdown to automatically resolve the problem. For example, if overspeed is the type of exceedance, overspeed beyond a certain RPM or time frame would be followed by an overspeed shutdown."

Actions to be taken — including whether to notify the operator or await results from subsequent downloads — vary according to the engine parameter exceedance involved and the context of other parameters. "For example, if an over-temperature exceedance is detected, the temperature attained and the duration of the over-temperature condition will determine if immediate action is required," PWC's Mandato said. "Likewise, fault codes can have different levels of required actions depending on the nature of the code. A trend shift … still within the recommended operating parameters of the engine … may merit further monitoring but may not require immediate action if still within limits."

Sometimes, reported events lead the designated analysis center, third-party specialist or the engine manufacturer's representative to give advice to the operator and flight crew that will disrupt the flight schedule. "If sufficiently severe, the recommendation may be to not operate the aircraft until the recommended [maintenance] actions have been undertaken," Mandato said. "This is the extreme-case scenario, but may be the most prudent course of action, depending on the circumstance."

Stress Reduction

Minimizing cockpit disruptions and distractions related to engine anomalies and relieving pilots of routine engine-data documentation tasks — especially freeing up crew time for other operational, safety and mission responsibilities — have been cited as risk-reduction factors.

"In the old days, the crew was obliged to record on paper the parameters of an event or warning signal," Cotti said. "Parameters changed frequently, however, and the crew may not have written down the correct parameters. These new systems capture the information instantaneously so that potential error in engine instrument interpretation is eliminated. This leaves the flight crews free to focus on flying the aircraft rather than troubleshooting." Even when business aircraft crews using these systems receive an in-flight alert, they feel more at ease knowing that recently downloaded engine data give maintenance specialists a head start on diagnosis, and quick problem resolution often awaits them upon arrival, he said.

Virtual "built-in support" has been touted as one of the real-world benefits of remote engine diagnostics, particularly by enhancing the operator's confidence about continuing to fly missions. Although equipment aboard the business aircraft subscribed to these services wirelessly download data to a diagnostic center only after landing — unlike commercial jets performing in-flight downloads — this capability still contributes to in-flight situational awareness.

"From a safety perspective, having in-flight knowledge of an event could help the crew decide if the mission is safe to continue or if an unscheduled landing is needed," Cotti said. "The crew also can plan ahead to meet needs of the unscheduled landing and proceed to a repair facility. Letting the operator's support organization know [about issues] well in advance reduces the amount of time the aircraft is going to be in maintenance or out of service."

Blurred Distinctions

Boundaries between what is feasible in the airline environment versus the business aircraft environment are blurring, PWC's Mandato said. "Significant inroads have been made to assist operators in determining whether an aircraft is 'safe' to fly," she said. "By fully capitalizing on the systems offered, the operator [obtains] invaluable and actionable information for maintenance planning that will assist them in validating their own [aircraft safety] experience and judgment. Operators get immediate confirmation that the engines have been operated within the established limits.

"Visibility of engine events and exceedances also encourages pilots to fly within the specified parameters. The more operators know about their aircraft, the better their decisions. Options available — such as instant-alert notifications in the cockpit and automatic data transfer from the aircraft [engines] to monitoring systems on the ground once a flight segment has been completed — maximize effectiveness."

Illumination of PWC's optional alert light, supplementing engine instruments on the flight deck, tells the pilots to seek immediate maintenance assistance for a serious engine problem.

Services that integrate analysis of engine data and flight data also help operators to make data-driven decisions. "Advanced diagnostics add objective operational, trending and exceedance data to the [operator's] decision-making process," she said. "The Internet-based data management system … automatically accepts, organizes and presents trend data for ground-based analysis that would normally take hours to process and tabulate."

© G. Schläger/Lufthansa Technik

Devices that add wireless connectivity to engine computers mitigate human factors errors.

Advantages of the services include consistent data collection after each flight; no need for the flight crew or maintenance technician to carry aboard a laptop computer with engine controller cable harness or to handle engine data storage media; and capability of engine troubleshooting from a remote location.

Airplane operators considering a subscription to remote ECM also have to decide whether they will rely on in-house technical expertise to interpret the new data available on a Web site or contract for external expertise. "By having direct access, operators can see [for themselves] how their engines are performing … with data in easy-to-understand format for ground-based analysis," Mandato said. The PWC software suite on the operator's side comprises engineering algorithms, analysis enhancement tools, fleet management information, automatic alerts, data warehousing and data-graphing capability.

If the operator does not want to rely on in-house expertise, the external service will provide required engine information and make decisions. "Data review by our designated analysis center assists in the detection of trend shifts, exceedances and events [with] expert analysis of trend data, watch lists, alerts and regular updates on the status of the aircraft engines," Mandato said. "The determination as to whether an alert … necessitates the removal of the aircraft from service would only be made once the aircraft has landed and the data have been downloaded into the Turbine-Tracker data repository for analysis."

Airline Precedents

Lufthansa Technik, which provides services covering about 1,450 engines for more than 50 operators, says that the basic objective of ECM is early failure detection that avoids a severe engine failure during flight. When the company's Frankfurt diagnostic center detects a deviation in engine data compared with preset threshold/limit values, an ECM engineer automatically receives an alert on a computer display.

"At first, we receive an alert e-mail from our system," said Wolfgang Reinert, an international media relations representative for the company. "An ECM engineer then analyzes the trend data and the raw data to find the cause for the alert. If a severe engine failure is detected, the engineer informs the customer via e-mail or phone call and recommends a maintenance action according to the aircraft maintenance manual or troubleshooting manual. The next action — from a visual inspection up to an engine change — depends on the findings."

From a safety standpoint, an ECM engineer usually plays a backup role to the real-time engine status information available to the commercial jet's flight crew. "In case of exceedance of a parameter over a certain level, the crew will get an alert via several displays and acoustic indications," Reinert said. "It is not very difficult for the flight crew to interpret their ECM data — the important parameters such as exhaust gas temperature, fuel flow, N1, N2 — and on Rolls-Royce engines, N3 — oil pressure and temperature, and vibrations."

Many air carriers routinely generate and transmit during every flight several types of engine condition data. "Our ECM uses takeoff, cruise and exceedance reports to detect engine problems," Reinert said. "These reports are generated at specific altitudes, speeds, etc. Takeoff and cruise reports are just snapshots transmitted by VHF radio. An exceedance report, however, will be forwarded immediately via satellite communication."

As a rule, timely rectification averts further problems that could affect airworthiness. "It is better to have a small delay than an engine failure during flight," he said. "The best examples are trouble with the bleed system, fuel metering, sensor and probe failures and engine-control [anomalies] like variable bleed valve or variable stator vane trouble."

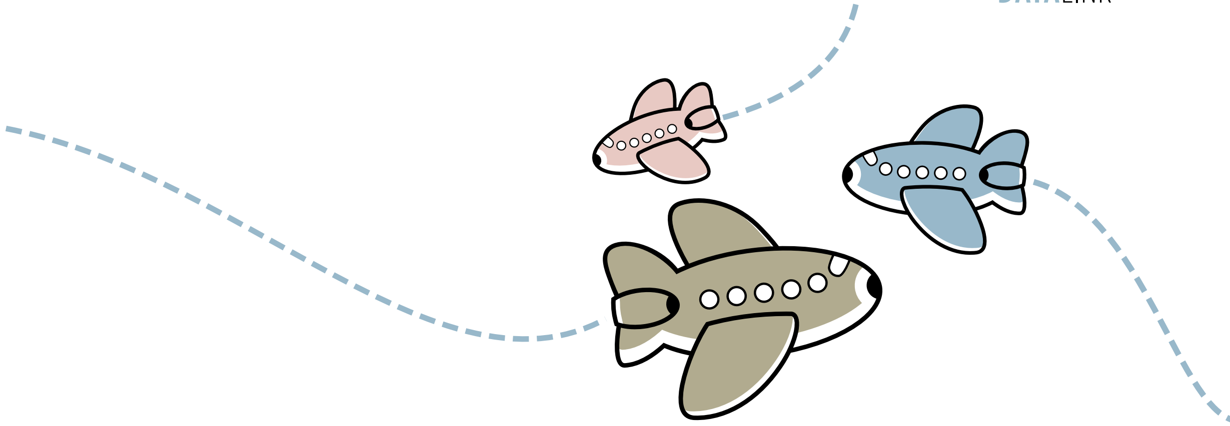
Air carriers and business operators alike look to the services to reduce the probability of an aircraft on ground at a remote site because of engine issues. This situation can be extremely costly because of the logistical complexity and additional work, and may entail more risk than engine work performed at major maintenance stations. "Engine removals at stations other than the home base are expensive because the operator has to bring the maintenance staff, tools and the spare engine to the [remote] station," Reinert said. "Special tooling or even a hangar is required for an engine change."

Even when the engine maintenance is performed at the home base or a preferred major maintenance station, knowledge gained from continuous engine analysis often eliminates some steps otherwise required to return the airplane to service. "Inspections and smaller repairs normally do not require an engine run-up," Reinert said. "A run-up is always a consequence due to a part or engine change. Our ECM system does not eliminate these run-ups, but due to early failure detection, we can conduct inspections before we have to change special engine parts."

Practically all decisions about maintenance action for an engine involve a degree of risk, requiring high quality of both data and data analysis. "We try to minimize this risk by analyzing the data very carefully," Reinert said. ECM engineers will not hesitate to advise changing an aircraft, if a spare is available to the operator, or a flight delay for maintenance to ensure that "everything is fine with the engines," he said.

Notes

1. Before 2007, ETOPS referred only to extended-range operation with two-engine airplanes.
2. *Telematics* in this context refers to integrating telecommunication, information systems and autonomous, self-contained electromechanical sensors in vehicles, including aircraft.
3. Jet-Care International. *A Guide to Gas Path Analysis.* November 2008. The company monitors the condition of more than 12,000 engines worldwide, including identification of problems with main engine instrumentation that can cause flight crews to inadvertently operate at off-design conditions that reduce engine component life. Analysis also gives operators advance warning of engines likely to be restricted for power on hot-day operations, Jet-Care said.



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Speaking of Clearances

U.S. pilots preferred speaking to writing when responding to non-U.S. controllers, but were divided about speech versus datalink in receiving ATC messages.

BY RICK DARBY

Concern about substandard English language use in aviation is often raised in terms of pilots whose native language is other than English. That was, for example, a critical factor in the 1990 accident involving Avianca Flight 52, which crashed because of fuel exhaustion on its third approach to New York's John F. Kennedy International Airport after being placed in a holding pattern for more than an hour. The pilots had been unable to make clear to controllers the nature of their emergency.

But U.S. pilots who have a native's command of English encounter problems at non-U.S. locations where they must communicate with controllers whose English is limited. Also, in some cases, being unable to understand non-English communication on the radio frequency reduces their situational awareness.

In the first of several reports on pilots' non-U.S. flying experience and practices by the U.S. Federal Aviation Administration,[1] researchers found that, based on small-group interviews with U.S. pilots experienced on international routes, "English language proficiency is often deficient in non-native-English countries and hampers effective communication. English language deficiency below a certain level hampers air traffic control [ATC] communication. Language proficiency includes pronunciation, structure, vocabulary, fluency, comprehension and interaction." The researchers also asked general questions about ATC differences in international operations and how they affected the pilots' procedures and performance.

Twelve airline transport pilots from each of four major U.S. air carriers, for a total of 48, were interviewed about their experiences. These pilots had an average of 15 years of international flight experience, with an average of five international flights in the 30 days before the interviews. All listed English as their first language. About 60 percent of the pilots said that they knew no languages other than English, and among the others, the majority spoke and understood some French and Spanish.

Responses were categorized into 10 sections. This report concerns their responses to the first two sections, "Background Information" and "Preflight Preparation." The pilots' answers to questions and discussions during the interviews "provide a wealth of ideas related to the international flight experiences," as well as "their perception of the situations they encountered," the report says.

Although the pilots' responses were partly anecdotal, they answered questionnaires that enabled the researchers

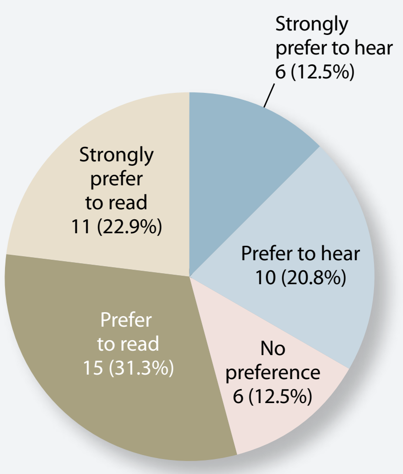
Countries Flown Through by U.S. Pilots In the Three Months Preceding the Interview

Number of Pilots	Countries
1–5	Argentina, Aruba, Antilles, Belgium, Belize, Bermuda, Bolivia, Cambodia, Chile, Colombia, Costa Rica, Crete, Cypress, Denmark, Ecuador, El Salvador, Fiji, Grand Cayman, Greece, Greenland, Guatemala, Haiti, Honduras, Iceland, Iraq, Israel, Jamaica, Kuwait, Laos, Luxembourg, Mongolia, The Netherlands, New Zealand, Nicaragua, Panama, Peru, Poland, Puerto Rico, Republic of the Philippines, Scotland, South Korea, Spain, St. Martin, Switzerland, Tahiti, Thailand, Trinidad, Turkey, Vietnam, United Arab Emirates
6–10	Brazil, China, Dominican Republic, Ireland, Italy, Japan, Russia, Venezuela
11–15	Cuba, France, Germany
16–24	Canada, England, Mexico

Source: U.S. Federal Aviation Administration

Table 1

U.S. Pilot Preferences for Modality of Receiving ATC Messages



ATC = air traffic control

Source: U.S. Federal Aviation Administration

Figure 1

to quantify the results. The report includes quotes, which amalgamated the words of various pilots for the sake of creating a single coherent narrative for each topic.

The 48 U.S. pilots listed 64 geographical areas they had flown through in the three months preceding the interviews (Table 1). Canada, England and Mexico were transited by at least 33 percent of the pilots. "They landed their aircraft in 47 different countries or regions during that time period," the report says. "Within the 30 days preceding the interviews, 83 percent of the pilots flew an average of five international flights, including multiple flights to Costa Rica, Guatemala and Venezuela."

Pilots were asked if they would prefer written communications, such as datalink, to voice communications from ATC. About 33 percent preferred to hear ATC communications, 54 percent preferred to read them and 13 percent had no preference (Figure 1).

One comment explaining a preference for hearing ATC messages was: "Information is rapidly conveyed; it can be questioned and clarified quickly." Another was: "Reading messages is a 'heads down' activity not suitable for many phases of flight."

The opposite viewpoint was expressed as: "When talking to some foreign controllers, their English is so bad, or radios are so scratchy, that you are simply listening for what you think they are going to tell you."

When *responding* to ATC, the majority preferred speech to typing (Figure 2). This was elaborated as: "Speaking … is less time-consuming and it takes less effort. It is easier to correct a misunderstanding. It is also easy to make non-standard requests. Speaking is faster, and I can listen to the inflection and cadence in speech."

Pilots who preferred to type their messages to ATC believe "it minimizes hearback/readback problems significantly. Written communication greatly reduces confusion. For non-English[-speaking] controllers, datalink would be easier for them to understand."

The next section of the questionnaire and interview concerned preparation for international flights.

Pilots were asked what language problems they expect, or have experienced, when flying in non-U.S. airspace. They listed 109 examples of language-based difficulties, which the researchers categorized into themes (Table 2). "English language comprehension and production" plus "controllers' inability to communicate in plain language" accounted for 56 percent of anticipated problems.

"At times, when you ask a basic question dealing with weather, runway conditions or something that is not standard, the controllers cannot answer that question if it's not something that they would expect to parrot back," was one example given of the "controllers' inability to communicate in plain language" category.

Another pilot said, "Sometimes there's difficulty conveying our wishes due to a controller's comprehension skills. When there is a large thunderstorm between my airplane and the airport … and I want to get across to the controller that I cannot do what was just asked of me, I'll say, 'Unable' and you can see a big question mark out there over his head. It is as though he is thinking, 'What do you mean, unable? I gave you a command.' Well, it's not the way we operate at our company. He can arrest me when we land if he wants."

Controllers' pronunciation of fixes, intersections, waypoints and numbers was accounted a major problem.

"Due to the accents and the speed that they're speaking, I personally have to ask them sometimes to repeat themselves more slowly or spell fixes phonetically to get the understanding correct," was one comment. "I have to make sure all of us are hearing the same thing. I've had it happen where we're all listening, but can't decide what fix he's trying to give us. We've been up for 18 hours, so give us a break and spell it for us because we can't understand the pronunciation."

Another comment was: "Again, because of the accent, we never really did come up with exactly what he was saying. We came up with a pretty good consensus of what we thought he meant, but I don't think any one of us was 100 percent certain what the clearance was."

During the small group interviews, "oral responses were embellished and discussions expanded to include cultural differences [in various countries]," the report said.

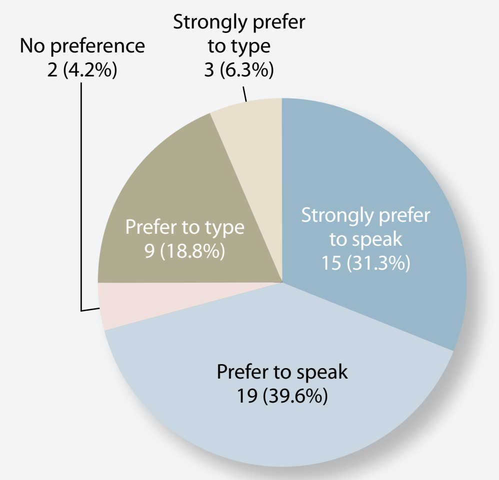
Asked about the effect of the difference in ATC "procedural complexities" from country to country on the pilots' flight experiences, about 10 percent reported a positive effect, about 40 percent said it was neutral, and half said it was negative. Among the choices offered, none said the effect was "very positive" or "very negative." Those who found the experience positive said it kept them on their toes, improved situational awareness and encouraged flexibility — "Aviation is a dynamic environment."

Pilots were asked how much differences in ATC "procedural complexities" had influenced their flight experiences. About 54 percent reported either a moderate or considerable influence, and the remainder reported a limited influence (Table 3, p. 52).

A comment from a pilot who answered "to a considerable extent" was: "One of the biggest problems is transition levels. There are some places we fly into where we don't know the transition level until it's reported on the ATIS [automatic terminal information service]. When we get close enough to where we can hear the ATIS, it will tell us — if we can understand it — what the transition level is. It may vary by 1,000 ft. One day it might be 6,000, one day it might be 7,000."

A pilot said, "I feel that we should have standardization anywhere we fly. I should expect that service, and pilots from other countries flying here [in the

U.S. Pilot Preferences for Modality of Responding to ATC Messages



ATC = air traffic control

Note: Percentages do not add to 100 because of rounding.

Source: U.S. Federal Aviation Administration

Figure 2

Anticipated Language Problems for International Flights

Survey Pilots' Response	Frequency	Percent
Controllers' inability to communicate in plain language	27	24.8
Controller voice quality and speech rate	10	9.2
English language comprehension and production	34	31.2
Frequency congestion*	3	1.8
Multiple languages on frequency	18	16.5
Non-standard terms for standard questions	14	12.8
Poor radio equipment, coverage, quality	3	2.7

* Frequency congestion was mentioned only in connection with "multiple languages on frequency."

Source: U.S. Federal Aviation Administration

Table 2

Influence of Differences in ATC Procedural Complexities on Pilot Flight Experiences

Survey Pilots' Response	Number of Pilots	Percent
To a great extent	0	0.00
To a considerable extent	7	14.58
To a moderate extent	19	39.58
To a limited extent	22	45.84
Not at all	0	0.00

ATC = air traffic control

Source: U.S. Federal Aviation Administration

Table 3

Extent to Which Pilot Performance Is Affected by Different ATC Procedures

Survey Pilots' Response	Number of Pilots	Percent
To a great extent	1	2.08
To a considerable extent	2	4.16
To a moderate extent	15	31.25
To a limited extent	25	52.08
To a very limited extent	1	2.08
It depends	1	2.08
Not at all	3	6.25

ATC = air traffic control

Note: Percentages do not add to 100 because of rounding.

Source: U.S. Federal Aviation Administration

Table 4

U.S.] should expect that same service. In other words, we are all best served by a single global standard."

The issue of cultural norms was mentioned under the subject of procedural complexities. A pilot said, "In South America, a lot of controllers have the opinion that 'el capitán' is always right. There is the hierarchy where the pilot knows what he is asking, and the controller should not try to interpret anything other than what he's asking. If a pilot asks to do something, they approve it because the pilot knows what he wants to ask, even if it's dangerous. So if 'el capitán' says he wants to go down to 6,000 ft and there is a 12,000-ft mountain in front of the aircraft, 'el capitán' will get permission to go down to 6,000 ft."

Forty of the 48 pilots reported that different ATC procedures affected their performance to a moderate or to a limited extent (Table 4).

"In Japan's, China's and Russia's airspace, ATC doesn't have the ability to cope with fast-moving situations like weather deviations or turbulence, and I think they have to stop and think of how to talk to us in English," said a pilot. "Things start falling apart and the communication stops."

Another comment was: "In the U.S., there are a lot more approaches or arrival routes, followed by a radar vector into the pattern behind some other aircraft, whereas with radar vectoring in other places, you'll either continue on your route, or if they need to adjust your position in line they'll say, 'After this point, instead of going to Lucia, you're now going to go straight to Mateo.' But once you get onto the approach, the routing leads you into the airport instead of the controller vectoring you all the way in, and the altitude restrictions have to be kept up with all the way around. The difference is, in the U.S., it's radar vectors and with controllers in other countries, you fly the complete approach."

The interviewed pilots were asked, "Is there any incongruence between what you would normally understand is written on a procedure and what the controller instructs or expects you to do during a flight?" Comments were received from 42 pilots, with the rest either seeing no examples of incongruities between written procedures and controller instructions or expectations, or providing no examples.

"I have had several occasions of being cleared for a standard terminal arrival, and it becomes ambiguous whether you are cleared to descend via the arrival altitude restrictions or not," a pilot said. "Foreign controllers — especially non-native English-speaking controllers — are unsure how to differentiate that specific thing. On the standard departure, you'll have an altitude restriction and they'll clear you directly to an altitude; they don't always mean that you are cleared to disregard the crossing restriction on the climb. So, I've made it a habit when this happens to read back and make sure I understand the clearance is to climb unrestricted to this altitude. A good percentage of the time, they'll come back and say, 'No, cross at the altitude that's listed' or 'comply with the restriction,' even though the altitude assignment should have removed the restrictions."

Note

1. Prinzo, O. Veronika; Campbell, Alan. *U.S. Airline Transport Pilot International Flight Language Experiences, Report 1: Background Information and General/Pre-Flight Preparation.* Report DOT/FAA/AM-08/19. September 2008. Available via the Internet at <www.faa.gov/library/reports/medical/oamtechreports/2000s/media/200819.pdf>.

We Still Need Exceptional People

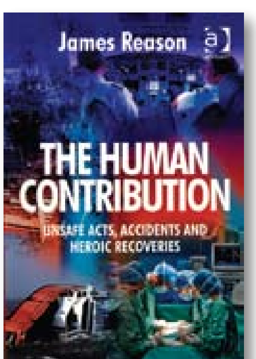
James Reason, analyst of organizational precursors in accidents, returns the focus to the individual.

BOOKS

Personal Qualities Make the 'System' Work

The Human Contribution: Unsafe Acts, Accidents and Heroic Recoveries

Reason, James. Farnham, Surrey, England, and Burlington, Vermont, U.S.: Ashgate. 310 pp. Figures, tables.



James Reason has been among the most prominent advocates of a "systems" approach to understanding accident causation. He is most closely associated with what has been called the "Swiss cheese" model — not his own term — in its successive versions. His model suggests that various latent failures sometimes combine with active failures, aligning organizational and individual factors, to create a temporary window of opportunity for an accident to break through defenses.

In *The Human Contribution*, Reason asks us to consider whether we have so absorbed his and others' system models that the balance has tilted too far from trying to understand the human side of accident scenarios. In particular, he wants to remind us that humans are not merely risk factors around whom safeguards need to be designed. They are also capable of creative and *heroic* actions on behalf of safety that no system design can accomplish.

As a prelude to discussing what he calls "heroic recoveries" that can be credited in large part to front-line individuals or small groups, Reason leads the reader step by step through the world of human factors in accidents and potential accidents.

He leads off with "A Mind User's Guide," a chapter about how the mind receives, interprets, stores and retrieves information. That might seem peripheral to heroic recoveries, but heroism usually must be allied with good decision making to be successful. Reason says, "Knowing something about how your mind works is often very helpful when making decisions in high-risk situations. Our heads are richly stocked with knowledge structures that are called to mind by similarity matching [observing common characteristics between a new situation and previously experienced ones] and frequency gambling [recalling the most frequently encountered information]. Sometimes … these unconscious search processes can lead us into error. But it is more likely that what is called to mind in this way is going to be an appropriate response."

He next considers "The Nature and Varieties of Human Error," classifying types of errors. For example, *omissions*, "a necessary or planned-for step is not done at the intended time." Any pilot who has made a gear-up landing understands this type of error. Omissions are likely to be the single most frequent type, he says, because they can occur at any stage of an activity. Another type is *wrong objects*, when "the right actions are carried out, but in relation to the wrong objects." A doctor who removes a kidney with impeccable skill from the wrong patient has committed this type of error.

"Errors cannot be eradicated, but they can be anticipated and managed accordingly," Reason says. "We can't fundamentally change the human condition, but we can change the conditions under which people work in order to make errors less likely and more easily recoverable."

Reason continues by surveying the main explanatory theories, or "models," of unsafe acts.

He first considers the "person model," in which "unsafe acts are thought of as arising mainly from wayward mental processes: forgetfulness, inattention, distraction, preoccupation, carelessness, poor motivation, inadequate knowledge, skills and experience, and on occasions culpable negligence or even recklessness." Safety management based on this model spawns countermeasures aimed at influencing cognitive processes — posters, rewards and punishments, audits, "writing another procedure to proscribe the specific unsafe acts implicated in the last adverse event," retraining, and blaming.

An overemphasis on systems that virtually ignores the human contribution risks instilling "learned helplessness" in personnel.

Reason acknowledges that the person model is intuitively appealing, not to mention attractive to management that would like to ascribe bad outcomes to wrongful acts by individuals. But, he says, "The shortcomings of the person model greatly outweigh its advantages," because as an explanatory framework it is "inextricably linked to a blame culture." He says the culture involves a set of pathologies called the "vulnerable system syndrome." Its three components are blame, denial and "the single-minded and blinkered pursuit of the wrong kind of excellence."

Blame is discussed at considerable length. Among its drawbacks, Reason says, is that it sabotages any attempt to create a reporting culture in which front-line operators report errors or even by-the-book acts that might have, but did not, result in accidents. "Closely investigated accidents are relatively infrequent; only through the analysis and dissemination of these 'free lessons' can the organizational managers learn how close their operations come to the 'edge.'"

Denial is the attitude that accidents happen to someone else who is less conscientious. "No statement from the managers of a hazardous system could chill me more than 'it couldn't happen here' — although the claim that 'we have an excellent safety culture' comes very close," Reason says.

What could be wrong with the pursuit of excellence? It depends, Reason says, on the real — as opposed to the official or "correct" — definition of excellence that prevails, and whether it is understood in terms of overall results rather than limited, sequestered successes. "When dealing with complex systems, people think in linear sequences," he says. "They are sensitive to the main effects of their actions upon their progress towards an immediate (often numerical) goal, but frequently remain ignorant of their side effects upon the rest of the system."

In contrast to the person model, "a system perspective is any accident explanation that goes beyond the local events to find contributory factors in the workplace, the organization and the system as a whole." He describes a number of such accident models, in addition to his own "Swiss cheese" versions.

"Although the system models seem, on the face of it, to be far more appropriate ways of considering accident causation, both in terms of understanding the contributing factors and in their remedial implications, they too have their limitations when taken to extremes," Reason says. People on the "sharp end" generally have little direct opportunity to bring about rapid system improvements and global changes. An overemphasis on systems that virtually ignores the human contribution risks instilling "learned helplessness" in personnel.

But personal attitudes are still important for safety, whether the system is benign or otherwise. "Personal qualities do matter," he says.

Reason concludes that the person and system models are inadequate in isolation: "We need to find a balance between the two that continues to promote systemic improvements while, at the same time, giving those who have little chance of changing the system some mental skills … that will help them to avoid error traps and recurrent accident patterns tomorrow rather than at some undetermined time in the future."

In the culminating chapters on heroic recovery, Reason looks at the needed personal characteristics under the headings of "training, discipline and leadership," "sheer unadulterated professionalism," "skill and luck," "inspired improvisations" and "the ingredients of heroic recovery." To illustrate his points, he cites numerous examples, not only from aviation but from military, naval, space flight and medical history. Reason's earliest example of discipline is drawn from an 1811 battle in Spain during the Napoleonic wars.

Several famous incidents in aviation are discussed in terms of the human qualities that enabled them to be ended successfully or partially successfully. The chapter on "sheer unadulterated professionalism" describes British Airways Flight 09 in 1982, when all four engines of the Boeing 747 failed after ingesting volcanic ash, and it looked like the airplane would have to glide to a water landing, which no one had ever tried in a 747. The captain's announcement to the passengers while the crew was working out emergency landing procedures was calmness itself: "Ladies and gentlemen, this is your captain speaking. We have a small problem. All four engines have stopped. We are doing our damnedest to get them going again. I trust you're not in too much distress." The engines were eventually restarted and the crew made an emergency landing at Jakarta, Indonesia.

Other incidents include the British Airways BAC 1-11 flight in which an explosive decompression blew the pilots' windscreen out of the aircraft; the Air Canada Boeing 767 that ran out of fuel because of a loading miscalculation and was glided to a landing at a disused military airstrip; the United Airlines McDonnell Douglas DC-10 in which the flight crew maintained controlled flight using thrust after an uncontained failure of the no. 2 tail-mounted engine resulted in the failure of all three hydraulic control systems; and the ingenious improvised procedures by which the captain of an Air New Zealand DC-10 was able to guide to safety the pilot of a Cessna 188 whose automatic direction finder had failed.

Reason analyzes the human qualities that underlie heroic recovery under three headings: coping with expected hazards; dealing with unlikely but possible hazards; and generic qualities "that could contribute to successful recoveries in any emergency."

Expected hazards are not necessarily likely, but rather ones that have occurred in the past and sooner or later will arise again. The human factors that improve the odds of a successful response, Reason says, are these: "Identification and assessment … ; the development, testing and training of a set of countermeasures designed to neutralize the threat (established long before it was called upon); and an effective and timely way of deploying these countermeasures, a process relying critically on situational awareness. The latter has three components: perceiving the critical elements in the current situation; understanding the significance of these elements; and making projections as to their future status."

For avoiding probable disaster in unlikely situations — fuel exhaustion in the 767 and the loss of normal control mechanisms in the DC-10, for instance — Reason believes one key element is "irreplaceable people." In the case of the 767, "the odds of having a skilled glider pilot as the captain and someone who had flown out of Gimli [the disused military airfield] as the copilot, the two things necessary to save the stricken aircraft, are almost infinitesimally small." The saving of the lives of many passengers and crewmembers on the United DC-10 was "a team effort, but I believe it was [Capt.] Al Haynes's personality and his cockpit management skills that were the key elements in bringing that about. And it was his inspirational use of the one and three engines that prevented the aircraft from turning onto its back and falling out of the sky at a very early stage of the emergency."

Decision-making styles are another important factor, Reason says, although different styles of decision making are needed in different kinds of situations. "There are four principal types of decision making: intuitive (recognition-primed), rule-based (where rules are available from remembered experience or from procedures), analytical (choice through comparison of options) and creative thinking (coming up with something entirely new to solve a novel

Different styles of decision making are needed in different kinds of situations.

problem). Selection of a decision-making mode depends crucially on assessing the situation."

"Realistic optimism" is one of the most important generic qualities, Reason believes: "It is high on the list of necessary attributes for aspiring heroic recoverers, and it is particularly important when there is a succession of problems, as was the case in many of these emergencies. What wins out is the stubborn belief that it will be all right in the end."

Reason sums up: "Many if not most recoveries were achieved as the result of a providential awareness, personality, professionalism, teamwork and, in certain circumstances, some unexpected skills. …But these individual ingredients did not appear altogether out of the blue. They had to be selected for and then trained, nurtured and supported by the organizations that the heroic recoverers served."

WEB SITES

Eurocontrol Airport Safety, <www.eurocontrol.int/runwaysafety/public/subsite_homepage.html>

This "Eurocontrol Web Site for the Prevention of Runway Incursions" offers information based on joint initiatives by Eurocontrol; the Joint Aviation Authorities; the International Civil Aviation Organization (ICAO); European, U.S. and Canadian regulatory bodies; and many professional and industry organizations.

The Web site contains the full text of the "European Action Plan for the Prevention of Runway Incursions," which may be downloaded at no cost. The plan provides a history of the combined efforts of interested parties in developing and implementing programs to reduce runway incursions. Also included are 56 recommendations, plus guidance materials and best practices to support actions. Guidelines are offered to assist local safety teams at airports in initiating runway safety programs. Local safety teams are a key component of the larger action plan.

Presentations and accompanying materials from runway safety workshops held in various European locations between 2002 and 2008 can be found in the "Airport Safety Archives" section.

Implementation products — posters, fact sheets and documents such as "Five Studies Relating to Different Runway Management Techniques" and "Air Traffic Control Situational Awareness Occupied Runways," ICAO's "Manual for Preventing Runway Incursions," and ARIA, an Aerodrome Runway Incursion Assessment tool — are available online for downloading. Most are in Adobe portable document format (PDF).

Eurocontrol says ARIA is a computer-based assessment methodology that can help identify specific airport locations where runway incursions could occur and remedial actions that might help reduce the odds of occurrences. ARIA software, user guide and methodology documents may be downloaded at no cost.

A link from Eurocontrol Airport Safety leads to a portal called "Preventing Runway Incursions." Clicking on the link opens a new Web site, <http://bluskyservices.brinkster.net/rsa>. The opening video says, "On average, there are two runway incursions every day in Europe. This portal contains material that you can use to help prevent runway incursions."

Readers can review videos on four runway incursion incidents. Videos — some with soundtracks — are accompanied by interactive quizzes, textual descriptions and analyses of events, and recommendations to prevent the impending incursions shown in the videos.

This portal Web site contains a facts and figures section with definitions, statistics, causal factors, accident reports and more. Several documents from the Eurocontrol Web site are duplicated at this site.

— Rick Darby and Patricia Setze

Roller Coaster Ride

Ice buildup on pitot probes caused erroneous airspeed indications.

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

Flight Crew's Response Was Uncoordinated

Boeing 717-200. No damage. No injuries.

While departing from Kansas City, Missouri, U.S., for a scheduled flight to Washington the night of May 12, 2005, the 717 encountered weather conditions "favorable for the accumulation of structural icing," said the report by the U.S. National Transportation Safety Board (NTSB). "At some point, the pitot-static system began accumulating ice because the air data heat system had not been activated."

The captain, who was flying the airplane on autopilot, maintained airspeed between 280 and 300 kt during the climb to cruise altitude. "The crew felt they did not need to utilize airplane anti-icing because the outside temperature was still too warm to require it," the report said. "The first indication of something abnormal was when the captain noticed the master caution light was illuminated."

The "RUDDER LIMIT FAULT" warning light also illuminated because ice had accumulated on the pitot probe for the rudder limiting system, which reduces maximum allowable rudder deflection as airspeed increases. "The icing continued to accumulate on the other probes of the air data system, degrading its ability to reliably determine the airplane's airspeed," the report said. The captain was about to ask the first officer to retrieve the quick reference handbook when the autopilot disengaged and the airplane, which had been climbing through 19,300 ft, pitched down and entered a steep dive.

During the recovery, the first officer assisted the captain on the flight controls. Both pilots told investigators that the controls felt heavy and that the airplane did not respond to their control inputs. "The flight crew initially applied uncoordinated control inputs, in the process reaching nearly 100 lb [45 kg] of differential force on the pitch-control column, while attempting to recover the airplane," the report said. "During this period … pitch continued to oscillate through five cycles, for a duration of eight minutes, reaching altitudes as low as 10,600 ft and as high as 23,300 ft."

The pilots observed erroneous airspeed indications that varied between 54 kt and 460 kt. "The captain stated that while he was trying to recover the airplane, he attempted to maintain a level pitch attitude by placing the pitch of the airplane in a fixed position and tried to level the wings of the airplane," the report said. "The first officer stated that, during the recovery, he was trying to keep the airspeed away from the stall speed and away from the overspeed red zone."

The crew eventually regained control of the airplane, declared an emergency and landed without further incident at Kirksville (Missouri) Regional Airport. None of the 80 people aboard the 717 was injured.

"Post-incident testing of the airplane's mechanical and electronic systems revealed no abnormalities that would have accounted for the unreliable airspeed indications or the loss of control reported by the flight crew," the report said. "Post-incident computer modeling also confirmed that the airplane performed in a manner consistent with all deviations from normal flight having been initiated or exacerbated by the control inputs of the flight crew."

Commander Overrules Go-Around Call

Cessna Citation 550. No damage. No injuries.

Inbound from Nice, France, the commander was flying an autopilot-coupled instrument landing system (ILS) approach to Runway 21 at Biggin Hill Airport in Kent, England, the evening of Feb. 5, 2008. Night visual meteorological conditions (VMC) prevailed, and surface winds were from 230 degrees at 15 kt. The pilots observed a wind velocity indication of 54 kt on the electronic flight instrument system (EFIS) as the Citation descended through 2,000 ft, said the report by the U.K. Air Accidents Investigation Branch (AAIB).

After the autopilot captured the glideslope, the commander reduced airspeed to 115 kt, which he described as the "minimum approach speed" — reference landing speed (VREF) plus 10 kt. "At two miles from the runway threshold, [the Citation] encountered severe wind shear, and the EFIS speed tape showed the speed trending to below 100 kt," the report said. "The autopilot pitched up to maintain the glideslope, and the aircraft appeared to stall with a right-wing drop. The [commander] recovered from the stall by lowering the nose and increasing power, and decided to continue the approach."

After the second bounce, the first officer called for a go-around. The commander responded, "Why?"

The pitch attitude was described as "flat" on touchdown, and the aircraft began to "porpoise," bouncing off the runway an unspecified number of times. After the second bounce, the first officer called for a go-around. The commander responded, "Why?"

The Citation was brought to a stop on the runway and taxied to its parking position. There was no damage, and none of the four people aboard was injured. Nevertheless, the commander filed an AAIB accident report, in which he "acknowledged that the aircraft bounced on landing but stated that at all times he had control of the aircraft and maintained the runway centerline," the incident report said. The first officer filed a mandatory occurrence report with the U.K. Civil Aviation Authority, saying that the aircraft had reached heights of 10 to 15 ft during the bounces.

Noting that the difference between the indicated wind velocity at 2,000 ft and the reported surface wind velocity provided warning that the pilots could expect significant wind shear, the report said, "The selection of a speed greater than minimum approach speed may have provided a greater margin for wind shear." The report also said that a go-around conducted after the stall recovery "may have prevented the subsequent bounced landing."

Reversed Anti-Skid Wiring Leads to Excursion

Airbus A320-200. Minor damage. Two minor injuries.

Surface winds were from 330 degrees at 17 kt, gusting to 23 kt, when the A320 was landed on Runway 22R at Chicago O'Hare International Airport the night of Oct. 9, 2007. Perceiving no deceleration by the autobrakes, the captain applied manual wheel braking when airspeed decreased below 100 kt.

"The aircraft immediately swerved hard right," the captain told NTSB investigators. "I corrected with full left rudder and brake, but the aircraft continued to the right. I then used nosewheel steering to attempt to straighten the aircraft, but it was ineffective."

The nosewheel and right main landing gear ran off the right side of the runway. The captain was able to steer the aircraft back onto the runway and bring it to a stop. A flight attendant and a passenger received minor injuries during the excursion; the other 125 occupants were not injured.

"Although I knew there was some aircraft damage, there was no indication of fire," the captain said. "Since the aircraft taxied normally, I taxied … and parked at the gate." After shutting down the engines, the captain observed that the indicated temperature of the brakes on the left main landing gear was about 60° C (140° F), and that the indicated temperature of the brakes on the right main gear was about 375˚ C (707˚ F). He then was informed by maintenance personnel that the left inboard tire had burst and that the engine nacelles had been damaged.

Examination of the A320 revealed that the wiring for the anti-skid braking system tachometers on the inboard and outboard wheels on the left main landing gear had been misrouted and reversed during replacement of the tachometers by a maintenance contractor the day before the accident. This resulted in a high level of braking on the inboard wheel but no braking of the outboard wheel.

"The operator reported that the reference documentation associated with the scheduled maintenance involving both of the left main landing gear tachometers was unclear and that the procedure for that maintenance was revised," the report said.

Turbulence Warning Not Passed to Crew

McDonnell Douglas DC-9-83. No damage. Two serious injuries.

The DC-9 was descending through 8,300 ft during an approach in VMC to Ontario (California, U.S.) International Airport when it encountered severe turbulence the morning of Dec. 25, 2007. Two flight attendants who were completing final cabin duties in preparation for landing were thrown to the floor. "One of the flight attendants sustained multiple fractures to one ankle, and the other flight attendant suffered a head injury with loss of consciousness and concussion," the NTSB report said. The other 112 people aboard the airplane were not hurt.

"The turbulence was likely the result of strong easterly winds interacting with the rough terrain in the area (mechanical turbulence)," the report said. The U.S. National Weather Service had issued a significant meteorological advisory (SIGMET) for occasional severe turbulence below 12,000 ft in the area. "The content of [the SIGMET] was available to the flight's dispatcher," the report said. "However, this information was not provided to the flight crew."

The report said the company that supplies weather information to the operator had not forecast severe turbulence in the area. Nevertheless, wind shear data included in the preflight paperwork had caused the captain to anticipate turbulence. Although the ride had been smooth during descent, the captain said that the DC-9 was descending through 13,000 ft when he "chimed the flight attendants early," indicating that they were to prepare the cabin for landing and then be seated. The captain described the turbulence encounter as a "violent jolt" that occurred with no warning.

The captain described the turbulence encounter as a "violent jolt" that occurred with no warning.

Pallet Loader Catches Fire

Airbus A320-200. No damage. No injuries.

The A320 was being readied for departure from Melbourne (Australia) Airport on Dec. 31, 2007. "The flight crew was in the cockpit preparing the aircraft for the flight, the passengers were boarding the aircraft through the left-forward door via the airbridge, and the ground handlers were loading and unloading baggage and other items," said the report by the Australian Transport Safety Bureau (ATSB).

The operator of a pallet loader on the right side of the aircraft detected the odor of an electrical fire while restarting the engine, which had stalled. About the same time, the loading supervisor noticed a fire in the pallet loader's engine compartment and warned the operator, who used a fire extinguisher attached to the pallet loader to put out the fire. The pallet loader was about 10 m (33 ft) from a fueler who was refueling the aircraft under the left wing.

"The ignition source for the fire was most probably intense electrical arcing within the pallet loader engine's starter motor solenoid," the report said, noting that after a similar incident on May 27, 2008, the operator retrofitted all of its pallet loaders with "a replacement starter motor that significantly reduces the risk of electrical arcing."

Roll Excursions Spoil Landing

Learjet 35A. Substantial damage. No injuries.

Weather conditions at Goodland (Kansas, U.S.) Municipal Airport the morning of Oct. 17, 2007, included winds from

330 degrees at 9 kt, 1 1/4 mi (2,000 m) visibility in mist and a 200-ft overcast ceiling. During the briefing for the ILS approach to Runway 30, the pilot told the copilot to fly the approach and that he (the pilot) would take the controls for landing if he acquired visual contact with the runway.

The copilot told investigators that the approach was stabilized. As the Learjet neared decision height, he was preparing to go around when the pilot announced that he had the runway environment in sight and took control of the airplane.

The pilot said that the airplane was slightly left of the extended runway centerline when it exited instrument meteorological conditions 250 ft above ground level (AGL). He said that when he made a "slight correction to the right," the Learjet "rolled excessively to the right"; he then corrected to the left, at which time the airplane "rolled excessively to the left."

The right wing tip fuel tank and then the left tip tank struck the runway before the airplane ran off the left side of the runway and came to a stop between the runway and a taxiway. Damage included separation of the left outboard wing about 3 ft (1 m) from the tip tank. The pilots, who were alone in the airplane, escaped injury.

The report said that maintenance had been initiated 15 days before the accident to correct a fault in the Learjet's spoileron system, which uses the ground spoilers to augment the ailerons at low airspeeds; the system is armed when the flaps are extended beyond 25 degrees for approach. Maintenance records indicated that the system was "not working properly."

Technicians at the maintenance facility were troubleshooting the problem when the operator recalled the airplane. "They deactivated the spoileron system in accordance with the Learjet minimum equipment list procedure," the report said. "The [spoileron] circuit breaker was pulled and secured with a tie wrap, and a decal was installed indicating the system was deactivated.

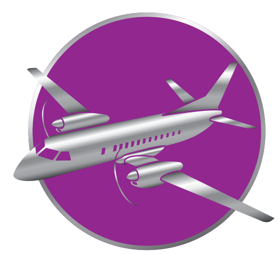
"Neither the tie wrap nor decal were noted during the [post-accident] examination of the cabin of the airplane, and both the spoiler and spoileron circuit breakers were in the closed position."

The pilot said that he had closed the spoileron circuit breaker for a short time during cruise flight while attempting to reset the system. "He stated that the system would not reset, so he pulled the circuit breaker, and it remained in that position for the remainder of the flight," the report said. "It was also stated that all cabin circuit breakers were reset [closed] following the accident."

The report said that examination and testing of the yaw damper and spoileron computer revealed "anomalies," but the manufacturer said that the anomalies would not prevent control of the airplane. "Greater control wheel displacement and force to achieve a desired roll rate when compared with an operative spoileron system would be required," the report said. "The result would be a slightly higher workload for the pilot, particularly in turbulence or crosswind conditions."

The report concluded that the probable cause of the accident was "the pilot's failure to maintain aircraft control during the landing."

TURBOPROPS



Snow Melts, Refreezes on Parked Airplane

Beech Super King Air 200. Destroyed. Two fatalities.

The pilot removed the King Air from a heated hangar and left it on the ramp at Salmon, Idaho, U.S., while having breakfast with a passenger and waiting for two more passengers to arrive the morning of Dec. 10, 2007. "The outside temperature was below freezing, and a steady light-to-moderate snow was falling," the NTSB report said. "The airplane sat in the aforementioned ambient conditions for at least 45 minutes before the initiation of the takeoff roll."

The pilot did not remove snow that had accumulated on the airplane or ice that had formed when snow melted on contact with the warm airframe and then refroze. Heavy snow was falling, with 2 in (5 cm) of wet snow on the runway, and the temperature was about 10° F (minus 12° C) when the takeoff was initiated.

After lifting off the runway, the King Air bounced once and banked steeply left and right several times. Passengers said that the airplane was shuddering. The pilot discontinued the climb and turned to a left downwind. "During this turn, the airplane reportedly again rolled to a steeper-than-normal bank angle, but the pilot successfully recovered," the report said. "While on the downwind, the airplane reportedly stabilized in a wings-level [attitude] without any significant rolling or shuddering."

However, when the pilot initiated a left turn toward the approach end of the runway, the airplane began to shudder, yaw and rapidly lose altitude, the report said. The pilot applied full power, but the King Air continued to descend and struck a hangar about 1,300 ft (396 m) from the runway threshold. The pilot and front-seat passenger were killed; the other two passengers escaped injury and were able to open the cabin door and exit the airplane before it was engulfed in flames.

No Cause Found for 'Partial Incapacitation'

Dornier 228-200. No damage. No injuries.

After several route-familiarization and promotional flights, the pilots were conducting a positioning flight from Westport, New Zealand, to Christchurch the night of March 20, 2007, when they began to feel dizzy while cruising at 10,000 ft. "The pilot flying told the check captain that he 'didn't feel very well' and thought he might 'faint or pass out,'" said the report by the New Zealand Transport Accident Investigation Commission.

Soon after taking control, the check captain also began to feel faint. He told the pilot that he felt light-headed and perceived a blurring of his peripheral vision. "The check captain turned off the air conditioning bleed air supplying the [flight deck] heating, selected external ram air and instructed the pilot to open the storm window," the report said. "The aircraft was not fitted with portable oxygen or side air vents [and did not have a cabin pressurization system]."

The pilot felt better after using a cupped hand to direct fresh air onto his face. "The check captain leaned across and breathed in some of the fresh cold air," the report said. "He also noticed an almost immediate improvement in his condition."

The check captain transferred aircraft control back to the pilot, transmitted a "pan pan" urgency call to air traffic control and requested clearance to descend to the minimum safe altitude. The crew initially was cleared to descend to 9,000 ft. "The crew considered that continuing to Christchurch was preferable as they were about midway between [Westport and Christchurch] and the terrain allowed for an earlier descent," the report said. VMC prevailed at Christchurch, which also had longer runways and full aircraft rescue and fire fighting service.

When the pilot removed his hand from the storm window, the check captain again said that he was becoming light-headed and that his vision was blurring. "The check captain alerted the pilot to again start directing fresh air into the cockpit and noted an immediate improvement in his condition," the report said. "The pilot continued to fly with his right hand, keeping his left hand at the storm window, which required the check captain to manage the power levers and radio."

The pilots acquired visual contact with the airport after descending to 6,500 ft and landed the Dornier without further incident. Although they felt better, the pilots went to a local hospital for a medical examination. "Blood samples were taken … and the pilots put on oxygen," the report said. "Displaying no ill effects, the pilots were released after about an hour." Toxicological tests of the blood samples showed slightly elevated levels of carbon monoxide.

The operator had recently purchased the aircraft, which had been in open storage for seven years, but had not yet placed it into service after refurbishment. The investigation focused on the heating and air conditioning system. "An initial examination of the engines, associated bleed-air systems and aircraft air conditioning identified no unusual smells and nothing that might have caused contamination of the flight deck air," the report said, noting that a subsequent examination and test flight also found "nothing untoward."

The check captain again said that he was becoming light-headed and that his vision was blurring.

Concluding that the incident was an "isolated occurrence," the report said, "The reason the pilots became partially incapacitated could not be determined but was most likely from some form of air contamination, because the symptoms disappeared when fresh air was introduced into the cockpit." As of December 2008, the aircraft had been flown more than 500 hours since the incident "with no reported problems, unexplained fumes or cases of ill health," the report said.

Pilots Did Not Notice Cargo Door Light

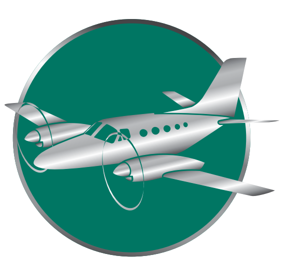
Raytheon 1900D. Minor damage. No injuries.

Cockpit voice recorder data indicated that, contrary to standard operating procedures (SOPs), the pilots discussed personal matters while the first officer conducted challenge-and-response checklist procedures by himself and taxied the airplane for departure from Page, Arizona, U.S., on March 26, 2008.

"Due to the flight crew's lack of professionalism and deviation from [SOPs], they most likely did not see that the [aft cargo door warning light] was illuminated prior to departure," the NTSB report said. The cargo door opened soon after liftoff. The captain took control, turned back to the airport and landed the 1900 without further incident. None of the 13 people aboard the airplane was injured.

The pilots told investigators that the aft cargo door light, which warns that the door is not closed and locked, was not illuminated before takeoff. The captain said that he saw the light shortly before the door opened. "Following the accident, operation of the door and functionality of the cockpit indicator light were verified," the report said. "No anomalies were noted."

PISTON AIRPLANES



Fuel Selector Set on Empty Tank

Beech C55 Baron. Destroyed. One fatality.

Witnesses heard the left engine sputter and surge, and saw the Baron yaw left on takeoff from Port Orange, Florida, U.S., on March 4, 2007. The airplane climbed no higher than 75 ft AGL and was in a nose-high attitude with the landing gear extended when it stalled, rolled left and descended to the ground, the NTSB report said.

Investigators found both fuel selectors positioned to the auxiliary tanks, a configuration that is prohibited for takeoff. There was 1/4 gal (1 L) of fuel remaining in the left auxiliary tank and 9 gal (34 L) in the right auxiliary tank.

NTSB said that the probable cause of the accident was "the pilot's failure to maintain airspeed during initial climb" and a contributing factor was "the pilot's improper positioning of the left fuel selector, which resulted in fuel starvation to the left engine."

Spatial Disorientation Leads to Crash at Sea

Cessna C337G Skymaster. Destroyed. Four fatalities.

Before departing from Moorabbin, Victoria, Australia, the pilot indicated that he would follow the coastline during the visual flight rules flight to Merimbula, New South Wales, on Nov. 17, 2007. Witnesses on a beach near Venus Bay, Victoria, saw the Skymaster emerge from fog, flying low over the water.

"Within seconds, it turned right to head out to sea," said the ATSB report. "It turned through about 90 degrees at a steep angle of bank while maintaining height before disappearing from sight into the fog." The witnesses then heard a bang.

Aircraft wreckage and the bodies of the three passengers were found washed up on the beach two days later. The pilot's body was not found. The report said that the pilot, who was not instrument-rated, likely had become spatially disoriented and had inadvertently descended into the water.

Improper Gear Adjustment Causes Collapse

Cessna 402B. Substantial damage. No injuries.

While preparing to land at Fort Lauderdale (Florida, U.S.) Executive Airport on March 15, 2008, the pilot observed indications that the right main gear was not down and locked. He recycled the landing gear and used the backup extension system, but saw green lights only for the left main gear and nosegear, the NTSB report said.

The pilot flew the 402 near the airport traffic control tower, and a controller radioed that all three gear appeared to be extended. However, on landing, the right main gear collapsed. The pilot and the three passengers escaped injury.

Investigators found that several days before the accident, the right main landing gear down lock had been improperly adjusted by maintenance technicians. The report concluded that the improper maintenance likely caused the accident.

HELICOPTERS

Windshield Shattered by Eagle

Eurocopter EC 130B4. Substantial damage. Three minor injuries.

The air tour helicopter was cruising at 100 to 120 kt at 500 ft AGL near Meadview, Arizona, U.S., the afternoon of Sept. 27, 2007, when the pilot saw a bird pass below and to the left. "Another large bird, tentatively believed to be a golden eagle with an 8-ft [2-m] wingspan, suddenly appeared directly ahead of the helicopter," the NTSB report said.

The bird shattered the left windshield. The pilot and two passengers were struck by debris; the other five passengers escaped injury. The helicopter was landed without further incident at a local airport.

No Room to Recover

Bell 206B JetRanger. Destroyed. Five serious injuries.

The pilot had rented the JetRanger to provide short flights at a friend's party near Hornsby, New South Wales, Australia, on March 1, 2008. Witnesses saw the helicopter making low passes over the party area at about 100 ft AGL. After one pass, it entered a steep left bank, rolled out and then descended into trees.

The pilot told investigators that the front-seat passenger might have pushed the collective control forward. The passenger, however, could not recall what happened before the crash. "Examination of the wreckage did not indicate any mechanical defects that would have affected the safe operation of the helicopter," the ATSB report said.

The report noted that flight below 500 ft AGL is prohibited in Australia. It said that during the steep turn, main rotor blade inertia and rotor rpm would have decreased. "If the pilot did not react rapidly to this condition, or if the front-seat passenger had pushed the collective control down, the result would be a loss of altitude," the report said. "Regardless, in either circumstance, the helicopter was being operated at a height from which recovery was not possible."

Loose Fastener Causes Control Disconnect

Aerospatiale AS 350BA. Substantial damage. Four fatalities, three serious injuries.

The helicopter was returning from a sightseeing flight on March 8, 2007, when the pilot reported hydraulic system problems (*ASW*, 11/08, p. 30) and that he would perform a run-on landing at the Princeville (Hawaii, U.S.) Airport. As the helicopter neared the runway, the pilot radioed, "Okay, we're done." The sound of the rotors changed, and the helicopter descended into a grassy area next to the runway. The pilot and three passengers were killed, and three other passengers sustained serious injuries.

"Postaccident examination of the helicopter revealed that the left lateral flight control servo became disconnected in flight at the transmission," the report said. The disconnection was traced to maintenance personnel who, while replacing the servo about a month before the accident, had installed a "severely worn" lock washer and had tightened the jam nut on the lower clevis — a U-shaped attachment fitting — to the lower torque value specified for the upper clevis.

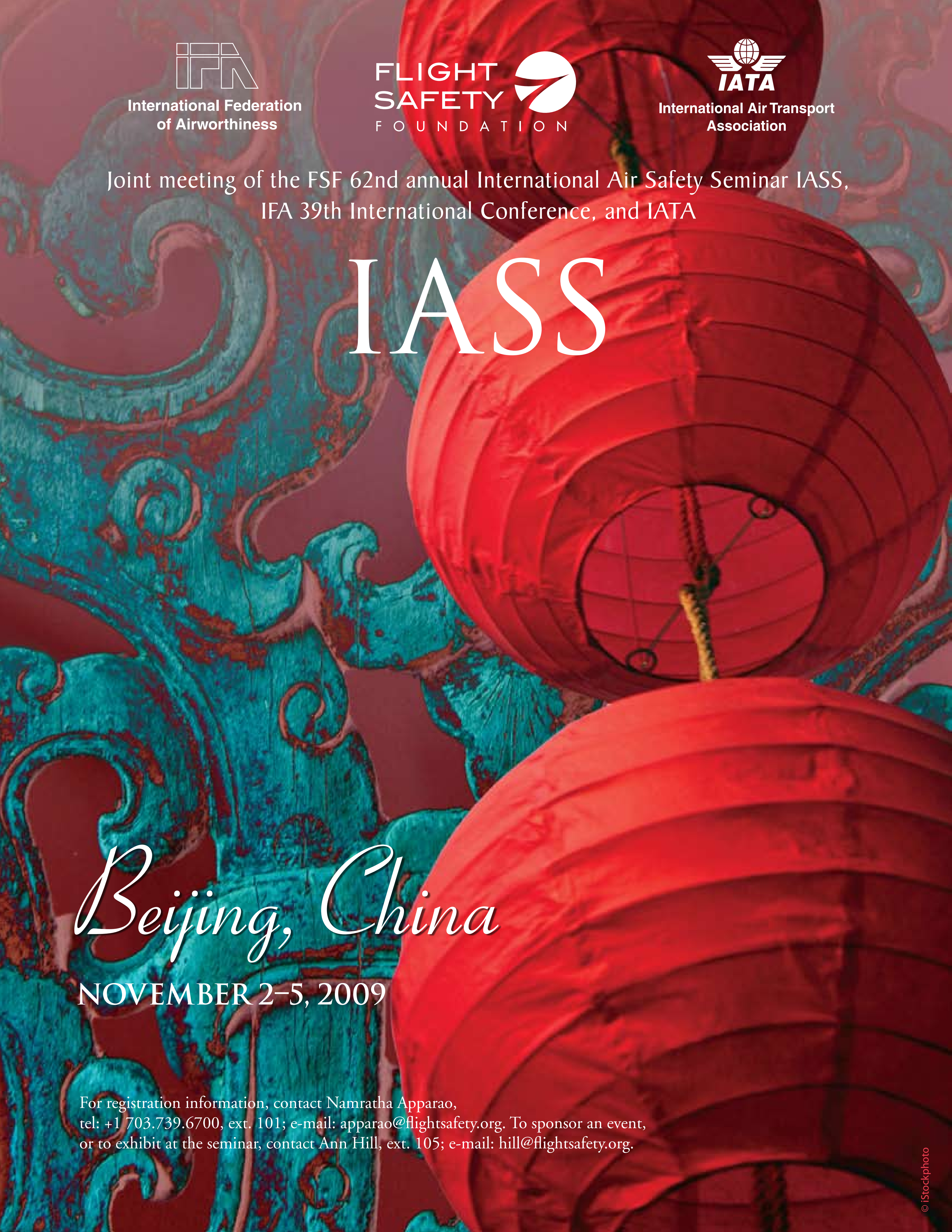
"Examination of the company's maintenance program revealed that none of the mechanics at the helicopter's base had received factory training and that the maintenance manuals they used were three revisions out of date," the report said.

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Jan. 3, 2009	Telluride, Colorado, U.S.	Learjet 45	substantial	2 minor
Light snow was falling when the Learjet overran the runway on landing.				
Jan. 4, 2009	Morgan City, Louisiana, U.S.	Sikorsky S-76C	destroyed	8 fatal, 1 serious
The helicopter crashed in a marsh shortly after departing from Amelia, Louisiana, in visual meteorological conditions to transport workers to an offshore oil rig.				
Jan. 5, 2009	Antarctica	Basler BT-67	destroyed	4 NA
The turboprop-converted Douglas DC-3 struck a mountain in an area of reduced visibility during a cargo flight. All four occupants reportedly survived.				
Jan. 11, 2009	Caticlan, Philippines	Xian MA60	substantial	25 NA
The twin-turboprop touched down short of the runway while landing in strong winds and struck a concrete fence. Three airport workers and at least two passengers reportedly were seriously injured.				
Jan. 11, 2009	Hayden, Colorado, U.S.	Pilatus PC-12/45	destroyed	2 fatal
Heavy snow was falling, and two line service workers saw wet snow on the airplane's wings before it crashed shortly after takeoff in a steep nose-down and inverted attitude.				
Jan. 12, 2009	East Anglia, England	Boeing 737-700	none	4 none
The 737 was on a positioning flight when it pitched down violently and exceeded maximum operating airspeed by 100 kt while losing 10,000 ft of altitude before the flight crew recovered control.				
Jan. 15, 2009	Makhachkala, Russia	Ilyushin 76MD	destroyed	3 fatal, 4 NA
The military transport was being taxied onto the runway when its forward fuselage was struck by the wing of another Il-76MD that was landing. The landing airplane was substantially damaged, but none of the 31 occupants was injured. The collision occurred at night and with visibility reduced by fog.				
Jan. 15, 2009	Wray, Colorado, U.S.	Gulfstream Commander 690C	destroyed	3 fatal
Witness reports indicate that the airplane stalled and spun to the ground during an instrument approach in night instrument meteorological conditions (IMC).				
Jan. 15, 2009	New York	Airbus A320	destroyed	1 serious, 154 none
The A320 was ditched in the Hudson River after it struck a flock of birds and lost power from both engines while departing from La Guardia Airport.				
Jan. 16, 2009	Oradea, Romania	Gulfstream G200	substantial	12 none
The airplane overran the runway while landing in adverse weather conditions.				
Jan. 19, 2009	Falkenstein, Germany	Piper Cheyenne IIIA	destroyed	1 fatal
The Cheyenne crashed in mountainous terrain shortly after departing from Frankfurt Main Airport in IMC.				
Jan. 19, 2009	Tehran, Iran	Fokker 100	substantial	114 NA
The Fokker veered off the runway after the right main gear collapsed on landing. No fatalities were reported.				
Jan. 20, 2009	Wichita, Kansas, U.S.	Bombardier Global 5000	substantial	none
Static engine tests were being conducted when the airplane struck a blast fence.				
Jan. 22, 2009	Midway Islands	Airbus A330-300	none	1 serious, 3 minor, 281 none
A flight attendant suffered head and neck injuries, and three passengers received minor injuries when the A330 encountered severe turbulence during a flight from Tokyo to Honolulu.				
Jan. 22, 2009	Naples, Florida, U.S.	Cessna 402C	none	7 none
The pilot landed the 402 at the Naples airport after both engines lost power during a charter flight from Key West to Fort Myers, both in Florida.				
Jan. 27, 2009	Lubbock, Texas, U.S.	ATR 42-320	substantial	1 serious, 1 minor
Night IMC prevailed, with light freezing drizzle and surface winds from 350 degrees at 10 kt, when the cargo airplane touched down short of Runway 17R and struck approach lights.				
Jan. 30, 2009	Huntington, West Virginia, U.S.	Piper Seneca II	destroyed	6 fatal
The pilot reported a low fuel state before the Seneca crashed in a wooded area while being vectored for an airport surveillance radar approach in IMC.				
Jan. 31, 2009	Mudurnu, Turkey	Eurocopter EC 135PC	destroyed	2 fatal
The helicopter crashed after the pilots reported adverse weather conditions during a ferry flight from Warsaw, Poland, to Ankara, Turkey.				

NA = not available

This information, gathered from various government and media sources, is subject to change as the investigations of the accidents and incidents are completed.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FLIGHT SAFETY FOUNDATION
IATA International Air Transport Association
Joint meeting of the FSF 62nd annual International Air Safety Seminar IASS, IFA 39th International Conference, and IATA
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