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THE FOURTH Estate

I was winding down from engagement in another flurry of news media stories, and thinking that many of our members probably don't understand Flight Safety Foundation's relationship with reporters, or are not even aware of all the things we do with the media.

One big reason the Foundation engages aggressively with the media is to give safety professionals the room they need to do their jobs. Today, there is no shortage of people who understand safety, but these people endure a lot of interference from politicians, judges and policymakers. When an aviation safety event finds its way into the public spotlight, these politicians are compelled to respond. That means the Foundation has to reach out quickly to global media outlets to provide a balanced viewpoint. We put the situation into a reasonable context and may suggest reasonable actions. If people insist on being unreasonable, we are in a position to clearly point that out.

Last year, a controller in Washington fell asleep on duty, which resulted in public outrage. The immediate political reaction was to fire a lot of people and put in place a bunch of draconian rules. We worked with dozens of media outlets to explain why this wouldn't be the best decision, as it wouldn't solve the problem. Our effort helped moderate the situation. It made room for more reasonable solutions to be heard.

There was a similar political reaction this year following two fatal crashes in Nigeria. Nigeria has been moving in a very positive direction since the tragic years of 2005 and 2006. But when the recent accidents occurred, local media and politicians threatened to undo the hard-won reforms that had already been put in place. The Foundation worked behind the scenes to shape the global coverage and send a strong message encouraging Nigeria to stay the course.

Another reason we engage with journalists is to advance views that are critical to the criminalization issue and data protection. We focused world attention on those subjects following the Gol mid-air in Brazil, the Concorde trial and the 15-year Air Inter prosecution. We also have been very vocal about rulings in Italy that have directly interfered with accident investigations.

Finally, we often engage with the media because we need to help them get the story right, or correct it when it is wrong. Following the tragic crash that killed high-ranking members of the Polish government in 2010, we had endless conversations with the Russian and Polish media, helping them understand that this horrible tragedy was an ordinary CFIT, not a conspiracy. More recently, we had the unpleasant job of pointing out to the world that the *Washington Post* had gotten a story wrong. They took an embarrassing ATC blunder on a clear day at Washington Reagan National Airport and turned it into a sensational tale of a near-death experience that made headlines around the world.

The result of all this is that you will see Flight Safety Foundation experts quoted in publications all around the world. We use our position and reputation as an international, unbiased safety organization to help reporters understand the latest safety news. It is a big job influencing the way aviation safety is covered in the world. We can't engage on every issue, but if we miss an important one, please let us know. We are not doing this for fun. We are doing it for you.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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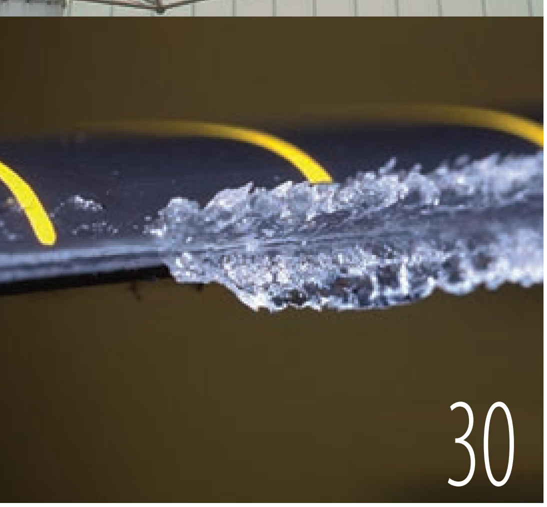

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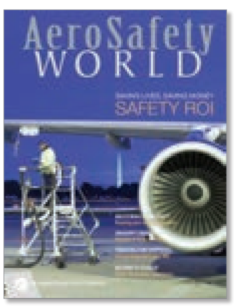

About the Cover
Ramp operations at
Reagan National Airport (DCA)
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If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about aviation safety, we will be glad to consider it. Send it to Director of Publications Frank Jackman, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA or jackman@flightsafety.org.

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Subscriptions: All members of Flight Safety Foundation automatically get a subscription to *AeroSafety World* magazine. For more information, please contact the membership department, Flight Safety Foundation, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA, +1 703.739.6700 or membership@flightsafety.org.

 ISSN 1934-4015 (print)/ ISSN 1937-0830 (digital). Published 11 times a year.

AeroSafetyWORLD

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USA SEQUESTRATION and Safety

Alarm bells are ringing in Washington. They are difficult to hear over the din of the U.S. presidential election, but aural alerts are sounding as the prospect of $1.2 trillion in automatic, mandatory federal budget cuts over nine years, beginning with the fiscal 2013 budget, grows more real. Elected officials, political appointees, civil servants, lobbyists and special interest groups all are worried about the across-the-board budget cuts known as "sequestration" and the possible short- and long-term ramifications.

The story behind sequestration is long and sordid, but basically a bipartisan congressional "super committee" late last year failed to identify $1.5 trillion in specific deficit reduction targets for fiscal year 2012, which began in October 2011, through fiscal year 2021. The Joint Select Committee on Deficit Reduction's inability to overcome the Republican vs. Democrat dynamic triggered sequestration under the Budget Control Act. Unless Congress acts to halt sequestration, which still is a possibility, budget cutting will begin in January.

In mid-August, the Aerospace Industries Association (AIA), which represents U.S. aerospace and defense manufacturers and suppliers, released a study, *Economic Impacts of FAA Budget Sequestration on the U.S. Economy*, which said the U.S. Federal Aviation Administration (FAA) could see sequestration-forced budget cuts of $1 billion a year over nine years. Such a loss of funding could cost the country up to 132,000 aviation jobs, tens of millions fewer passenger enplanements per year and the loss of 1 billion pounds or more of air freight annually as system capacity shrinks because of control tower closures, air traffic controller layoffs and other personnel and infrastructure cutbacks. The budget cuts also could have a devastating impact on full implementation of the Next Generation Air Transportation System, more commonly known as NextGen, which currently is scheduled for 2025.

In releasing the study, which was conducted by Philadelphia-based economic consulting firm Econsult Corp., AIA President and CEO Marion C. Blakey said, "With proper funding, the FAA can be both safe and efficient. Under sequestration, the air traffic control system will be hobbled for decades, leaving travelers, shippers and our economy in the lurch."

But while the system might be hobbled, Blakey was adamant that safety will not be affected, and an AIA spokesman later confirmed those comments. "We have been very insistent in our commentary that FAA will never forsake safety," the spokesman told me. "Safety is the cardinal rule."

Still, there is cause for concern. How does an agency absorb a blow of that potential magnitude and not falter, if only briefly? If sequestration results in significant layoffs among controllers and other safety-critical personnel, such as inspectors, can FAA shrink the system fast enough and efficiently enough to avoid a possibly dangerous additional workload being dropped on the remaining professionals? And what about the human factors, the stress of uncertainty and its impact on performance?

As former Transportation Secretary Norman Mineta said in August, "The FAA is a critical safety organization that regulates our national air transportation system. Putting it at risk is a folly beyond comparison."

The Econsult study is available at <secondtonone.org>.

Frank Jackman
Editor-in-Chief
AeroSafety World

Serving Aviation Safety Interests for More Than 60 Years

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

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IASS 2012 — Santiago

On a clear day, Santiago basks in one of the most spectacular settings of any city in the world. A mighty circle of mountains — the snowcapped Andean peaks to the east, and a smaller coastal range to the west frame the Chilean capital. This will be the backdrop for the 65th annual International Air Safety Seminar (IASS) scheduled for Oct. 23–25, 2012. Coming to this region was a natural choice due to the partnerships the Foundation has formed over the past few years. I thought I would use my operations update this month to provide some insight on our partners.

The IASS will be presented by the Foundation and the Latin American and Caribbean Air Transport Association (ALTA). It will be hosted by the Directorate General of Civil Aviation (DGAC) of Chile. ALTA is a private, non-profit organization, whose member airlines represent more than 90 percent of the region's commercial air traffic. ALTA coordinates the collaborative efforts of its members to facilitate the development of safer, more efficient and environmentally friendly air transport in the Latin American and Caribbean region for the mutual benefit of the association's members, their customers and the industry. It is a natural fit with our Foundation activities in safety.

The DGAC provides Chilean aviation and foreign operators in Chile the necessary services for the security and regularity of air navigation. It participates directly in the planning of the aeronautical infrastructure, contributing to national integration and regional development, and is responsible for the security of the civil aviation system. The organization works closely with international organizations (Flight Safety Foundation), general aviation interests, airlines, maintenance centers, aviation schools and other public services.

Meeting in conjunction with the IASS — in order to take advantage of this gathering of well-known presenters, interesting topics and great networking opportunities — will be the Regional Aviation Safety Group–Pan America (RASG-PA). RASG-PA was established in November 2008 to be the focal point to ensure harmonization and coordination of safety efforts aimed at reducing aviation safety risks in the North American, Central American, Caribbean (NAM/CAR) and South American (SAM) regions and to promote the implementation of safety initiatives by all stakeholders. This is another great alliance with the Foundation activities.

ALTA, the International Air Transport Association, the International Federation of Air Line Pilots' Associations, the Air Line Pilots Association, International and various other associations also will be at IASS.

The Foundation has not held an event in this region of the world since 1999, so it will definitely be *the* safety event to attend. As I have mentioned previously in my articles, the seminar formats have been enhanced and at this one we will have some presentations that are oriented to this region of the world on how some safety programs are implemented. We will have the usual high-quality exhibitors there, along with a great reception at the National Museum of Air and Space.

Overall, this is one safety seminar that you do not want to miss. See you in Santiago!

Capt. Kevin L. Hiatt
Chief Operating Officer
Flight Safety Foundation

(Re)drawing the Line

ILS signal interference (*ASW*, 7/12, p. 20) is a serious problem that has existed for decades.

To fix this, the FAA needs to draw the lines at 1,500 and 5, not 800 and 2. There is no reason a plane should be on instruments inside the final approach fix when the signal is not protected!

Martin Coddington

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 Frank Jackman, director of publications, Flight Safety Foundation, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA, or e-mail <jackman@flightsafety.org>.

SEPT. 17–18 ➤ Flight Safety 2012. Flightglobal. London. <events.registration@rbi.co.uk>, <bit.ly/K4OT3A>, +44 (0)20 8652 3233.

SEPT. 19 ➤ Fatigue Risk Management and Operational Human Factors. Global Aerospace SM4 and the Minnesota Business Aviation Association. Minneapolis. <safety@global-aero.com>, <sm4.global-aero.com/upcoming-events>, +1 206.818.0877.

SEPT. 19–21 ➤ SMS Workshop and SMS Manual Development. ATC Vantage. Tampa, Florida, U.S. <info@atcvantage.com>, <bit.ly/OCyfrQ>, +1 727.410.4759.

SEPT. 23 ➤ Quality Auditing in Aviation Training. Avisa Gulf. Abu Dhabi, United Arab Emirates. <info@avisa-ltd.com, <bit.ly/NwQrpl>, +44 (0)845 0344477. (Also MARCH 10, SEPT. 15, 2013.)

SEPT. 24–25 ➤ Barrier Based Risk Management Network Event. CGE Risk Management Solutions. Amsterdam. <www.cgerisk.com/training-a-events/details/33-Barrier-Based-Risk-Management-Network-Event>.

SEPT. 25 ➤ Fuel Tank Safety Phase 1 and 2 Training. Avisa Gulf. Abu Dhabi, United Arab Emirates. <info@avisa-ltd.com>, <bit.ly/RYpGvA>, +44 (0)845 0344477. (Also SEPT. 19, 2013.)

SEPT. 26 ➤ Human Factors in Aviation Maintenance One-Day Refresher Training. Avisa Gulf. Abu Dhabi, United Arab Emirates. <info@avisa-ltd.com>, <bit.ly/RsssqJ>, +44 (0)845 0344477.

SEPT. 26–28 ➤ Airport Operations Practicum. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Beth Wigger, <maimail@mitre.org>, <mai.mitrecaasd.org/sms_course/sms_practicum.cfm>, +1 703.983.5617.

OCT. 1–5 ➤ Operational Risk Management. Southern California Safety Institute. San Pedro, California, U.S. <registrar@scsi-inc.com>, <www.scsi-inc.com/ORM.php>, 800.545.3766, +1 310.517.8844, ext. 104.

OCT. 1–5 ➤ Air Traffic Control Investigation. Southern California Safety Institute. San Pedro, California, U.S. <registrar@scsi-inc.com>, <www.scsi-inc.com/ATCI.php>, 800.545.3766, +1 310.517.8844, ext. 104. (Also NOV. 4–8, 2013.)

OCT. 2–4 ➤ CAE Flightscape Users Conference. CAE Flightscape. Montreal. EunKyung Choi, <fsconference@cae.com>, <bit.ly/T0PNyQ>, + 1 613.225.0070, ext. 3224.

OCT. 8–12 ➤ Aviation English for Pilots and Air Traffic Controllers. Joint Aviation Authorities Training Organisation. Hoofddorp, Netherlands. <jaato.com/courses/69>.

OCT. 10–11 ➤ EASA Annual Safety Conference. European Aviation Safety Agency. Cologne, Germany. Gian Andrea Bandieri, <asc@easa.europa.eu>, <bit.ly/y2HfJp>, +49 221 89990 6044.

OCT. 16–19 ➤ SMS II and SMS Audit. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Beth Wigger, <maimail@mitre.org>, <mai.mitrecaasd.org/sms_course/sms2.cfm>, +1 703.983.5617.

OCT. 17–18 ➤ Latin America and Caribbean Engineering and MRO Summit 2012. Latin American and Caribbean Air Transport Association and UBM Aviation. São Paulo, Brazil. <www.alta-ubma-mrosummit.com>, +1 786.388.0222.

OCT. 20 ➤ AAAE Safety Risk Assessment Compliance Workshop. American Association of Airport Executives. New Orleans. Janet Skelley, <janet.skelley@aaae.org>, +1 703.824.0500, ext. 180.

OCT. 22–24 ➤ SAFE Annual Symposium. SAFE Association. Reno, Nevada, U.S. Jeani Benton, <safe@peak.org>, <www.safeassociation.com>, +1 541.895.3012.

OCT. 22–26 ➤ OSHA/Aviation Ground Safety. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, case@erau.edu, <bit.ly/wtWHIn>, +1 386.226.6000. (Also APRIL 15–19, 2013.)

OCT. 23–24 ➤ FRMS Forum Conference. FRMS Forum. Brisbane, Australia. <info@frmsforum.org>, <bit.ly/MZIoQD>, +44 (0)7879 887489.

OCT. 23–25 ➤ 65th annual International Air Safety Seminar. Flight Safety Foundation and Latin American and Caribbean Air Transport Association. Santiago, Chile. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/aviation-safety-seminars/international-air-safety-seminar>, +1 703.739.6700, ext. 101.

OCT. 23–25 ➤ International Cabin Safety Conference. (L/D)max Aviation Safety Group. Amsterdam. Chrissy Kelley, Chrissy.kelley@ldmaxaviation.com, <www.ldmaxaviation.com>, 877.455.3629, ext. 3; +1 805.285.3629.

OCT. 28–29 ➤ Flight Operations Manual Workshop: Employing IS-BAO. National Business Aviation Association. Orlando, Florida, U.S. Sarah Wolf, <swolf@nbaa.org>, <bit.ly/zBvVZI>, +1 202.783.9251.

OCT. 29–NOV. 2 ➤ Aviation Safety Program Management. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, case@erau.edu, <bit.ly/wtWHIn>, +1 386.226.6000. (Also APRIL 22–26, 2013.)

OCT. 29–NOV. 2 ➤ Global ATM Safety Conference. Civil Air Navigation Services Organisation. Cape Town, South Africa. Anouk Achterhuis, <anouk.achterhuis@canso.org>, <www.canso.org/safetyconference2012>, +31 (0)23 568 5390.

OCT. 30–NOV. 1 ➤ NBAA 2012. National Business Aviation Association. Orlando. Donna Raphael, <draphael@nbaa.org>, <www.nbaa.org/events/amc/2012>, +1 202.478.7760.

OCT. 30–NOV. 8 ➤ SMS Training Certificate Course. U.S. Transportation Safety Institute. Oklahoma City, Oklahoma, U.S. D. Smith, <d.smith@dot.gov>, <www.tsi.dot.gov>, +1 405.954.2913. (Also JAN. 8–17, MAY 14–23, JULY 30–AUG. 8, 2013).

NOV. 5–9 ➤ Aircraft Accident Investigation. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, case@erau.edu, <bit.ly/wtWHIn>, +1 386.226.6000. (Also APRIL 29–MAY 3, 2013.)

NOV. 6–7 ➤ IATA Lithium Battery Workshop. IATA Cargo Events. Houston. <idfsevents@iata.org>, <bit.ly/PfziKu>.

NOV. 6–9 ➤ Aircraft Fire and Explosion Course. BlazeTech. Woburn, Massachusetts, U.S. N. Albert Moussa, <amoussa@blazetech.com>, <www.blazetech.com/resources/pro_services/FireCourse.pdf>, +1 781.759.0700.

NOV. 8 ➤ Creating Safety Assurance: How to Move From Concepts to Action. Global Aerospace SM4 and the Kansas City Business Aviation Association. Kansas City, Missouri, U.S. <safety@global-aero.com>, <sm4.global-aero.com/upcoming-events>, +1 206.818.0877.

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. Send listings to Rick Darby at Flight Safety Foundation, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA, or <darby@flightsafety.org>.

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

NON-PUNITIVE Is Not Easy

Safety management systems (SMS) have been required by many state regulatory agencies for years now. This is in compliance with the standards and recommended practices (SARPs) established by the International Civil Aviation Organization (ICAO). Non-punitive policies that encourage open reporting of safety issues are crucial to an effective SMS. But the implementation of non-punitive policies has had mixed results for a variety of reasons.

Many states have established voluntary reporting processes that they say are non-punitive. However, it is important to understand the context. In some of these voluntary programs, information received by the regulatory authority must be assessed against regulatory requirements. If a violation of civil aviation code exists, the information is processed through normal means, which often results in a punitive action against the report submitter. Only when no violation of aviation code is identified can a report submitter be assured that the information will be treated in a non-punitive manner.

In other cases, regulatory authorities have established non-punitive voluntary reporting programs that do not contain sufficient guidance and limitations on how these non-punitive reports should be processed. As a result, in some cases, operators have leveraged the programs to circumvent punitive action by the civil aviation authority, even in cases involving evidence that the operator did not act in the best interests of safety.

To complicate matters, operators with advanced programs and documented non-punitive policies are sometimes found in violation by local civil aviation authorities as a result of information gathered though the operator's own safety reporting systems. In some cases, both the operator and its employees are found in violation. After that happens, information that could identify safety issues and hazards is not likely to be shared openly in the future.

Flight Safety Foundation, as part of an effort to understand how the adoption of recommended practices at state levels has affected front line operations of operators in ICAO member states, began a project this year to evaluate the effectiveness of safety reporting systems in capturing information that could identify safety hazards and to manage the risk, the very essence of SMS. The Foundation, in collaboration with Copa Airlines in Panama, the Panamanian Pilots Union and the Civil Aviation Authority of Panama, established an aviation safety system enhancement team, which is developing a voluntary open reporting program that establishes clear guidance and limits on non-punitive information.

The project in Panama aims to align the state's regulatory guidance with an operator's reporting system to maximize the open exchange of information that can be used to enhance safety. While the program draws on experience from the Federal Aviation Administration's Aviation Safety Action Program, Voluntary Disclosure Reporting Program and other successful models throughout the world, the team's goal is to ensure the program is designed specifically for the needs of Panama and its aviation industry.

Once established in Panama, the program can be used as a model for similar processes throughout the world.

— Rudy Quevedo
Deputy Director of Technical Programs


AIRPORT

Safety News

New UAS Rules

The International Civil Aviation Organization (ICAO) has finalized measures concerning the operation of unmanned aircraft systems (UAS), which ICAO characterizes as remotely piloted aircraft systems (RPAS).

The amendments to ICAO Annex 2 (Rules of the Air) and Annex 7 (Aircraft Nationality and Registration Marks) were developed by the ICAO Unmanned Aircraft Systems Study Group, in collaboration with a number of other organizations.

"Remotely piloted aircraft are becoming very sophisticated very quickly," said Mitchell Fox, chief of the ICAO Air Traffic Management Section. "Their civilian and scientific applications are expanding rapidly, and states from every ICAO region are now developing and employing RPAS in a variety of domains."

The amendments discuss items that should be considered when a civil aviation authority is considering authorizing UAS operations, including airworthiness certificates, operator certificates and remote pilot licenses.

©Proxy Aviation

Fox said that ICAO is reviewing all standards and recommendations to determine how they will be affected by the introduction of UAS.

"This is a completely new area that will require new classifications and licensing, not only for aircraft but pilots as well," he said.

Helicopter Accident Prevention

Helicopter operators could help prevent accidents by implementing enhanced pilot training, safety management programs, careful maintenance practices and installation of flight data monitoring equipment, the International Helicopter Safety Team (IHST) says.

The IHST, an international organization with a goal of reducing the helicopter accident rate worldwide 80 percent by 2016, said its list of the top 10 ways to prevent helicopter accidents is intended to help pilots, owners, maintenance personnel, instructors and other members of the helicopter community.

The 10 recommendations include a measure calling for the installation of flight data monitoring equipment to provide immediate feedback to trainers, operators and pilots, and to aid in accident investigation.

Training recommendations include improved autorotation training, the addition of advanced maneuvers to simulator training, an emphasis on critical issues awareness and more attention to emergency procedures training.

Other recommendations call for implementation of a personal risk management program and a "mission-specific" risk management program, as well as increased emphasis on compliance with a manufacturer's maintenance manuals and maintenance practices.

Jackie (Flickr)/Wikimedia

787 Engine Failure

The contained engine failure on a Boeing 787 General Electric GEnx engine during a late July test run was a result of the fracture of a fan mid-shaft, the U.S. National Transportation Safety Board (NTSB) says.

The engine failure occurred during a pre-delivery taxi test in Charleston, South Carolina, U.S.

The NTSB said that metallurgical inspections and other detailed examinations were being performed on the engine, which fractured at the forward end of the shaft, "rear of the threads where the retaining nut is installed."

The GEnx is a dual-shaft engine, with one shaft connecting the compressor spool to the high-pressure turbine spool and a second, longer "fan shaft" connecting the fan and booster to the low-pressure turbine.

The investigation was continuing.

FAA Go-Ahead for Wind Farm

Rebell/istockphoto

The 130-turbine wind farm planned off the coast of Massachusetts presents no hazard to air traffic, the U.S. Federal Aviation Administration (FAA) said in a mid-August decision that supporters said was the final federal approval required before the project could proceed.

The FAA said a lengthy study of the Cape Wind project determined that the wind turbines would have no effect on aeronautical operations. The project, planned for Nantucket Sound, would be the first offshore wind farm in the United States.

A report prepared by Mitre Corp. several years ago for the U.S. Department of Homeland Security had warned that the "radar signature" of spinning wind turbine blades can sometimes create false images on air traffic control radar screens or block radar signals. The distortions generally affect older radars, the study said.

The FAA said that, because the wind farm will be located more than 2.4 nm (4.4 km) from the closest radar sites, there will be no effect on radar images.

Don't Slam the Door

Maintenance personnel must be given stronger warnings about the potential for injury and damage when working on or around the rear cargo door on Airbus A330s, the U.S. Federal Aviation Administration (FAA) says.

The FAA issued Safety Alert for Operators (SAFO) 12004, citing an incident involving an A330 undergoing a lengthy maintenance procedure in which the rear cargo door was kept open about four weeks.

After work in the cargo bay had been completed, maintenance technicians "selected the manual selector valve to the closed position and used the hand pump to close the door," the FAA said. "The cargo door dropped approximately 2 ft [0.6 m], damaging the floor frame … , door actuator and actuator support frame. The door did not completely fall shut or contact the fuselage."

The SAFO said that Airbus has acknowledged that cargo door "slamming" can result when air is "trapped in the system actuator and lines."

The A330 maintenance manual contains a warning that calls for the cargo door system to be bled before closing if the door has been open longer than 12 hours, but the FAA said the warning is insufficient.

"Due to maintenance shift changes, maintenance schedule interruptions and other factors, a maintenance technician may be unaware of the time [elapsed] with the door open," the SAFO said. "Further, defects in the system may allow air to enter the system within the 12-hour margin."

To deal with the problem, Airbus issued Service Bulletin A330-52-3065, which calls for replacement of the manual selector valve to prevent the door from slamming, and the SAFO recommended that information in the bulletin be incorporated into maintenance manuals and that a warning placard be installed near the selector valve.

Pilot Distraction

The Australian Transport Safety Bureau (ATSB), citing an Oct. 8, 2011, incident involving an Airbus A380-800, is warning of the risks of pilot distractions during flight preparations.

The incident involved the crew of a Qantas A380 preparing for departure from Los Angeles International Airport.

"Before takeoff, the captain changed the departure runway that was entered in the aircraft's flight management system," the ATSB said. "The procedure for completing that task was not followed exactly, resulting in the takeoff speeds not being displayed on the flight instruments."

The ATSB said that twice during the crew's preparations, aircraft systems had displayed a message calling for a check of the takeoff data.

"The first officer cleared the first message on the understanding that the takeoff data would be checked, and in the second instance, believing that it had been checked," the ATSB said. "There were no other warnings to alert the crew that they were commencing the takeoff without the takeoff speeds in the aircraft's navigation systems."

The pilots did not realize until they had begun the takeoff roll that the speeds were not being displayed and referred to their notes to call out the correct speeds.

The ATSB said that, after the incident, Airbus "updated the aircraft's warning systems as part of a planned upgrade program … [to] issue a warning if takeoff is commenced without the takeoff speeds having been entered."

In addition, Qantas modified its standard operating procedures to "avoid any misinterpretation of the required actions in the case of a runway change," the ATSB said.

Eluveitie/Wikimedia

Changes for ATSAP

Major changes will be required in the U.S. Federal Aviation Administration (FAA) non-punitive reporting program for air traffic controllers before the program can effectively identify and address safety concerns, a report from a government oversight office says.

The U.S. Department of Transportation's Office of Inspector General (OIG) said in the report that program safeguards of controller confidentiality mean that some data collected through the Air Traffic Safety Action Program (ATSAP) are not validated, "raising questions about the effectiveness of these data for analyzing safety trends."

The confidential system was designed to encourage controllers to report situations that they believe might present problems, without fear that they might be punished for making mistakes. The system was implemented at all FAA air traffic control facilities in 2010.

The OIG report also said that FAA oversight of ATSAP "lacks effective program management controls. For example, FAA does not have a formal process to review the effectiveness of decisions made by the program's review committees to ensure that report acceptance criteria are rigorously followed and that conduct issues are dealt with appropriately. Failure to address potential deficiencies in transparency and accountability may lead to the perception that ATSAP is an amnesty program in which reports are automatically accepted, regardless of whether they qualify under the program's guidelines."

Proposed Penalties

The U.S. Federal Aviation Administration has proposed a $1 million civil penalty against Horizon Air for its alleged operation of 22 Bombardier DHC-8-402 turboprops on 186,000 revenue flights without the required solid rivets in flight deck security doors.


Dustin Brice/Wikimedia

The blind rivets that were used instead can damage wiring and other components, the FAA said.

The agency said the flights occurred between December 2007 and June 2011, when the blind rivets were replaced.

The FAA said that it learned of the alleged violations of U.S. Federal Aviation Regulations when the airline "incorrectly modified a 23rd aircraft with blind rivets, and the plane experienced an in-flight wiring damage incident during a non-revenue flight."

The FAA also said that, even after Horizon was told that the airplanes were not in compliance with regulations, the company operated one of the airplanes on 22 more passenger-carrying revenue flights before the blind rivets were replaced.

In a separate case, the FAA proposed a $681,000 civil penalty against Federal Express (FedEx) for alleged violations of government hazardous materials regulations.

The FAA said that, in early August 2010, FedEx improperly accepted dozens of shipments of hazardous materials and failed to provide pilots with "accurate and legible written information" about the materials loaded into their airplanes. The agency said that it discovered the violations during an inspection of FedEx facilities in southern California.

Both airlines were given 30 days to respond to the allegations.

In Other News …

Aviation in India is facing a "multi-faceted crisis," according to Tony Tyler, director general and CEO of the International Air Transport Association. Tyler says the problems must be dealt with through coordinated government efforts to address "the crippling issues of high costs, exorbitant taxes and insufficient infrastructure." … The Australian Civil Aviation Safety Authority (CASA) is nearing the end of a lengthy **regulatory reform** effort, Aviation Safety Director John McCormick says. The primary goal of the regulatory overhaul, he says, has been to bolster safety throughout the nation's aviation community.


Prateek Karandikar/Wikimedia

Compiled and edited by Linda Werfelman.

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Safety ROI

The surest route to profitability is an evolving investment in safety.

BY MARIO PIEROBON

Despite the sensitivity of most civil aviation senior managers to safety issues, safety still is a tough sell. Many aviation safety managers are seen by their chief financial officers more as necessary evils than supervisors of value centers. When asked to justify their budget requests, their rationale sometimes sounds more grounded in desperation than in sound business reasoning: "The regulator mandates it. The authority strongly recommends it. We have to do it if we want to remain part of that alliance," are recurrent themes.

That is a pity. Safety, more than anything else, drives the reliability of an aviation organization, building and strengthening its reputation and operational effectiveness. If airline safety managers provided more convincing business cases and harder evidence, the budgeting process would be less frustrating and safety managers would see more money for their departments. The good news is that there is much evidence supporting safety as a worthwhile investment, not only in general but also for specific safety measures.

Safety Pays

First, it is necessary to debunk the myth that safety is simply a cost. Safety goes with functionality. When production systems are put in place, the expectation is that they will be functional. Unsafe occurrences are unplanned and undesired interruptions of a production system.

Safety systems are in place to control unavoidable but necessary costs and to minimize unplanned costs.

The view that safety has a positive contribution to operational efficiency is shared and reinforced by safety management researcher Jose Blanco.[1] Referring to his personal safety management experience in an aircraft maintenance organization, Blanco writes: "The safety management systems we set up at the time have survived and have delivered additional improvements for another 10 years. Worker's compensation dropped in half. As for the safety-efficiency ROI (return on investment), it is difficult to calculate, but it was huge because we released much 'found capacity.' Operating and capital budgets were still lower six or seven years into the program despite significant inflation. The safety and incident management systems paid in spades."

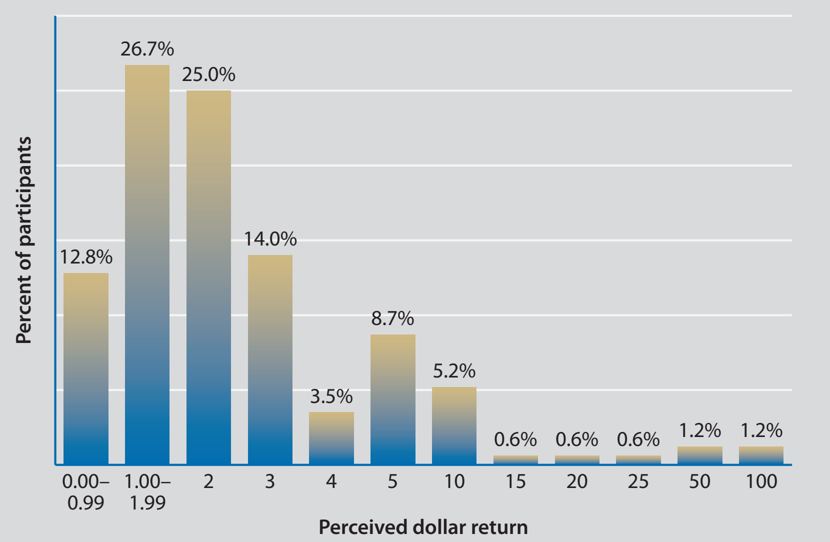
The cost efficiency of safety management was confirmed in more quantifiable terms by a study that explored the perceptions of corporate financial decision makers. This study was conducted through telephone interviews with several U.S. senior executives or managers responsible for decisions about property and casualty risk management or insurance-related services of medium to large organizations — those with more than 100 employees and not strictly in the aviation business. According to this study, financial decision makers perceive that, on average, for every dollar spent improving safety in the workplace, about $4.41 is returned.[2] We can assume that the return for an average aviation organization — equipped with some of the most technologically sophisticated, and expensive, assets — is higher. Although the study was based on telephone interviews and not on raw data and although the study's reported results do not specify the estimated time frame for the ROI, knowing that financial executives believe that "the top benefits of an effective workplace safety program are predominantly financial in nature"[3] provides additional evidence that safety is a profitable investment (Figure 1).

Support for the idea that investing in safety management pays off can be found in the 1999 annual report of Weyerhaeuser, one of the world's largest pulp and paper companies: "Why should our shareholders care about our safety performance? Because, statistically, good safety performance correlates closely with other performance indicators — such as productivity and quality — that bear directly on Weyerhaeuser's profitability. But, even more important, we know our investors don't want to see people get hurt any more than we do."[4]

Best Practices

One of the most common forms of investment by aviation safety departments has been the adoption of industry best practices for operational safety management. For airlines, this has taken the form of the International Air Transport Association Operational Safety Audit (IOSA). For business operations, the International Business Aviation Council's (IBAC's) International

Workplace Safety ROI



ROI = return on investment

Note: Data are based on a researcher's interviews with U.S. managers in aviation and other organizations with more than 100 employees.

Source: Mario Pierobon, and Huang, Y.H.; Leamon, T.B.; Courtney, T.K.; De Armond, S.; Chen, P.Y.; Blair, M.F. "Financial Decision Makers' Views on Safety." *Professional Safety* Volume 54 (April 2009): 36–42.

Figure 1

Standard for Business Aircraft Operations (IS-BAO) was introduced in 2002. It was designed to raise the safety bar, in part by requiring adoption of safety management systems (SMS).

An IBAC study of the safety value of IS-BAO reviewed 500 accidents that occurred between 1998 and 2003, some 297 of which contained sufficient information to warrant further assessment to determine the probability that, if the flight department had known about and implemented IS-BAO, the accident could have been avoided.[5] The data were de-identified, and the accidents were rated on a five-point scale ranging from certainty of prevention to no effect.

The IBAC study found that, assuming that the operator had implemented IS-BAO in full, the accident could have been prevented in 107 (36 percent) of the 297 accidents (Figure 2).

Other findings were that:

- Prevention would have been probable in 63 accidents (21.2 percent);
- Prevention would have been possible in 38 accidents (12.8 percent);
- Prevention would have been doubtful in 43 accidents 14.5 percent; and
- There was no possibility of prevention in 46 accidents (15.5 percent).

Overstretching

But just because safety investments have had a high rate of return in the past does not mean that they will continue to yield such substantial returns indefinitely. At some point, it is no longer sensible to invest in safety solely on this basis because there is no longer a cost-justifiable safety enhancement.

As the International Civil Aviation Organization (ICAO) says in its *Safety Management Manual*, a balance must be struck between production and protection.[6]

The point is highlighted by Rene Amalberti, senior adviser for patient safety at the Haute Autorité de Santé, the French medical accreditation agency, and a doctor of aerospace medicine who also has a Ph.D. in cognitive psychology.

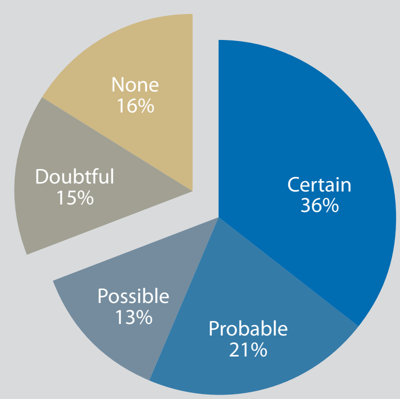
"When an industry or an organization has a safety record that is not particularly brilliant and it plans to implement a safety improvement initiative of some sort, it is generally easier to make an estimate of how much the safety improvement could be," he said. "The air transport industry has instead a very remarkable safety record, and because of this, it is harder to make an estimate of how much a safety innovation, like a safety management system, can bring in terms of an improved safety performance."

In an article published in 2001, Amalberti wrote, "Subjects running into difficulty tend to escape into tried and tested solutions, setting aside difficult points. They systematically and erroneously tend to carry out linear extrapolations, and never sufficiently take into account the collateral effects of the measures undertaken. ... Even though safety no longer improves, safety managers still think of risk controls in terms of linear extrapolations, and still apply the same old solutions (hunting down errors and failures, adding procedures) based on well-known recipes which help them to feel secure (tried and tested values), without taking into consideration the collateral effects of these overstretched measures."[7]

The risk of overreliance on tried and tested solutions can be found in the enormous efforts invested in recent years in occurrence reporting systems. Accidents typically result from a combination of factors, none of which by themselves can cause an accident or even a serious incident. These combinations remain difficult to detect using traditional safety analysis logic; for the same reason, reporting becomes less relevant in predicting major disasters, Amalberti said. Still, many aviation organizations, within their newly implemented SMS, believe that they have found the solution to all of their safety problems in a thorough reporting system, thus underestimating its limits.

"Mandatory and non-mandatory reporting, as compared to flight data analysis, represents a limit in terms of its ability to deliver valuable information for safety management decisions," Amalberti said.

Probability of Prevention



Note: The probability that accidents could have been prevented is based on an assumption that IS-BAO had been implemented.

Source: Mario Pierobon and International Business Aviation Council

Figure 2

"Flight data analysis is very good because it is not based on people and therefore on varying reporting sensitivities and situational understanding. The real problem with reporting is to derive an objective analysis of the reported information. Reporting does not allow for automatic analysis, and it is also very demanding in terms of resources.

"Analysis of flight data is instead based on objective parameters; thus, not only is it possible to have a very accurate picture of what is going on during flight operations within the scope of the flight data recorder, but the application of predictive tools also becomes valuable in terms of identifying emerging safety and operational trends.

"From reporting, you cannot expect a particular, measurable, gain in the safety performance. On the other hand, the immeasurable contribution of reporting to safety should not be underestimated. What you can expect from reporting is an improvement of the safety culture, whose health is generally testified by a high number of non-mandatory safety reports."

To the Future

The aviation industry should not be complacent about its outstanding safety performance.

The risk of maintaining the current accident rate is that, at the current rate of growth in aviation operations, in the years from 2020 to 2030, the industry will suffer twice as many accidents as today. The public's concern will increase because of more frequent news about aircraft accidents, and flying will no longer be considered as safe as it is today.

The industry has achieved a remarkable history of improvement in safety performance, and it makes no sense to stop now. Tried and tested solutions, whether effective or not at maintaining the current safety record, are not likely to produce dramatic new improvements in safety performance. What should aviation organizations do, then, to improve their safety record in the long run?

The current operational system of air transportation has reached a positive but stable safety record. The system is aging, and safety and operational efficiency can be improved only with a major infrastructural overhaul and appropriate investments in the technological upgrade of operational equipment.

"Aviation will benefit sooner or later [by 2030 or 2040] from much greater guidance automation, full implementation of … satellite navigation systems, at least on the main international routes, full automatic parallel approaches to airports, etc.," Amalberti said.

"This greater automation will probably result in improving safety figures to nearly 1 accident every 10 million sectors on selected international routes/airports, although very rare — but probably more severe — accidents could result from this transfer of technology (larger aircraft, greater risk of collisions when automated systems fail totally). A significant effort will have to be made on the logistics and on infrastructure development, in addition, to a further refining of flying techniques."

Another area that should capture the attention of aviation safety departments is that of ultra-long-range operations, with its emerging safety threats.

"One point could become critical," Amalberti said. "It concerns long-range and very-long-range passenger journeys that progressively expand and could easily reach a standard of 20 or 24 hours."

He added that large airplanes on lengthy flights probably will experience an increased number of problems involving sick passengers. These situations could result in "difficult decisions on problematic flight diversions to unsafe airports" that lack the facilities to handle the influx of passengers, he said.

Earning profits and paying returns to shareholders are priorities for airlines. A precondition for profitability, however, is providing safe and reliable flights in airworthy aircraft.

Mario Pierobon works in business development and project support at Great Circle Services in Lucerne, Switzerland, and was formerly with the International Air Transport Association in Montreal.

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EXPECT THE UNEXPECTED

BY LINDA WERFELMAN

The 2009 crash of an A330 into the Atlantic should be an impetus for enhanced pilot training, accident investigators say.

French accident investigators, citing the June 1, 2009, crash into the Atlantic Ocean of an Air France Airbus A330, are calling for changes in pilot training to help crews recognize — and safely cope with — "unusual and unexpected" developments during flight.

The French Bureau d'Enquêtes et d'Analyses (BEA) included more than two dozen safety recommendations in its final report on the accident, issued in July. Other recommendations were issued earlier in the course of the three-year investigation.

The final report concluded that the A330's crash resulted from a succession of events, beginning with the "temporary inconsistency between measured airspeeds" — probably caused by ice crystals clogging the pitot probes — and followed by what the report said were "inappropriate control inputs that destabilized the flight path," misinterpretations of instrument indications, a failure to recognize that the airplane was entering a stall and "the crew's failure to diagnose … the stall situation and, consequently, the lack of any actions that would have made recovery possible" (*ASW*, 8/12, p. 14).

All 228 people in the airplane were killed in the crash, a little more than two hours after takeoff from Rio de Janeiro, Brazil, for Paris.

The BEA focused many of its 41 safety recommendations on aircraft configuration problems, calling on the European Aviation Safety Agency (EASA) to take steps to ensure that type rating training and recurrent training not only "take into account the specificities of the aircraft for which they are designed" but also incorporate "exercises that take into account all of the reconfiguration laws," the final report said.

The four reconfiguration laws are inherent elements of the Airbus fly-by-wire system, with each one providing different degrees of protection against flight-envelope deviations.

Current training does not adequately focus a crew's attention on "the precise identification of the type of reconfiguration and of the level of protection and on the necessity to monitor the trajectory and the primary parameters," the report said.

The document noted that, after the autopilot disconnect, control inputs by the flight crew "significantly degraded the airplane's kinetic energy."

The BEA also recommended that EASA require that pilot training include exercises to ensure that pilots possess solid theoretical knowledge of flight mechanics.

Citing the accident flight, the BEA said, "The rapid exit from the flight envelope was not anticipated by the pilots, nor was it understood. In the absence of any reliable speed indications, understanding of the overall physics of flight at high altitude could have considerably helped the pilots to anticipate the rapid degradation of the situation."

In addition, the BEA said that pilots should receive initial, recurrent and type training designed to enable them to "develop and maintain a capacity to manage crew resources when faced with the surprise generated by unexpected situations."

Illustration: Susan Reed

During the accident flight, "the startle effect played a major role in the destabilization of the flight path and in the two pilots' understanding [of] the situation," the BEA report said.

The report criticized existing initial and recurrent training for failing to ensure that pilots can respond quickly and correctly to unexpected in-flight situations.

"The exercises are repetitive, well known to crews and do not enable skills in resource management to be tested outside of this context," the report said. "All of the effort invested in anticipation and predetermination of procedural responses does not exclude the possibility of situations with a 'fundamental surprise' for which the current system does not generate the indispensable capacity to react."

During the accident flight, the "rapid increase in crew workload in an unusual and unexpected situation led to the degradation of the quality of communication and coordination between the pilots," the report said.

In accompanying recommendations, the BEA said EASA should review pilot training requirements to ensure that operators "reinforce [crew resource management] training to enable acquisition and maintenance of adequate behavioral automatic responses in unexpected and unusual situations with a highly charged emotional factor."

In addition, EASA should define the criteria for selecting and training instructors to provide a "high and standardized level of instruction," the BEA said.

Flight Simulators

Other recommendations called on EASA to address training issues for flight simulators:

- To modify existing regulations to "ensure better fidelity for simulators in reproducing realistic scenarios of abnormal situations"; and,
- To "ensure the introduction into the training scenarios of the effects of surprise."

The report noted that the pilots of the accident airplane did not recognize the significance of the disappearance of airspeed information and appearance of "unreliable IAS [indicated airspeed]" warnings on the electronic centralized aircraft monitor (ECAM).

"The three crewmembers had undertaken their training according to a known scenario on the simulator, though the technical limitations of the simulator, whose fidelity is satisfactory in most cases, do not allow certain unusual situations to be simulated," the report said. Those limitations mean that, during training, the pilots are unlikely to experience the startle effect triggered by encountering an unexpected situation or the "inappropriate reflex actions on the controls that can occur as a consequence," the report added.


Bureau d'Enquêtes et d'Analyses

The search for the airplane's flight recorders continued for 22 months after the accident.

Ergonomics

Several recommendations addressed what the BEA characterized as ergonomic issues involving flight director displays. The agency recommended that EASA "require a review of the redisplay and reconnection logic" of the flight directors to determine the conditions under which the pilots would be required to take action to re-engage them after a display disappeared and then reappeared.

The accident pilots might not have noticed that the crossbars on a display appeared and disappeared on the flight directors and probably did not realize that the mode had changed because they were "reading and assimilating the displays on the FMA [flight mode annunciator] in dynamic and stressful conditions not being instinctive or natural," the report said.

"It seems that requiring an action from the crew to re-engage this automatic system would, on the one hand, lead to a consistency with the autopilot and the autothrust, and on the other hand, stimulate a check on the modes and the consistency of the commands presented at the time of the re-engagement."

The BEA said the recommended flight director review should examine several other issues, including the functional or display logic "so that it disappears or presents appropriate orders when the stall warning is triggered" and "the relevance of having a dedicated warning … when specific monitoring is triggered, in order to facilitate comprehension of the situation."

The pilots should see a dedicated warning when a specific type of monitoring begins, the report said, noting that, during the accident flight, the series of failure messages appearing on the ECAM "did not allow the crew to make a rapid and effective diagnosis of the situation the airplane was in, in particular of the blockage of the pitot probes."

Several of the airplane's systems had identified the problem, but the failure messages dealt only with narrow aspects of the effects of the failure while providing no information that would aid the pilots in their diagnosis.

Related recommendations said that EASA should determine the conditions in which an aural stall warning should be accompanied by a visual indication that a stall is imminent and should require action to determine the conditions, at very slow airspeeds, under which a stall warning should be required.

Feedback

Noting that programs already exist under which the holders of aircraft type certificates define the aircraft's minimum associated training program, the BEA said that EASA should make mandatory the operational and human factors analyses of in-service events — action that the BEA said would improve training procedures. In addition, the BEA recommended that the French Direction Generale de l'Aviation Civile (DGAC) "take steps aimed at improving the relevance and the quality of incident reports written by flight crews" and see that the documents are distributed to manufacturers.

"In-service feedback is an essential prerequisite in the process of improving flight safety," the report said. "The reports written by crews after events do not always reveal their severity or all of the elements [involved]. This makes somewhat random the preservation of the indispensable elements needed for an investigation and thus difficult for the operator, the manufacturer and the authorities to evaluate the associated risks and threats and to undertake an exhaustive analysis that makes it possible to take appropriate measures."

The report also noted that past DGAC in-flight and ground inspections of Air France had failed to reveal major problems, including the "fragile nature of the CRM [and] the weaknesses of the two copilots in manual aeroplane handling."

As a result, the BEA recommended that the DGAC review its oversight "so as to improve its cohesion and effectiveness."

Other recommendations included in the final report called for better coordination of search and rescue efforts in the South Atlantic and other maritime and remote areas (*ASW*, 8/12, p. 13).

Earlier in the investigation, the BEA issued a number of related safety recommendations, including several intended to aid in the recovery of flight recorders installed in airplanes that crash into deep water and others that would require studies of other methods of delivering basic information on aircraft flight parameters.

The search for the airplane's flight recorders continued for 22 months after the accident, and the BEA noted in its final report that the crash not only "confirms the importance of data from the flight recorders in order to establish the circumstances and causes of an accident" but also "brings to light the difficulties that can be encountered in [locating], recovering and reading out the recorders after an accident at sea."

The crash prompted the BEA to establish an international working group to review methods of safeguarding flight data, of locating aircraft wreckage — especially underwater wreckage, and recovering flight recorders. The working group's proposals were followed by recommendations from the BEA to EASA and the International Civil Aviation Organization (ICAO) that included:

- Extending to 90 days (from the currently required 30) the required transmission time for the underwater locator beacons (ULBs) on flight recorders in passenger airplanes used in public transport flights in maritime areas; and,
- Studying the possibility of requiring airplanes on public transport passenger flights to regularly transmit data on altitude, airspeed, heading and other basic flight parameters.

Subsequent recommendations called for requiring the installation of equipment in these airplanes to enable the "triggering of data transmission to facilitate localization as soon as an emergency situation is detected on board" and for studying the possibility of requiring activation of emergency locator transmitters, also at the first indication of an emergency.

The recommendations gave impetus to ongoing efforts to develop alternative methods of delivering the data contained on aircraft flight data recorders, including the use of streaming data.

A number of existing systems transmit data automatically from aircraft to ground stations, typically for maintenance or flight monitoring. Two such systems are AeroMechanical Services' FLYHTStream, which provides on-demand triggered data streaming based on global positioning system data, and Airborne Data Service, a satellite communications data service developed by Star Navigation Systems Group and Astrium Services to provide for real-time flight data transmission to operators (*ASW*, 4/12, p. 26).

This article is based on the English translation of the BEA's "Final Report on the Accident on 1st June 2009 to the Airbus A330-203, Registered F-CZCP, Operated by Air France, Flight AF 447, Rio de Janeiro–Paris." The report is available in English and the original French at <www.bea.aero>.

Bureau d'Enquêtes et d'Analyses

The crash prompted the BEA to establish an international working group to review methods of …recovering flight recorders.

John Eisele Colorado State University

Showing Where Not to Go

Radar plays a lead role in forecasting severe weather.

BY ED BROTAK

Radar has become an indispensable tool for weather forecasting and plays a critical role in aviation safety. Simply put, weather radar is the best tool that meteorologists have to predict general precipitation and to develop short-term forecasts of severe weather.

A weather radar display provides a comprehensive picture of the weather in real time. For aviation interests, radar provides a depiction of weather hazards such as thunderstorms in detail unavailable from any other source.

Radar and aviation go way back. The term *radar* is an acronym derived from radio detection and ranging, the original name of a technology that initially was based on the use of radio waves. Radar was developed to track aircraft in flight and was first widely used during World War II.

During the war, radar operators noticed that their equipment detected not only aircraft but also areas of precipitation. This presented a problem because the display of enemy airplanes could be lost in the "clutter" that resulted when the radio waves were reflected by raindrops. However, meteorologists looked at this "problem" differently and foresaw radar as a tool for detecting precipitation.

Patrick Kennedy Colorado State University

The CSU-CHILL National Weather Radar Facility in Greeley, Colorado, features a nine-meter parabolic dual-offset reflector antenna housed inside a protective, air-supported dome.

By 1943, the military was successfully using radar to monitor areas of rain and to make short-range weather forecasts.

After the war, experimentation with surplus military radar equipment was begun to determine if radar could be useful in the burgeoning science of weather forecasting. In the late 1950s, the Weather Surveillance Radar System was set up in the United States with approximately 60 sites. The radar equipment was updated, and more sites were added in the 1970s and again in the 1990s.

Today, more than 150 radar sites operated by the U.S. National Weather Service (NWS) provide radar coverage for most of the country.

Echo Location

The principle of radar is simple. A pulse of electromagnetic energy — microwaves are used today — is transmitted from the radar site. The radar transmitter does a 360-degree sweep while emitting microwaves at a constant elevation angle (usually 0.5 degree). When a portion of the energy hits an object, it is reflected back to the radar antenna. How much energy comes back and from where are recorded. The object's distance from the radar site can be determined by measuring the time it takes for the energy to be transmitted and to return to the antenna.

The reflected energy is reproduced electronically on the radar screen to show the object's relative position and distance. The displayed object is called a radar return, or more commonly an echo. The image shown on a standard radar display is called the base reflectivity.

Radar is capable of detecting precipitation more than 200 mi (322 km) away. Raindrops are excellent reflectors of electromagnetic energy. The larger the raindrop, the greater the reflection. Larger raindrops are associated with higher or more intense rainfall rates. So, in addition to position and display, the intensity of the precipitation can be depicted.

Color Coding

On the old monochrome radar screens, higher precipitation intensities would show up simply as brighter echoes. As radar technology advanced and the displays featured higher resolutions, the echoes were colorized to make differences in precipitation intensity more obvious.

The colors seen on a standard radar display today correspond specifically to the returned energy, technically as measured in dBZ, or decibels of Z (a radar term). The range of colors and their associated dBZ levels typically are shown in a legend on the side of the display.

For example, Figure 1 (p. 26) is the base reflectivity image recorded by the radar site in Sterling, Virginia, at 0248 coordinated universal time on June 30, 2012. Clearly depicted is a wavy line of red echoes with a maximum reflectivity of 62 dBZ. This is the extremely powerful derecho squall line system that moved through the area that evening. Winds at Washington Dulles International Airport gusted to 62 kt.

For practical purposes, the display colors correspond to rainfall rates and to storm intensity. Blues and greens indicate light rain. Sometimes, although it shows up on radar, this rain does not even reach the ground and is known as virga. Yellow, orange and red correspond to heavier rainfall, likely associated with convective activity.

Snow can be detected by radar, but it does not show up as well as rain. The crystal structure of snowflakes does not provide a good reflective surface. And snow has lower water content. The old rule of thumb that 10 in (25 cm) of snow equals 1.0 in (2.5 cm) of water means that a heavy snow equates to a light to moderate rainfall.

The radar itself cannot discern the difference between rain and snow. The radar displays often seen on television, which show snow in a different color, have been augmented with additional information.

Clouds are not detected by radar. The droplets or ice crystals that make up clouds are too small to reflect the microwave energy. Interestingly, radar can detect flocks of birds or bats, and at times even swarms of insects, which are all better reflectors than clouds.

Using radar equipment for forecasting is a fairly straightforward process. Meteorologists observe an area of precipitation over time and determine its speed, direction of movement and any changes in intensity. (Precipitation seldom simply develops over any particular region. Usually, it moves into a region.) Once the speed, direction and intensity trend are known, a continuity forecast can be made by projecting further movement of the precipitation area.

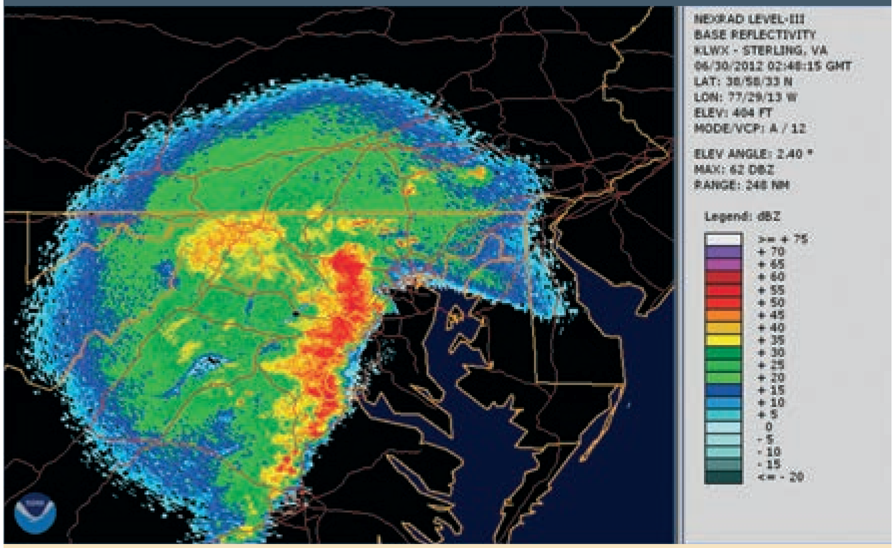
Meteorologists can use this process to forecast precipitation for the next several hours. Short-term forecasts for severe storms actually can be done by computers linked to the radar equipment.

Cones and Clutter

There are some problems and limitations in using radar for short-term forecasting. Precipitation directly above the radar site and in the immediate surroundings cannot be detected; the radar beam does not travel upward through this so-called cone of silence.

Microwaves cannot penetrate solid objects; thus, we have the problem of ground clutter. Nearby buildings and even distant mountains reflect the electromagnetic energy. The resulting false echoes can be deleted automatically

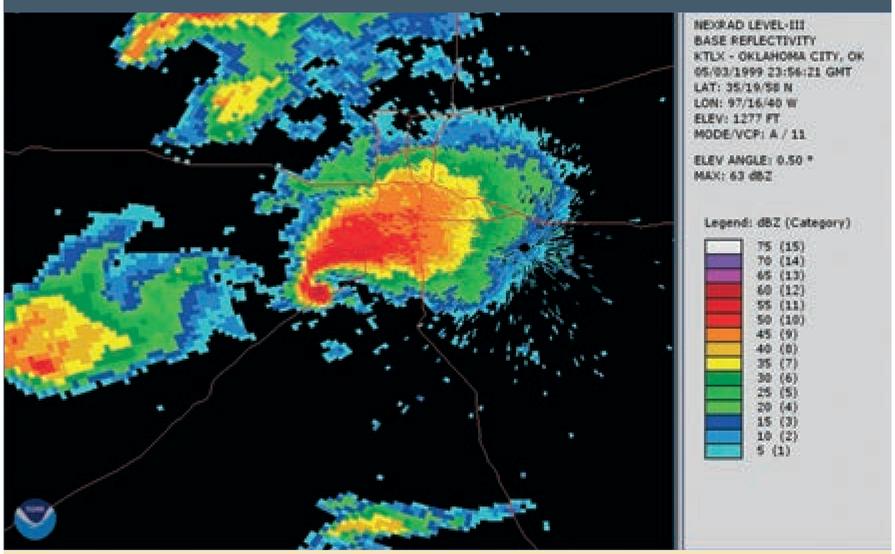
Base reflectivity image from Sterling, VA 0248Z June 30, 2012



Source: U.S. National Oceanic and Atmospheric Administration

Figure 1

Base reflectivity image from Oklahoma City, OK 2356Z May 3, 1999



Source: U.S. National Oceanic and Atmospheric Administration

Figure 2

from the radar display, but any real precipitation behind the clutter does not show up on the screen. To allow for this, the radar transmitter is tilted slightly upward. This creates its own problem, however, because the radar beam can overshoot areas of precipitation that are far away.

Because of the tilting of the transmitter, as well as the curvature of the earth, the maximum range of precipitation detection is about 100 mi (161 km) for most precipitation and 200 mi (322 km) for intense precipitation.

Anomalous propagation is another effect that can produce false echoes. Certain atmospheric conditions, such as temperature inversions (warmer air overrunning colder air), can cause the transmitted microwaves to bend or refract, rather than move in straight lines. Similar to a mirage, surface objects can appear on the radar screen to be airborne. This situation often develops at night and explains the false echo area that engulfs the radar site.

Storm Detection

Thunderstorms always have posed a tremendous threat to aviation. As mentioned earlier, the idea that radar could be used to detect and track thunderstorms was recognized almost immediately by the aviation community. In the late 1940s, in addition to the establishment of ground-based sites, on-board radar equipment began showing up in aircraft. By 1964, all passenger airplanes in the United States were required to have on-board radar systems. Today, weather radar equipment also is standard at major air traffic terminals.

Interestingly, radar cannot directly tell where thunderstorms are occurring. It cannot detect electrical activity (although some modern on-board systems now have “lightning-detection” capability). Nevertheless, rainfall rates in thunderstorms usually are extreme; therefore, it can be inferred that precipitation cells with very heavy rainfall rates also may contain lightning and, more importantly, extreme turbulence.

Most standard radar displays use red to indicate echoes that likely came from a thunderstorm. Also, if there is a possibility that thunderstorms are within range, the horizontal sweep can be stopped, and the radar can be aimed at the potential thunderstorm cell to scan it vertically. This provides cloud top information that can be used to determine possible electrical activity and turbulence. The higher the cloud top, the greater the likelihood of lightning and strong turbulence. Cloud top information also can be used by pilots to determine if flying over the storm is feasible.

Hail produced by thunderstorms poses a tremendous threat of damage to aircraft. It also is indicative of extreme updrafts and strong turbulence. Hail has a very high reflectivity. A dBZ value over 60, which shows up as purple on the display, indicates large hail.

Bow echo squall lines frequently produce the strong winds that can generate the extreme low-level wind shear that is so dangerous to aircraft taking off and landing. The phenomena of bow echoes were discovered through radar analysis. As was determined, whenever a line of thunderstorms curves, or bows out, there likely are strong winds in the bowing part of the line.

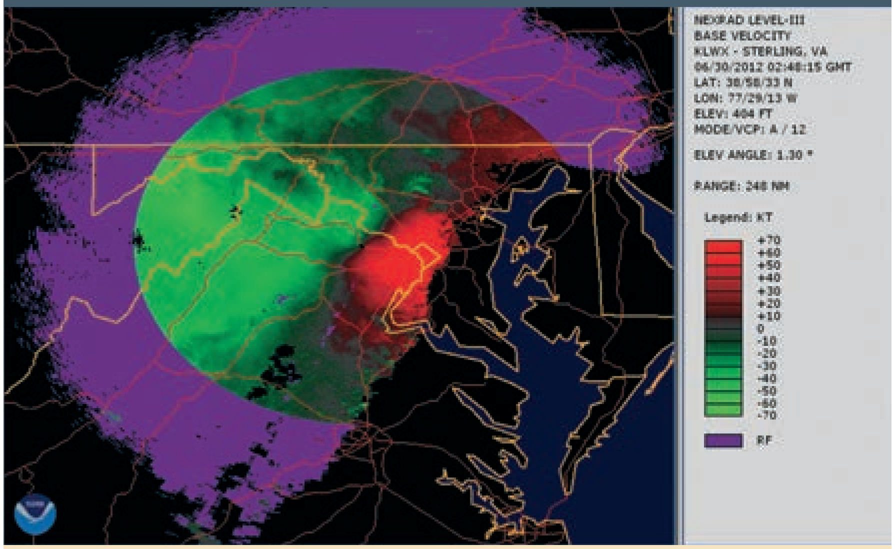
As shown in Figure 1, the system that affected the Washington area displayed the bowing characteristic. In fact, this system had developed 12 hours earlier in Illinois and had moved southeastward during the day, continuously producing bow echo thunderstorm lines and associated strong winds. Radar clearly showed this, and advanced warnings certainly prevented more casualties from occurring.

Among other aviation hazards that can be detected by radar are pulse thunderstorms, which can quickly produce strong downdrafts and dangerous wind shear (*ASW*, 10/09, p. 12). Warnings can be issued when the characteristic vertical radar profile of a pulse storm is detected.

At times, the outflow boundaries, or gust fronts, from convective weather systems — which also can contain strong low-level winds and wind shear — shows up on radar.

The strongest of all thunderstorms, the supercell, also has a distinct radar image. Figure 2 shows the base reflectivity image produced by the Oklahoma City radar site the evening of May 3, 1999. This massive supercell thunderstorm had a telltale appendage, the classic hook echo, indicative of strong winds, large hail and, in this case, a devastating F5 tornado.[1]

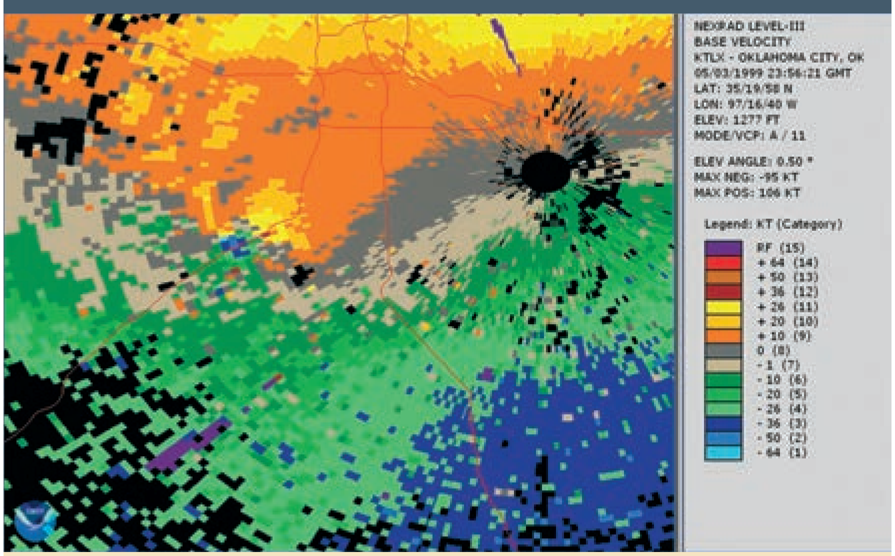
Base velocity Doppler image from Sterling, VA 0248 Z June 30, 2012



Source: U.S. National Oceanic and Atmospheric Administration

Figure 3

Base velocity Doppler image from Oklahoma City 2356Z May 3, 1999



Source: U.S. National Oceanic and Atmospheric Administration

Figure 4

Doppler Effect

Doppler is a term we often hear today when describing radar sites or radar displays. It can be misleading. The Doppler component is just one of many capacities that most new radar sets have. It has nothing to do with the detection and tracking of precipitation. True Doppler displays seldom are used.

Doppler's primary purpose is the detection of potentially severe thunderstorms. The Doppler effect, or Doppler shift, is the change in frequency of a wave when there is movement between the wave emitter and receiver.[2] The classic example is the change in pitch of a train whistle as it approaches and then passes the station. The sound waves are impacted by the movement of the train relative to the listener.

In radar application, the microwaves reflecting off a moving target change frequency as they come back to the radar site. This change in frequency can be measured and is proportional to how fast the target is moving toward or away from the radar receiver. Simply stated, Doppler shows which way the air is moving relative to the radar site and how fast it is moving.

Color is used to make the Doppler display easier to interpret. Winds blowing toward the radar site are depicted with "cool" colors such as green and blue, and are given negative values. "Hot" colors such as yellow and red indicate air moving away from the site and are shown as positive values.

Figure 3 is the base velocity Doppler product from the Sterling radar site. As the squall line passed over the site, strong winds from the west-northwest were blowing toward the site and away from the site to the east. The strongest depicted velocities were in the 60- to 70-kt range.

In addition to the depiction of strong winds, Doppler can be used in other ways to detect severe thunderstorms. Rotation is a characteristic of most strong to severe thunderstorms. Doppler can detect such rotation from "couplets" of airstreams moving toward and away from the site in close proximity. This is depicted on the radar screen as a hot color next to a cold color. The faster the air is moving, the stronger the rotation and the more likely the storm will be strong to severe.

Figure 4 shows the Doppler image from the Oklahoma City storm. The blue pixels next to the orange pixels indicate its intense rotation.

Relative velocities recorded from previous storms are stored in the radar site's computer and used for comparison with current readings. When certain storm elements such as a mesocyclone or tornado vortex signature are detected, automatic warnings are generated. This is the origin of the now familiar phrase "Doppler-indicated" severe weather. Meteorologists no longer have to wait for severe weather to actually be observed before warnings are issued.

Doppler radar presented another major breakthrough for aviation. Back in the 1970s and 1980s, a number of fatal aircraft accidents were caused by wind shear associated with intense thunderstorm downdrafts or microbursts. Doppler radar usually can detect this type of wind shear, but only if it is fairly close to the radar site. Microbursts can be detected out to about 20 mi (32 km).

The NWS Doppler radar network established in the late 1980s and early 1990s left many areas without coverage. As mentioned, however, a number of major terminals have installed their own Doppler radars. Today, there are 45 terminal Doppler weather radar sites in the United States, and many aircraft are equipped with onboard Doppler radar wind shear sensors.

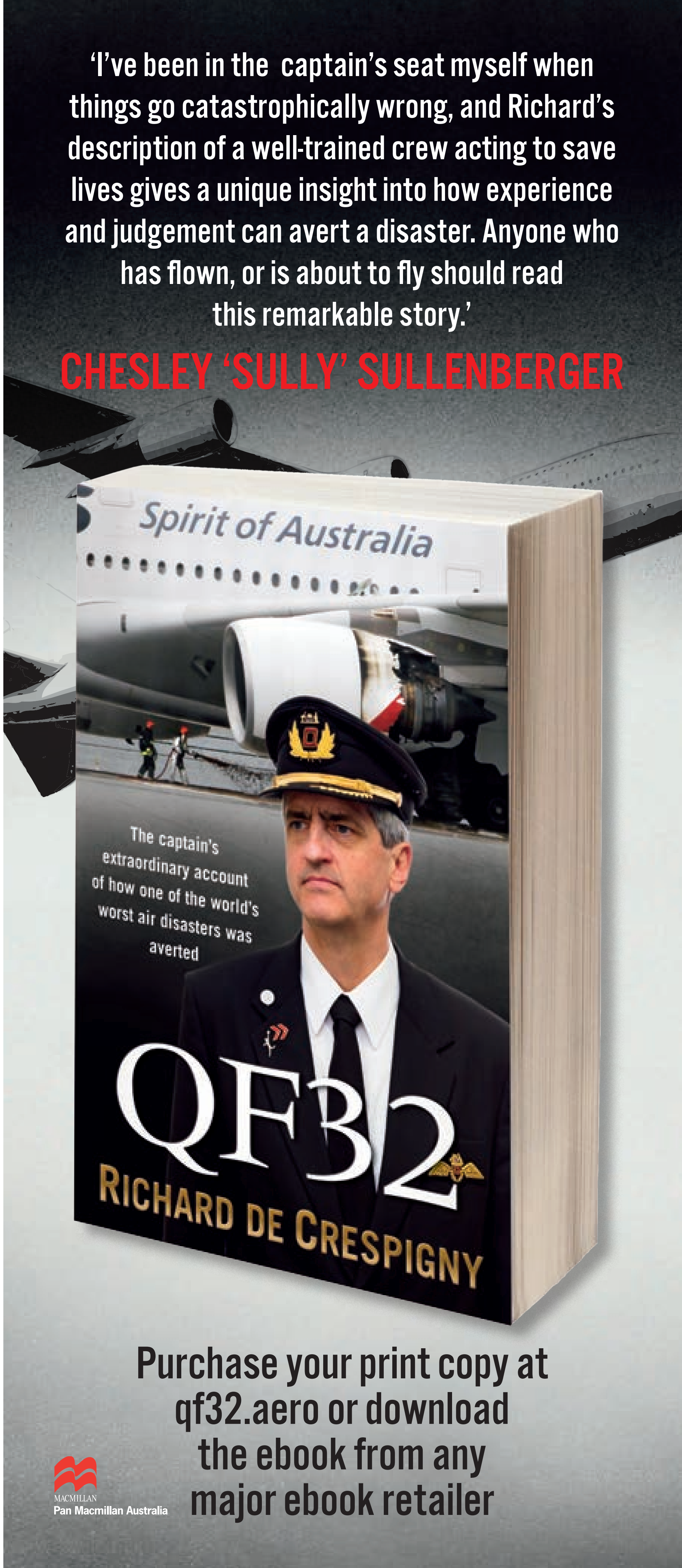
An important consideration mentioned in the July issue of *ASW* ("Weather Warning," p. 11) is to always check the time on a display of radar information. In particular, mosaic images derived from multiple Next Generation Radar (NEXRAD) sites may be as much as 20 minutes older than indicated on the display. This can be especially crucial for convective situations in which thunderstorms move at speeds of 50 mph.

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

Notes

1. F5 is the highest rating on the Fujita-Pearson Scale, indicating wind velocities greater than 261 mph and capable of causing "incredible damage."

2. The effect was hypothesized in 1842 by Austrian physicist Christian Doppler.



From Bad to Worse

Threats from in-flight ice accretion become crystal clear during flight simulator scenarios.

BY WAYNE ROSENKRANS | FROM ORLANDO

Upgrading scenarios in flight simulation training devices holds promise for reinforcing pilot awareness of potential in-flight icing effects on specific aircraft types. The advances also fit well into today's heightened attention to pilots' mission and automation management, says Dan Littman, flight dynamics manager, FlightSafety International.

"The natural phenomenon of in-flight icing can affect aircraft in several different ways," Littman said during his presentation at the World Aviation Training Conference and Tradeshow (WATS 2012) in Orlando, Florida, U.S., in April. "Any aircraft will collect ice if flown slowly enough in icing conditions with the protection turned off, disabled or absent. If you do get ice, particularly on the wings, upsets can be abrupt and surprise the flight crew. It is [only the in-flight] ice on the leading edge of the wings that causes a stall. … If your airplane is certified for flight in known icing — and [you] use the equipment when it needs to be used — you'll never see any of this. But if your airplane is not certified for flight in known icing and/or your ice protection is turned off or disabled, then watch out. … The trouble with ice is what it does to the [airflow], not the weight that it adds."

Robust icing models can be used to increase pilot awareness of operating in icing conditions — preferably in a brief scenario — but historically, models were hampered in that they considered mainly the weight of accreted ice. The weight now is regarded as a negligible/secondary issue in large transport airplanes, he said. "If you throw [the relevant data] together, and you say there is a 3.0-in (7.6-cm) coating of ice across the entire

© CAE Inc.

Left, updated methods of simulating in-flight icing effects could represent rare scenarios of deselected or disabled aircraft ice-protection systems. Above, a lobster tail–shaped rime-ice accretion formed on the leading edge of an airplane tail section in an icing research tunnel.

cross-sectional area of a [Boeing] 737-800, it would weigh 403 lb [183 kg]," Littman said. "That is 0.26 percent of the maximum takeoff weight [of 155,500 lb (70,533 kg)]."

Although in-flight icing has been recognized as more of a threat to smaller aircraft, all flight crews must be familiar with managing the risk. Two properties of ice normally create the principal hazards.

"Accretion rate of the ice is certainly important," Littman said. "However, it is the quantity, shape and location of the ice on the aircraft which determine the severity of the effects. … The drag can increase, which is the retarding force on the aircraft in flight. The thrust can decrease. The stall speed increases. The controllability can be degraded, particularly for aircraft that have manually powered flight controls. And sensors can become inoperative; this was a contributing factor in the case of Air France [Flight] 447 (*ASW,* 8/12, p. 14)."

Large commercial jets are the airplanes least susceptible to in-flight icing. "They cruise above icing conditions most of the time," he said. "They fly at higher airspeeds and … the faster [airplanes] go, the colder the air has to be for [them] to collect any ice at all. The large radii of their [airfoil] leading edges means they have a low collection efficiency; they are just simply not as prone to pick up ice. …They have big engines, which in most cases have lots of excess thrust, which can generate lots of power to run all kinds of powerful ice-protection systems. So [for them, in-flight icing is] just not really a problem if the aircraft is being operated correctly."

Basic Factors

The prerequisites for in-flight icing to occur are a collecting surface and suspended liquid water — or *supercooled droplets* — that are both colder than freezing. The severity of ice accretion is determined by several factors, which can be listed in order of significance. The amount of liquid water suspended in the atmosphere through which the flight crew is flying and the temperature of the air rank first. Next, Littman said, are "the droplet-size spectra, that means on average, how big are the droplets? Are they large? Are they small? Is it a uniform mixture? [Then] true airspeed, how fast are you flying through this? The *collection efficiency* of the surface, which refers mainly to the radius of the leading edge of whatever part of the aircraft you're talking about. Lastly, when the ice does accrete, how much? What is the shape? And how rough is it?"

The location, shape and roughness "affect different parts of the aircraft in different ways, whether it be airframe components or the engine air inlets or the propellers (if it has propellers) or the sensors," he said. For brevity, his description of effects was limited to some flying surfaces.

Pilot training typically groups in-flight icing into categories of "*rime ice,* where the air tends to be colder and the droplets smaller; *clear ice* [also called *glaze ice*], where the air tends to be closer to the freezing mark [0 degrees Celsius, 32 degrees Fahrenheit] and the droplets are larger; and then a special condition we call *supercooled large droplets* or SLD," Littman said. "In reality though, icing tends to be a continuum with rime [ice] at one end of the spectrum and clear [ice] at the other."

FlightSafety International's simplified terminology for training reinforces the relative threat from each category. "[We] call [rime ice] the 'bad ice,'" he said. "Clear ice, on the other hand, I would call 'hazardous.' It can seriously degrade the aerodynamic performance of the aircraft. … [SLD] is a rare condition [defined by U.S. authorities as droplets larger than 40 microns in diameter]; it is the most dangerous form of icing. … In SLD conditions, ice can form aft of protected areas. This can result in unforeseen effects."

Legacy Simulations

Some previous attempts at icing scenarios in simulators have lacked realism. "[In] legacy simulations in the not-so-distant past, icing effects were represented by huge and unrealistic weight increases … that just isn't the case," Littman said. "[Original equipment manufacturers'] data for simulation of icing effects, particularly for smaller aircraft, have sometimes been inconsistent or

U.S. National Aeronautics and Space Administration, Glenn Research Center nonexistent — and the simulation effects are usually pretty benign."

In response to audience questions, Littman acknowledged continued difficulties obtaining a complete in-flight, icing-effect data set for some simulators, typically those for the smaller aircraft used in commercial air transport and business aviation.

He also agreed that strong precautions to prevent negative training in simulators about this subject must be in place. "I didn't have time to talk about tailplane icing or aileron snatch, such as befell the ATR[-72] over Roselawn, Indiana [U.S.], in 1994 because those topics get a little bit involved," he said. "[Negative training] is an issue — which led me to try and come up with something to address it. But there's still more work to be done."

His company's design philosophy aimed for what he called a new and improved aircraft icing model. "There are a large number of difficult-to-predict [atmospheric] variables," Littman said.

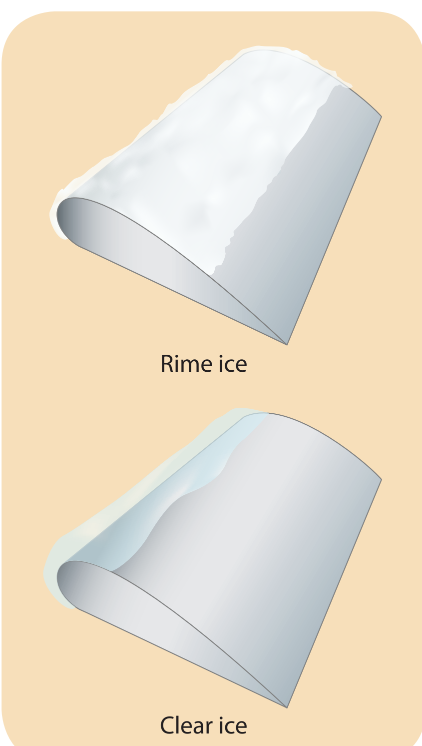


Illustration: Susan Reed, U.S. National Aeronautics and Space Administration

The development strategy has been to move away from a top-down, cause-to-effect simulation concept in which specific data inputs to the flight simulator, defining ice accretion on a percentage scale, would produce only a generic result for a selected intensity.

In contrast, the latest model focuses on the two levels: a bad ice/50-percent icing intensity level and a hazardous ice/100-percent icing intensity level. "The model should allocate the distribution of ice according to what is unprotected or under-protected on the airframe," Littman said.

Using one of these two selectable intensities in the model, the time allotted for the selected effects in the in-flight icing simulator session can vary between five minutes and 20 minutes. "Anything less than five minutes is just really too fast to be the least bit realistic," Littman said. "Anything more than 20 minutes is probably too long to be used in a training session. So yes [in reality], you can get ice in less than five minutes, and it can accrete for longer than 20 [minutes], but in terms of bounding it for a training session, we chose that range."

Evaporative cooling effects in high humidity tend to lower the temperature required before supercooled droplets will freeze on a surface with a temperature below freezing. The icing effects in the simulator, therefore, ideally should reflect the quantity of ice accreted on the specific component, but few simulations currently account for this. "The model's [lift coefficient] curve also includes the effects of evaporative cooling at 100 percent relative humidity," Littman said. "Icing usually occurs in a cloud. … Also, the maximum outside air temperature for ice accretion is a decreasing function of true airspeed. The faster you go, the more aerodynamic heating you get because of friction against the air, and that means that the air has to be colder before you can actually get icing."

Boundaries of Reality

These training scenarios occur in visible moisture at or below 22,000 ft pressure altitude. "The chances of icing occurring above that altitude are pretty small because there is just not that much water in the air above 22,000 ft," he said. "Leading-edge ice causes early flow separation on the wing upper surfaces, and the angle-of-attack increases. It results in a reduction of the maximum lift coefficient [CLmax]; in other words, the maximum lifting efficiency of that wing is reduced when you have ice on the leading edge. The effect of that is that the stall speed goes up. … [However,] ice on the leading edge usually has little effect on the lift prior to the stall."

These implementations of icing-effects data sets use U.S. National Aeronautics and Space Administration research involving a scientific-instrumented de Havilland DHC-6 Twin Otter and wind tunnel experiments. Artificial shapes representing wing leading-edge accretions of rime ice and clear ice for various periods of time generated the data sets. For example, these data show in part that two minutes of clear ice has roughly the same aerodynamic effect as about 17 minutes of rime ice, Littman said.

Graphs of the data (Figure 1) showed that in the most severe in-flight icing condition simulated — about 22 minutes of clear ice accretion — the wing's CLmax deteriorates to about 0.65. For the bad ice/rime ice condition, CLmax is just below 1.0. By comparison, a clean wing — that is, one free of ice contamination — attains a CLmax of 1.33 in the tables integrated into the simulation.

The simulation overcomes the former benign portrayal of practical consequences. "The stall, when the wing has accreted ice, will tend to be abrupt and asymmetric … because the ice is not going to be uniform across the span of the wing," he said. "It's almost a 100 percent chance that one wing will [stop generating lift] before other one does because the shape won't be exactly the same all the way across. When it does let go, it is going to tend to let go quickly. The stall warning system may not necessarily provide — and in many cases does not provide — advance notice of an impending stall with ice on the wing."

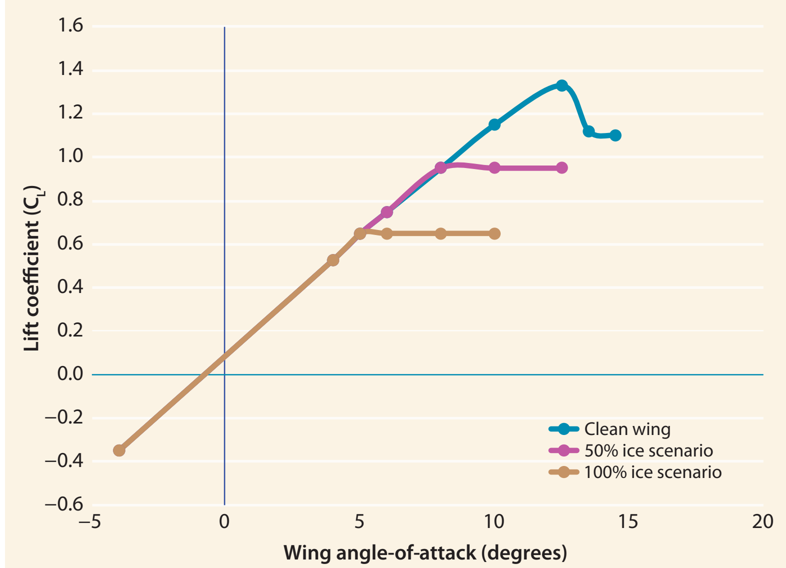
The simulation also now reflects that in-flight icing has much less effect on a wing with an extended leading-edge device. "So, in a simulator, you might have ice accreting on one or both wings; the leading-edge devices would be retracted or not there at all," Littman said. "For 50 percent icing … the [CLmax] is reduced by 20 percent. That [results] in a 12 percent stall speed increase. … For 100 percent icing, CLmax is reduced by almost half, which means the stall speed goes up by 39 percent. …When you get to the stall, there [will] be a pronounced wing drop because that is what will most likely occur in the real world if this happens."

Readily Apparent Drag

Drag caused by ice on the wing varies with angle-of-attack. "Ice on the wing affects drag at any angle-of-attack, more so at higher angles," Littman said. "Also, drag on the aircraft can increase when there is ice on components other than the wing. The simulator model should apportion the drag increases among the airframe components according to their various ice-protection states. In other words, 'Is the ice protection turned on? Is it turned off? Is that part of the aircraft protected at all?'" Relevant icing-effect data (Figure 2) also show that at the 100 percent/hazardous condition, the drag increase is "much higher, much sooner" as the angle-of-attack increases, he said.

Several of FlightSafety International's icing simulations currently represent the drag this way. The data sets include the relative drag contributions when ice accretes on the fuselage, the horizontal tail, the vertical tail and/or the extended landing gear. "It becomes very apparent," Littman said. "You have to really add lots of thrust just to keep it flying when you get to the 100 percent ice condition."

In-Flight Icing Effect Simulation — Reduced Maximum Lift

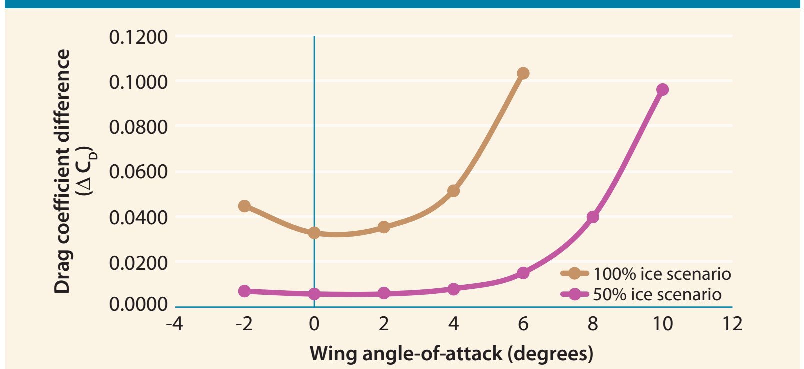


Note: The lift coefficent is equal to the lift divided by the quantity comprising air density times half the velocity-squared times the wing area. By varying velocity, air density and/or wing area in a wind tunnel, lift and lift coefficient — which has no unit of measurement — can be calculated to compare ice effects among wing shapes with/without ice contamination. For training purposes in flight simulators, the 50-percent ice scenario represents rime/"bad" ice accretion and the 100-percent ice scenario represents clear/"hazardous" ice accretion.

Source: FlightSafety International

Figure 1

In-Flight Icing Effect Simulation — Drag Increase



Note: For training purposes in flight simulators, the 50-percent ice scenario represents rime/"bad" ice accretion and the 100-percent ice scenario represents clear/"hazardous" ice accretion. "Even at the minimum drag condition, the drag increase for the 'hazardous ice' is much greater," said Dan Littman of FlightSafety International.

Source: FlightSafety International

Figure 2

Double Whammy

A 757 overran a short, contaminated runway after the speed brakes and thrust reversers failed to deploy on landing.

BY MARK LACAGNINA

The pilots were distracted and confused by the failure of the thrust reversers to deploy on command and did not notice that the speed brakes had not extended automatically on touchdown. Lacking adequate deceleration, the airplane — a Boeing 757-200 — ran off the end of the wet runway and became mired in deep snow.

There were no injuries and only minor damage to the airplane during the Dec. 29, 2010, incident, which occurred at Jackson Hole (Wyoming, U.S.) Airport. In its final report, the U.S. National Transportation Safety Board (NTSB) said that the investigation revealed that a manufacturing defect in a clutch mechanism had prevented the speed brakes from extending and that the thrust reversers momentarily had become locked in transit when the weight-on-wheels "ground" signal was interrupted on touchdown.

The clutch defect and the captain's "failure to monitor and extend the speed brakes manually" were cited as the probable causes of the incident. Contributing factors were the captain's reflexive callout of speed brake extension without confirmation that they had indeed deployed and the distraction resulting from the nondeployment of the thrust reversers.

The report said that safety issues identified during the incident investigation included "inadequate pilot training for recognition of a situation in which the speed brakes do not

© Rick Colson NewFlight Charters

automatically deploy as expected after landing; lack of an alert to warn pilots when speed brakes have not automatically deployed during the landing roll; lack of guidance for pilots of certain Boeing airplanes to follow when an unintended thrust reverser lockout occurs; lack of pilot training for multiple emergency and abnormal situations; and lack of pilot training emphasizing monitoring skills and workload management."

The NTSB made several recommendations urging the U.S. Federal Aviation Administration to address these issues. (The recommendations will be discussed in the October issue of *ASW.)*

'Special Airport'

The 757 was en route to Jackson Hole as American Airlines Flight 2253 from Chicago, with 179 passengers and six crewmembers aboard. The captain had 19,645 flight hours, including 10,779 hours in 757s. The first officer had about 11,800 flight hours, including 3,582 hours in type.

The airline had designated Jackson Hole (JAC) as a "special airport" because of its challenging landing conditions, and both pilots had completed the extra training required to operate there. Moreover, the captain had flown to JAC about 400 times. The first officer told investigators that he had made frequent flights there, including four with the captain during the month of the incident.

The airport is located at 6,491 ft in the Rocky Mountains of western Wyoming and has one runway, 01/19, which is 6,300 ft (1,920 m) long. The pilots told investigators that the runway is usually slippery during the ski season and that high landing weights are common when operating at the airport. "As a result, they said they were especially vigilant and began preparing for the approach and landing at JAC early during what they described as an uneventful flight," the report said.

During the flight, the pilots obtained several updates on the weather conditions at the airport. As the 757 neared JAC in late morning, weather conditions were reported as 3/4 mi (1,200 m) visibility in light snow, winds from 190 degrees at 6 kt, a broken ceiling at 400 ft and an overcast at 1,000 ft. The active runway, 19, was wet and contaminated with snow; braking action was reported as "good" on the first two-thirds of the runway and as "poor" on the last third.

Speed Brakes Armed

The airplane's landing weight was 194,055 lb (88,023 kg), or 3,945 lb (1,789 kg) lower than maximum. Planning to touch down within 1,000 ft (305 m) of the approach threshold and to stop the airplane within the first two-thirds of the runway, the flight crew armed the speed brakes for automatic deployment and selected the "MAX AUTO" autobrake setting.

The report indicates that the crew conducted the instrument landing system approach to Runway 19. The 757 touched down firmly about 600 ft (183 m) from the runway threshold. According to the flight crew's performance calculations and a study conducted by investigators, the remaining 5,700 ft (1,737 m) of runway should have been sufficient to complete the landing with all systems operating normally (Figure 1, p. 37).

However, "the first officer (the pilot flying) reported that he tried to deploy the thrust reversers promptly after touchdown, but they did not initially deploy," the report said. "After the first officer made several attempts to deploy the thrust reversers, the captain took over the thrust reverser controls and eventually succeeded in deploying the thrust reversers with about 2,100 ft [640 m] of runway remaining."

Recorded flight data indicated that the thrust reversers deployed fully about 18 seconds after the airplane touched down and that full reverse thrust was developed 10 seconds later.

Both pilots told investigators they were not aware that the speed brakes — six panels atop each wing — had not extended until the airplane came to a stop beyond the departure end of the runway. "The pilots could have manually extended the speed brakes at any time during the landing roll, had they recognized the nondeployment," the report said.

Boeing 757-200

© Lasse Fuss/Wikimedia

In the mid-1970s, Boeing began the development of a fuel-efficient, twin-engine, advanced-technology replacement for the three-engine 727, which was introduced in 1963 and set a sales record of more than 1,830 units before production was discontinued.

The 727's replacement, the 757-200, was introduced in 1982. The narrowbody airplane can accommodate 178 to 239 passengers. Another model, the 757-300, was introduced in 1998 with a longer fuselage designed to accommodate 243 to 280 passengers.

Powered by Pratt & Whitney PW2037- or PW2040-series engines, or by Rolls-Royce 535-series engines, the 757-200 has a maximum takeoff weight of 230,000 lb (104,328 kg), a normal cruising speed of 0.80 Mach and a maximum range of 2,980 nm (5,519 km).

After a production run of 1,050 airplanes, the last 757 was delivered in November 2005.

Sources: Boeing, Jane's All the World's Aircraft, The Encyclopedia of Civil Aircraft

Erroneous Callouts

Investigators found that the 757's air/ground sensing system, which is based on proximity sensors on the main landing gear, transitioned from "air" to "ground" when the airplane touched down. About one second later, however, the system cycled back to the air mode for about a half second. This likely occurred when one or both of the main gear unloaded after touchdown, possibly because of a slight bounce, causing at least one of the proximity sensors to open.

"This brief cycling of the air/ground signal during a landing is not uncommon," the report said. "However, in this case, it coincided with the first officer's attempt to deploy the thrust reversers immediately after touchdown. … Because of the precise timing of these events, a rare mechanical/hydraulic interaction occurred in the thrust-reverser system, and the thrust reversers were locked in transit instead of continuing to deploy."

The thrust-reverser system on 757s and 767s equipped with Pratt & Whitney engines has a "sync-lock" mechanism that is intended to prevent the translating sleeves from extending accidentally due to a fault in the system. "This lockout would prevent movement of the thrust reversers until about 5 seconds after a pilot moves the reverse-thrust levers back to their stowed position, allowing the thrust reverser system to deactivate and begin deployment again when commanded," the report said. "During post-incident interviews, both pilots indicated that they were unaware of a circumstance in which the thrust reversers could be locked in transit and were unaware of the actions needed to correct the situation."

Investigators found that many other 757 and 767 pilots were not aware that this situation could occur. "The potential for this type of event had not been identified before this incident," the report said. "As a result, Boeing's 757/767 guidance did not contain related guidance."

Standard operating procedure required the pilot monitoring — the captain in this case — to observe speed brake, thrust reverser and autobrake operations during the landing roll. Automatic deployment of the speed brakes is indicated in part by movement of the speed brake handle, which is on the middle left side of the center console. Green "REV" annunciator lights, one for each engine, illuminate on the engine indicating and crew alerting system (EICAS) when the thrust reversers deploy fully.

"Specifically with regard to the speed brake lever, the procedures indicated that the pilot monitoring should observe and call out the position of the speed brake lever after landing and that, if the speed brakes do not automatically deploy, the captain should manually deploy the speed brakes (regardless of which pilot had monitoring responsibilities)," the report said.

The American Airlines 757/767 Operating Manual notes that awareness of speed brake lever position is important in preventing runway excursions. "Without speed brakes deployed after touchdown, braking effectiveness may be reduced initially by as much as 60 [percent]," the manual says.

Although there were no indications that either the speed brakes or the thrust reversers had deployed fully, the captain called out "deployed" about 2.8 seconds after touchdown and "two in reverse" 1.2 seconds later.

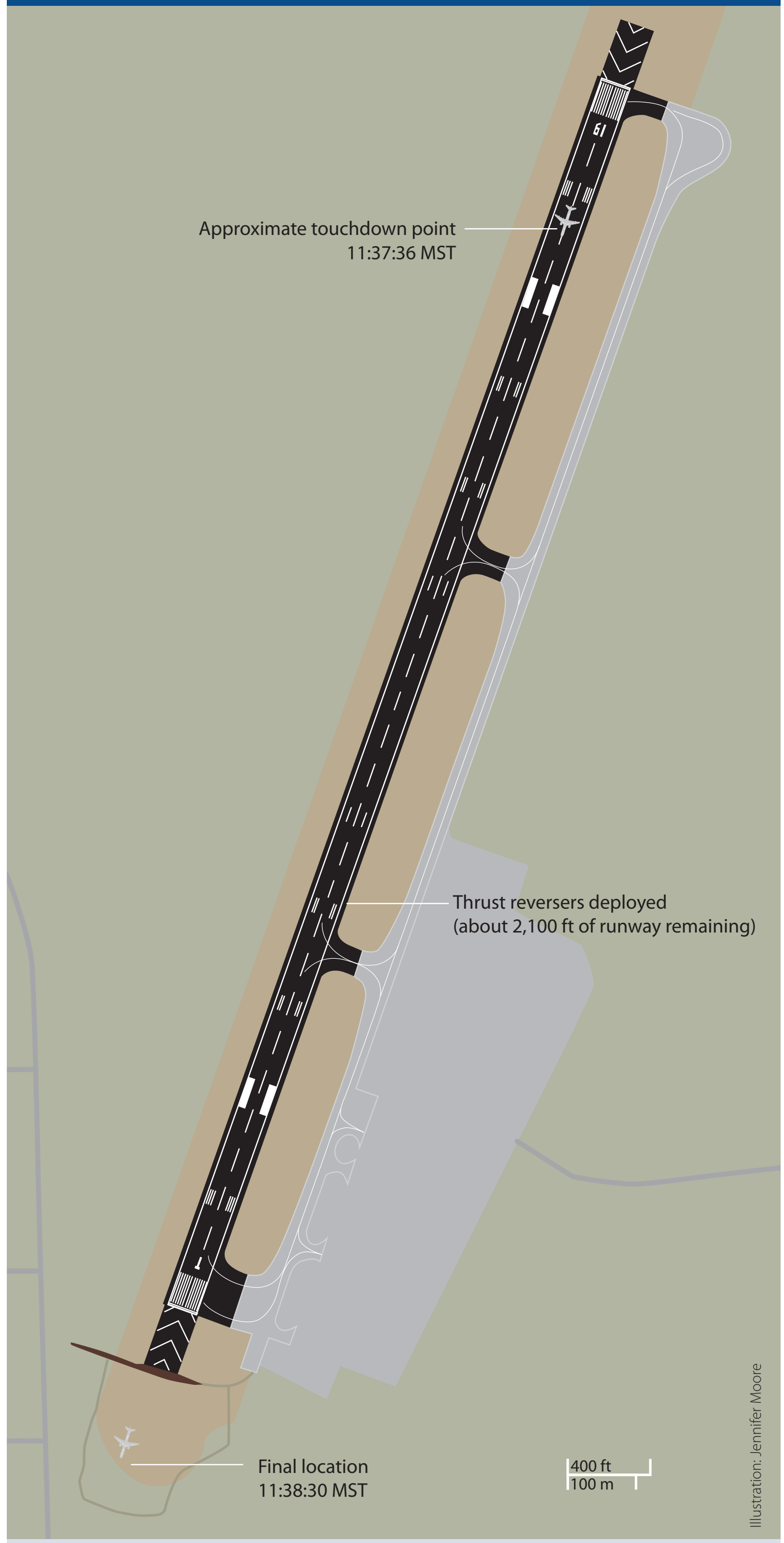
The speed brake handle had moved slightly out of the armed position but had not continued moving aft toward the extended position. "The captain's erroneous speed brakes 'deployed' callout was likely made in anticipation (not in confirmation) of speed brake deployment after he observed the speed brake handle's initial movement," the report said. "After the 'deployed' callout was made, both pilots likely presumed that the reliable automatic speed brakes were functioning normally."

The slight movement of the speed brake handle coincided with the illumination of amber lights on the EICAS indicating that the thrust reversers were in transit; the green "REV" lights, indicating full deployment, did not illuminate. "Given the typical reliability of the thrust-reverser system, it is likely that the captain made the ['two in reverse'] callout because he expected normal thrust reverser deployment after seeing the amber EICAS annunciation."

Despite the captain's callout, the first officer recognized immediately that the thrust reversers were not functioning normally. Both pilots then "tunneled their attention on deploying the thrust reversers," the report said. "Both pilots were distracted by, confused by, and trying to resolve the thrust reversers' nondeployment. … Neither pilot was able to broaden his focus enough to look at the big picture and notice that the speed brakes (the more crucial deceleration tool) had not deployed."

Noting that multiple emergency situations typically are not presented during pilot training, the report said, "If the incident pilots had received specific pilot training on the handling of

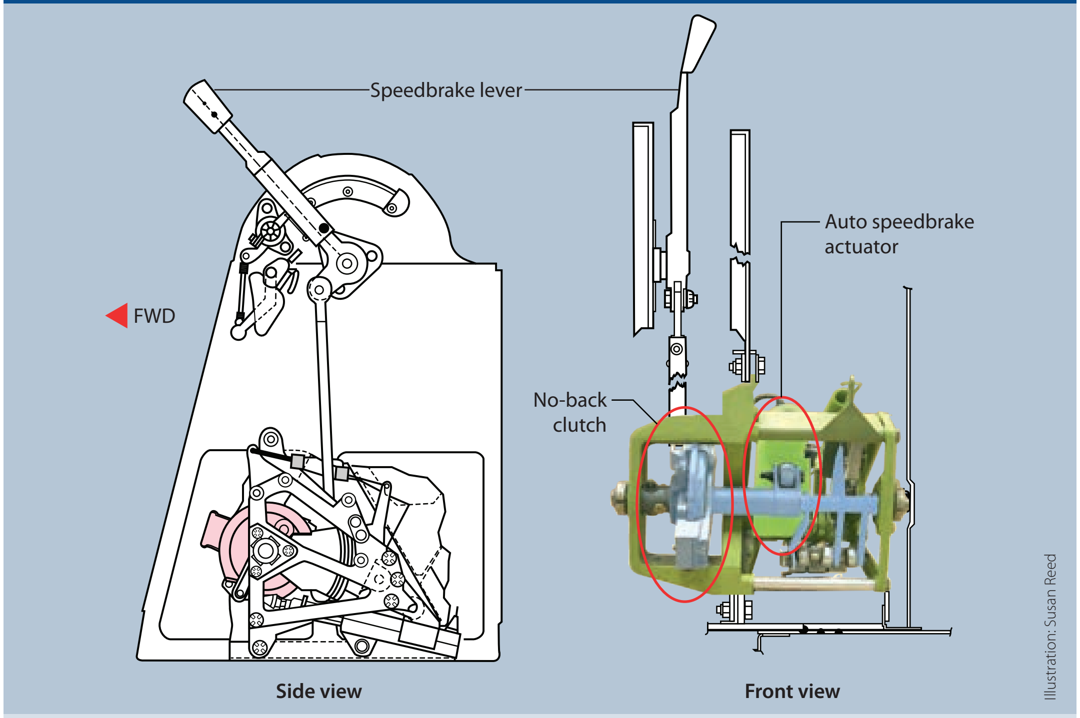
Flight 2253 Overrun



Source: U.S. National Transportation Safety Board

Figure 1

Speedbrake Assembly



Note: Investigators found that automatic deployment of the speedbrakes on the accident airplane had been prevented by a lever braking pin in the clutch mechanism that had not been secured properly during assembly.

Source: U.S. National Transportation Safety Board

Figure 2

multiple emergency or abnormal situations, they might not have focused exclusively on the thrust reverser nondeployment and might have been more likely to recognize and properly resolve the speed brake nondeployment during the landing."

Speed Brake Defect

Initial examination and testing of the automatic speed brake system revealed nothing that could have prevented normal operation. However, about three months later, the speed brakes again failed to deploy automatically; the flight crew in this case noticed the failure and manually deployed the speed brakes.

After this incident, the system was removed and examined again. This time, investigators found a "latent assembly defect" in the clutch mechanism that intermittently prevented an actuator from driving the speed brake lever out of the "ARMED" detent to extend the speed brakes (Figure 2), the report said.

"Specifically, one of the four speed brake lever braking pins was improperly secured, which allowed it to intermittently rotate within its assembly and prevent the clutch from transmitting the torque from the automatic speed brake actuator to the speed brake lever," the report said. "Further, it was noted that this defect only affected the speed brakes' automatic deployment function and would not have prevented the pilots from manually deploying the speed brakes."

The manufacturing defect can be found only by disassembling the clutch, which is not required during normal maintenance. "As a result of this investigation, the manufacturer clarified its documentation to ensure proper assembly of the clutch units," the report said.

This article is based on NTSB Incident Report AAR-12-01: "Runway Overrun; American Airlines Flight 2253; Boeing 757-200, N668AA; Jackson Hole, Wyoming; December 29, 2010." The report is available at <ntsb.gov/investigations/reports_aviation.html>.

Flight Path-ogens

An SMS is a defense against safety pathogens, but not a cure.

BY ROBERT I. BARON

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Recently, the following events occurred at a jet charter flight operation:

- A pilot flew an airplane with inoperative radar through a line of convective activity.
- A pilot continued an unstable approach and touched down halfway down the runway.
- A pilot exceeded an aircraft operating limitation by intentionally deploying the spoilers with the flaps extended while airborne, which violated the manufacturer's instructions for that model.

The safety implication for each of these actions is clear. Although they ended without incident, the outcomes could have been much different, especially for the first two. In each of these examples, the pilot committed a violation. A violation is different from common everyday errors in that the violator is aware of, and consciously chooses, his or her intended action. In contrast, everyday errors are beyond the awareness of the erring individual. While both violations and everyday human errors can be problematic, violations are worth increased scrutiny due to their possible relationship to the organizational culture. Determining whether the violations are occurring as individual aberrations, or are part of a broader cultural manifestation, is key to the corrective process.

'Safety Disease'

In the human body, pathogens can be defined as disease-producing agents. Organizations such as flight departments can have their own "safety disease" pathogens.

Depending on the size of the company, the dynamics of cultural pathogens may vary considerably. For instance, in a very small charter operation, where the owner also flies as a line pilot, the potential pathogens may be "right in your face." I once knew an owner-pilot who explained to me that "you think differently when it's your personal wallet attached to the throttles." This comment was in response to my question about why he made an overweight takeoff (the fuel was a few cents a gallon cheaper than at the destination airport).

On the other hand, in larger operations, there may be more levels of separation between upper management and line pilots. In these cases, the pathogens may have a longer trajectory to reach the line pilots, but, perhaps beneficially, there may be multiple opportunities for mitigation or even elimination (i.e., James Reason's Swiss cheese model).

With that said, let's refocus on the violations committed by the pilots in the above examples — again, behaviors that can be controlled by the pilot, as he or she freely chooses the intended behavior. The question, then, is why were these violations committed? Here are the restated events and the answers to that question:

A pilot flew an airplane with inoperative radar through a line of convective activity.

The company had a documented history of flying aircraft contrary to its minimum equipment list (MEL). Over time, this became a company norm (everyone was doing it), and pilots were in fact encouraged to "overlook some of the minor MEL issues in order to keep their paychecks coming."

Result: The pilot committed a routine violation (everyone does it all the time) as a result of a cultural pathogen.

A pilot continued an unstable approach and touched down halfway down the runway.

This pilot was highly experienced, with over 10,000 hours of flight time and more than 2,500 hours in type. The company was proactive about safety and required the pilots to attend an annual refresher course on approach and landing accident reduction. On this particular approach, the pilot was being pressured by the passenger to land even though the weather conditions were unfavorable due to reported wind shear. However, during the approach, the high-profile passenger told the pilot that he would "take good care of him" if he could assure an on-time arrival. The pilot succumbed to this incentive and consequently made an unsafe landing decision.

Result: The pilot committed a situational violation — an act motivated by a specific reason such as time pressure or stress. This act, in itself, may not be considered a cultural pathogen; however, if it were allowed to continue on a regular basis with the company's knowledge, it could then be considered a cultural pathogen.

A pilot exceeded an aircraft operating limitation by intentionally deploying the spoilers with the flaps extended while airborne, which violated the manufacturer's instructions for that model.

This pilot had a known history of exceeding aircraft operating limitations. The company was aware of it but did not act because the company's position was that the pilot "always got the job done, and he was reliable." The pilot himself felt that aircraft operating limitations were always very conservative and that there was "plenty of wiggle room."

Result: The pilot committed an optimizing violation (just for kicks), which was also considered a personal routine violation (committing the same violation regularly but not necessarily as part of a group norm). In this case there was a cultural pathogen compounded by a renegade employee with his own agenda.

A healthy immune system in the human body naturally helps to fend off pathogens, whereas a weakened immune system may promote them. In aviation, the corporate safety culture can be considered the immune system. Just as with the human body, a healthy immune system will help to fight off cultural pathogens, but from time to time, the immune system can become weak or compromised. At these times, the pathogens may spread quickly throughout the system and affect all parts of the operation, with line employees affected most significantly.

SMS as Immune System Component

A safety management system (SMS) can be considered part of the organizational immunization process. But an initial SMS vaccination is only the beginning. Just as with some human vaccinations, an SMS requires booster shots to fully develop its efficacy.

Booster shots would include, but are not limited to:

- Continued high-level management buy-in, visibility and support;
- Consistently scheduled safety meetings;
- Fostering of a non-punitive reporting culture; and,
- Consistent and effective safety communication throughout all levels.

Conversely, if the SMS is just a “fill in the blanks” program or a “book on the shelf,” the system is going to be more susceptible to unmitigated pathogens.

In the first and third examples, the pathogens were propagated at the highest levels of the organization (the second was considered a one-time individual aberration). For some reason(s), these pathogens were allowed to penetrate the system and reach the pilots, who in turn activated them.

Neutral Boundary

This company did not have a functional SMS in place. If it had, would it have guaranteed that these pathogens would have been contained? The answer is unequivocally, no. However, with a functional SMS, there would have been a higher level of monitoring (specifically in the proactive hazard identification and risk analysis area), which in turn might have identified these threats and inoculated the system. This is easier to do in the middle levels of the organization, where there tends to be something of a neutral boundary between the upper and lower levels of the organizational hierarchy.

What if, however, the pathogens originate at the very top of the organizational hierarchy and the SMS is not, in reality, reaching this level? In this situation, upper-level management, including the CEO, are clearly focused on revenue at the expense of safety. They are purely reactive (thinking “we'll deal with it if we have an accident”). They will do whatever it takes, at any cost, to top the competition. How would you, as the safety manager, change that mindset and make upper-management truly listen, buy into, act upon and support the SMS and its requisite generative safety culture? That has been one of the most vexing questions in the SMS implementation process.

Robert Baron, Ph.D., is the president and chief consultant of The Aviation Consulting Group and an adjunct professor at Embry-Riddle Aeronautical University. As a consultant, he has assisted aviation organizations in the development of their human factors, SMS, crew resource management and line-oriented safety audit training programs.

Just as with some human vaccinations, an SMS requires booster shots to fully develop its efficacy.

Philosophies, policies, procedures and resilience engineering — not just pilots — defend against loss of control in flight.

Top-Level Automation

BY WAYNE ROSENKRANS

In the past few years, pilot qualifications to manage abnormal situations while operating large commercial jets have dominated discourse about loss of control–in flight (LOC–I). Yet reducing the risks in this accident category at the level of resilience engineering also is essential, several subject matter experts told the ALPA Safety Forum 2012, held in August in Washington by the Air Line Pilots Association, International.

"While the ultimate responsibility of flying the airplane remains with the pilots, we have learned that crews are not all adequately trained to handle these automated systems, especially in high-demand situations," said Dave McKenney, a captain for United Airlines and ALPA's director of pilot training programs, who moderated a session on automation. "Most operators recognize that the use of automated systems may not always reduce the workload but in fact may actually increase it and lead to error. And when an automated system fails, [we have] relied on the human pilots to intercede and resolve the issues. … The automated systems must be clear [as] to

Photo illustration: Jennifer Moore;
photo: © Tuomas Kujansuu/iStockphoto

'How you build resilience in the system is [by giving] the pilot the same capability as the automatic system.'

the message and the information they provide to the pilots. The pilots need to know the status of the aircraft at all times and be able to predict what the system is doing so they can anticipate changes that need to be made."

One audience member expressed a view shared by others: The industry essentially expects flight crews to "intervene during any or all malfunctions with the aircraft system through the use of manual flying skills" but normally requires pilots to engage automation from takeoff until a few minutes before landing, with minimal or no procedures to help them maintain manual flying skills.

Presenter David Woods, an Ohio State University (OSU) professor currently specializing in complexity science[1] and adaptive-systems engineering, said that this issue has been identified and addressed since 1996 by U.S. Federal Aviation Administration specialists and academic researchers for the National Aeronautics and Space Administration (NASA), and in 2012 by specialists studying related issues for the Department of Defense.

"We pointed out that de-skilling and erosion of pilot skills would contribute to difficulties in this plan, this model of safety … that it was brittle, it wasn't as effective as we thought," Woods said. "And it was going to become less effective because the automation worked so well. … The recommendation we made back in the middle-1990s was, '[Pilots] have to practice more non-routine situations. You have to practice handling a cascade of events. … Initial training to proficiency was getting easier and easier, but long-term growth of expertise — the new forms of airmanship that are necessary — were lagging behind. … We still have not taken this seriously. We have new cases of problems in this area, and it is time we moved forward [and] got proactive."

The airline industry often takes for granted in 2012 the precise autoflight guidance of large commercial jets — including their automated responses to non-normal situations — compared with a few decades ago, said Mike Carriker, a captain and chief pilot, new airplane development, Boeing Commercial Airplanes. "On the [Boeing] 787 … if both engines fail, you hit [FLC, flight level control], heading select [HS] and sit there," he said. "The autopilot stays engaged on the RAT [ram air turbine] and the engines go into auto-relight."

Current-generation airplanes typically provide closed-loop flight control systems with alleviations and compensations; flight directors integrated with the autoflight system; full-time autothrottles; engine autostart; full authority digital engine control (FADEC); flight management computers that tune frequencies in the navigation system as necessary; engine indicating and crew alerting systems; automation of cabin pressurization and other systems controls; and global positioning system receiver accuracy far higher than 15 years ago, with robust navigational redundancy from technology such as ring laser gyros, he said.

On such flight decks, however, further improvements to pilot training will have to complement this handover of functions to the automation. "How you build resilience in the system is [by giving] the pilot the same capability as the automatic system," Carriker said. "Then you try to encourage the pilots to fly that manual system and [to] understand what the airplane just did on the automatic system. So when the automatic system drops, [pilots will realize,] 'I've been here before. I've been on approach. … I know the pitch attitudes. … I know how this airplane flies.'"

Philosophical Origins

From the high-level perspective, automation design and flight path management originate from philosophies written by airframe manufacturers. Ideally, these shape operator policies, procedures and practices as the creators intended, said Helena Reidemar, a first officer with Delta Air Lines and ALPA's director of human factors. Sometimes, however, these "4P" elements become disjointed or even conflict with each other.

"We've been seeing way too many automation surprise and startle issues in recent years," she said. "We need to reverse that trend, and it's time to do that at the threshold of NextGen [the U.S. Next Generation Air Transportation System]. … In [this] near-term future, we'll be working with tighter tolerances, self-separation, 4-D trajectory[2] — we need to maintain some manual flying skills more than anything," Reidemar said. "Automated systems are a tool for the pilot — not a replacement of us as operators or as monitors — and we need to consider the role of the automation in the overall system. Manual flying skills — cognitive and psychomotor skills — will degrade if they are not practiced."

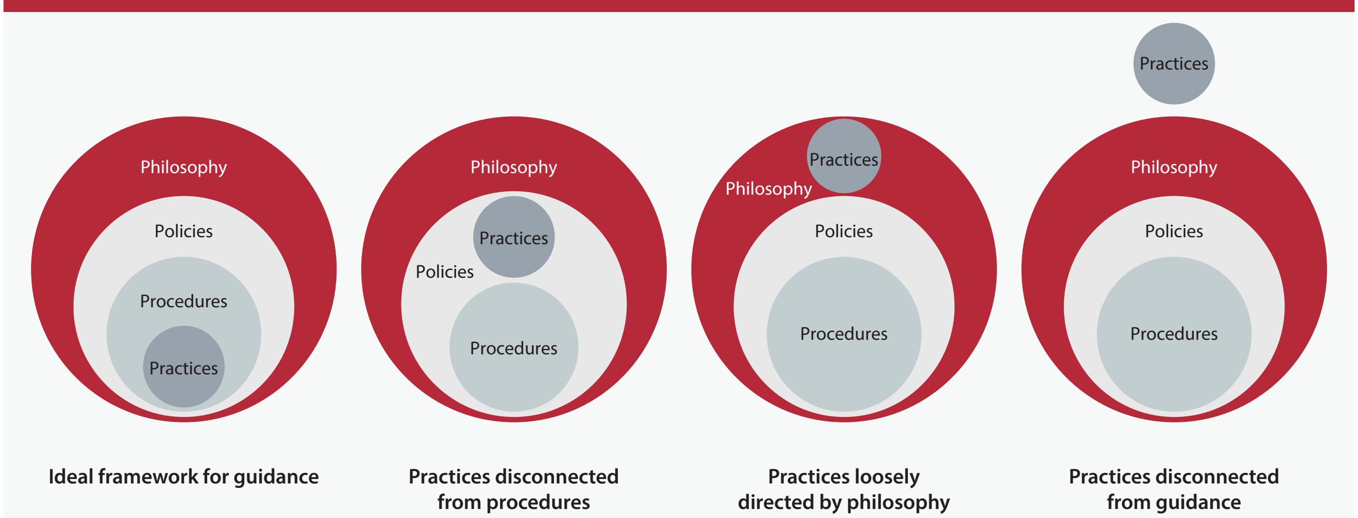
Any effort to update an airline's philosophy, policies or procedures with respect to automation should begin with an understanding of the manufacturer's formal automation philosophy, she advised. "Manufacturers' automation philosophy [in two examples] is about design … it doesn't talk about the operation and it provides little guidance for training, procedures, division of labor, workload management," Reidemar said. "Then we need to work within our own organizations to fix the disconnects."

She cited the work of NASA scientist Asaf Degani[3] in flow-diagram visualizations of the ideal and non-ideal relationships among philosophy, policy, procedures and practice (Figure 1). "Unfortunately, we can find ourselves in situations where there is no overarching philosophy," Reidemar said. "And this is truly problematic for the pilot and the organization. Now you are in uncharted territory. Nobody wants to be there. And it is not expected in normal operations. Perhaps the aircraft is doing something unexpected that we have no mental model for. Think Air France [Flight] 447 or Colgan [Air Flight] 3407. The complexity of component interactions can truly lead to some unanticipated systems behavior."

While anticipating further NextGen implementation, taking the high-level perspective enables all responsible entities to introduce flight path management as "part of an elegant whole for [pilot] proficiency standardization — coherency in the broadest sense," she added.

This effort also requires operators to be knowledgeable, considerate and highly sensitive to the limitations of current and anticipated automation. "Traditionally, we have seen [the company policy of selecting] the maximum automation available as necessary for [the] phase of flight," Reidemar said. "That's no longer

Automation Guidance to Flight Crews: Ideal Relationship and Disconnects



Note: Helena Reidemar's presentation adapted a flow diagram concept by Asaf Degani. "Philosophy [of flight path management] dictates policies, policies are translated into procedures and then, at the very bottom, we have practices … every activity we perform on the flight deck," Reidemar said.

Source: Asaf Degani, U.S. National Aeronautics and Space Administration

Figure 1

'You end up being a critical ingredient in making this complexity work every day.'

sufficient. … [Airlines will have to] minimize the impact on the flow of traffic, and then maximize the smoothness and elegance of the human-automation interaction, mode switching and crew interface."

She presented examples of the diversity of airline automation philosophies that she has studied. In one case, the de-identified airline used automation to a minimal degree and did not revisit the practice for 30 years, until recognizing potential savings in time and fuel that required rewriting its philosophy, policy and procedures. "So be cautious in just changing the order or flow of things," Reidemar said. "You need to actually back it up and support it with policy, so the expectation for the pilot is clear."

She described two airlines operating the same aircraft type, the Airbus A330, but one with a relatively rigid culture prohibiting open descent below 1,000 ft and another with a relatively flexible culture prohibiting open descent below 500 ft. "So two airlines [are] operating the same aircraft [with] significantly different philosophical differences in their automation policy," she said.

Appreciating History

Debates about automation benefit from a reality check against the old days, said Terry Lutz, a captain and experimental test pilot, Airbus. "The [pilot's] navigation and communication roles are now largely automated, but the pilot still has to do the basic aviating task," he said. "And a new task has been required of the pilot … to manage the overall mission. … If you look at the flying task in 2012, you realize that there is still a manual skill set required. But there is now a new skill set, which is extensively mental, that's also required." He cited progress in automated flight controls and "thrust-by-wire" engine controls that should factor into safety conversations about automated flight path management.

"You can view the controllers in modern fly-by-wire airplanes as either 'super autopilot' controllers, or you can view them as pilot controllers where the airplane itself is compensating for all of the undesirable motions — for the Dutch roll, for example, for the short-period mode of motion, for phugoid[4] and to control the spiral, [all of] which will allow you to fly a very precise bank angle," Lutz said. "Whether it be the sidestick controller that we use [in an Airbus] airplane or the manual controller in the Boeing 787, you also have two [flight] axes in one controller. Excellent HMI [human-machine interface provides] for force displacement and rate capability, and in pitch you find that it is basically a pitch rate command/pitch attitude hold. And in roll, a roll rate command and a bank angle hold.

"We can have an airplane today [in which] you can take off at maximum gross weight, have an engine failure and continue to rotate and take off and the airplane will stay wings level, maintain its heading and allow you to climb out and operate your normal procedures after that."

Sea of Complexity

Thinking of pilots in an abstract way — as a flight deck subsystem notable for unique capability in risk management and system resiliency — yields further insights into an overall LOC–I solution, according to OSU's Woods. "It's very complex what you do … extremely complex what you manage … under fast-paced conditions," he told pilots attending the forum session. "Sudden things can happen; unexpected and non-routine events occur. This is the sea of complexity that you operate in. … You end up being a critical ingredient in making this complexity work every day."

Within the science of complexity and resilience engineering, a critical concept relevant to aviation safety can be expressed by the terms *brittleness* and *resilience*. These academic disciplines' goals in analyzing complex adaptive systems, he said, include identifying failures in the interactions, understanding/measuring how systems are brittle, and extracting lessons about sources of resilience from aviation incidents or accidents so that extra "adaptive capacity" can be applied to future situations.

Commercial air transport has proven to be a popular example to other industry sectors of how people function as a hidden source of resilience. "When systems fail, they reveal points of brittleness and they reveal hidden sources of resilience," Woods said. "There are regularities about how complex adaptive systems fail. … The question is, 'Can resilience be engineered into organizations that carry out complex activities?'"

Teams of complexity scientists have noted since about 2000 that "the automation [in air transport] creates a layer of apparent simplicity over those increasing interdependent relationships, between more and more parts, so that everything looks simple and runs super smooth until it doesn't," he said. "Then we see cascades [pilots] have to try to keep up with. We see tipping points, we see surprises. … You have to be able to keep up with the cascade of events when a sensor failure [occurs,] and you don't know what to trust in terms of cockpit indications. … You have to maintain a control margin [so] that you can act to compensate for those unexpected or non-routine events."

Taking his complex adaptive system resilience approach is particularly relevant to compensating for any gradual de-skilling of airline pilots. "You've gotten good [in balancing safety and efficiency] because you have adapted," Woods said. "[But] the present is more precarious than we think, and it's a common finding from all approaches to safety, from an organizational perspective, that safe organizations are constantly on edge, recognizing that past success is no guarantee of future ultra-high safety performance."

Questions and Concerns

One attendee recalled that Airbus's Lutz, on another occasion, mentioned people imagining large commercial jets equipped with a "big red button, the recovery button." Lutz said, "I think from both the Airbus and Boeing standpoint, what we are going to see … in future designs is [that] even in degraded modes … degraded hydraulics or degraded electrics or degraded flight control modes, you're going to have some basic protections in the airplane that will keep you from exiting the … normal flight envelope. I think you'll also find the ability to use the autopilot in a lot of degraded situations."

He cited an existing automated system that maintains flight control on the Airbus A380, which is both a hydraulically controlled and an electro-hydrostatically controlled airplane. "We can switch off eight hydraulic pumps [two on each of four engines] and still fly the airplane normally on the electro-hydrostatic actuators and use the autopilot," Lutz said.

The concept of a fully automated recovery system sounds great, he added, but current technology may not be up to the task because of the complexity. "Let's think about it," he said. "But to actually flight-test it and make it happen in the situations where you want it to happen — and then go to all the fringe cases — is very, very difficult."

Boeing's Carriker noted that one of the technology-based solutions from company engineers has been the adoption of transient-free switches between normal airplane modes of operation, which reduces the probability of situations requiring non-normal piloting. "You roll the airplane and [select] a switch in the overhead [panel] that turns on the flight controls," he said, describing an in-flight demonstration. Activating that switch causes no perceptible tactile-feedback change such as a bump or a thump, he said.

Other attendees voiced concern about whether the future airspace environment will have enough margin of error for emergency changes of the programmed flight path by pilots. "The coming changes through NextGen–SESAR [Single European Sky Air Traffic Management Research] airspace, and the efficiencies [that authorities attempt to design] into that airspace in order to increase the density of operations are going to force us … to rely on automation to the exclusion of allowing either a human pilot or a human controller to intervene," one attendee said. If pilots cannot turn the airplane safely within the constraints of the airspace, "Isn't that the most brittle system you can imagine?" he asked.

Airbus's Lutz reiterated that fly-by-wire technology compensates for the relatively imprecise human control inputs and aircraft type–specific aerodynamic characteristics. "We also have to provide [solutions] on the training side so that pilots can see that they can, in fact, fly the airplane in those environments," he said. "And if they can't, if manual control is not possible, then other measures have to be taken if traffic becomes truly that dense in NextGen."

Notes

1. Specialists in *complexity science* study how adaptive systems work, focusing on "how people in various roles learn, recognize, anticipate," Woods said.
2. In NextGen and SESAR planning, *4-D trajectories* are four-dimensional paths — latitude, longitude, altitude and estimated time of arrival — that aircraft take or are expected to take.
3. Degani, a scientist based at the NASA Ames Research Center, has applied expertise in human interaction with computers and automated systems to aviation safety contexts.
4. *Phugoid* refers to a long-period longitudinal oscillation in the airplane's flight path.

BY RICK DARBY

Ten Million to One

EASA member states had a fatal accident rate of 0.96 per 10 million flights in 2011.

The fatal accident rate for scheduled passenger and cargo flights among the 31 European Aviation Safety Agency (EASA) member states (MS) improved in the latest 10-year survey, and in 2011 the fatal accident rate was 0.96 per 10 million flights.[1,2]

For the decade 2002–2011, there were 1.6 fatal accidents per 10 million flights, the same rate as for North America. As recently as the 2001–2010 period, the EASA MS rate had been 3.3. That was influenced by the exceptionally high rate of 11.7 in 2001. EASA member states are the 27 European Union states plus Iceland, Liechtenstein, Norway and Switzerland.

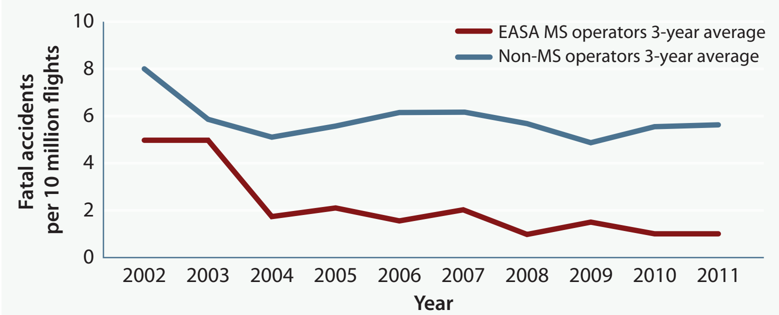
One fatal accident occurred in EASA MS commercial air transport airplanes in 2011, with six on-board fatalities.[3] There were no fatal accidents in the category in 2010. For the 2000–2009 decade, fatal accidents averaged four per year. The number of fatal accidents was as high as five in both 2005 and 2006.

The reduction in the number of fatal accidents does not just reflect fewer flights. The traffic level in 2011 was similar to the one of 2006, the report says. EASA MS had 32 accidents in 2011, versus 28 in the previous year and an average of 30 for 2000–2009.

The trend, based on a three-year moving average, has improved in the most recent 10-year period (Figure 1). The higher rate of non-MS fatal accidents, which in 2002 and 2003 appeared to be converging with that of EASA MS, has maintained a wide gap since.[4]

Fatal and non-fatal accidents involving EASA MS–operated airplanes were assigned to categories based on the standardized definitions of the Commercial Aviation Safety Team-International Civil Aviation Organization

Fatal Accident Rates, EASA Member States vs. Non-Member States, 2002–2011

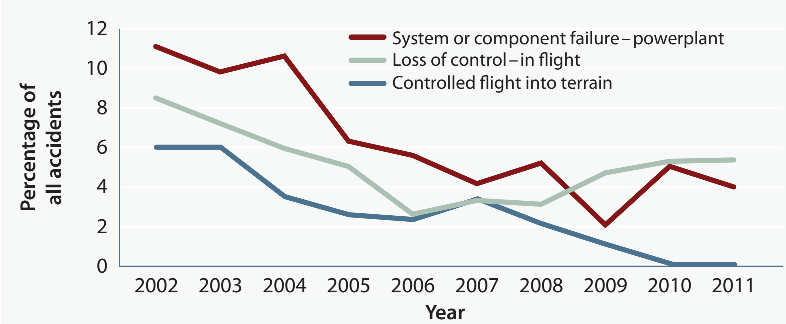


EASA = European Aviation Safety Agency; MS = member state

Source: European Aviation Safety Agency

Figure 1

Proportion of CFIT, SCF-PP and LOC-I Accidents, EASA Member States, 2002–2011

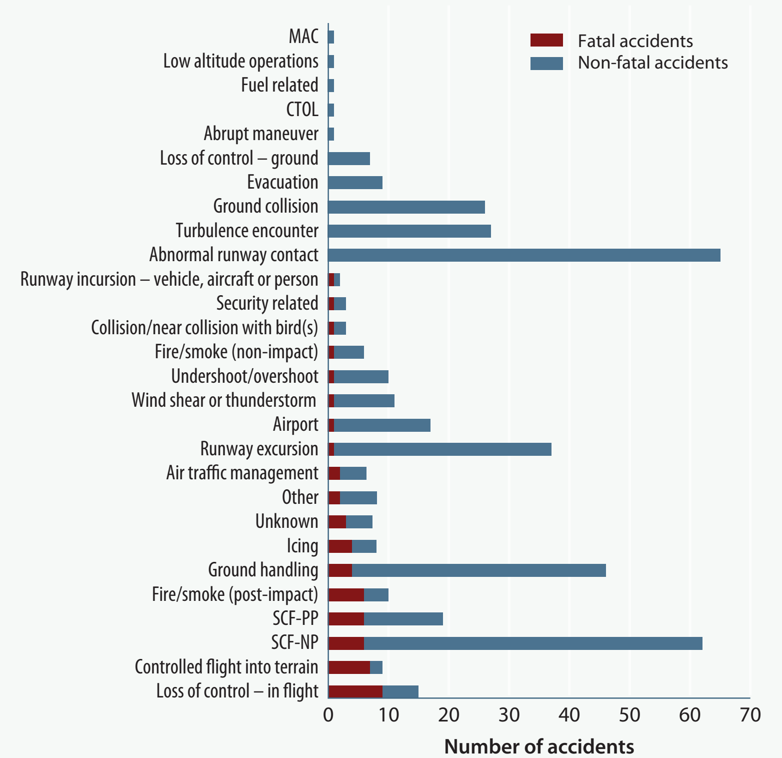


CFIT = controlled flight into terrain; EASA = European Aviation Safety Agency; LOC-I = loss of control – in flight; SCF-PP = system or component failure – powerplant

Source: European Aviation Safety Agency

Figure 2

Accident Categories, Fatal and Non-Fatal Accidents, EASA Member State Airplanes, 2002–2011

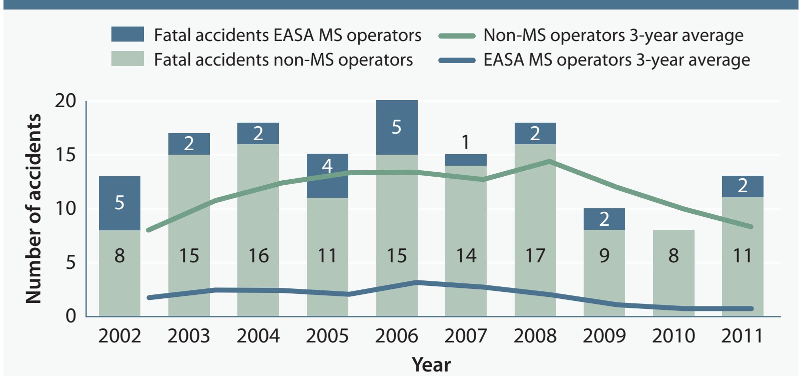


EASA = European Aviation Safety Agency; CTOL = collision with obstacle(s) during takeoff and landing ; MAC = airprox/traffic-alert and collision avoidance system alert/loss of separation/ near midair collision/midair collision; SCF-NP = system/component failure or malfunction (non-powerplant); SCF-PP = system component failure or malfunction (powerplant)

Source: European Aviation Safety Agency

Figure 3

Fatal Helicopter Accidents, EASA Member States and Non-Member States, 2002–2011



EASA = European Aviation Safety Agency; MS = member state

Source: European Aviation Safety Agency

Figure 4

(CAST-ICAO) Common Taxonomy Team (CICTT). Controlled flight into terrain (CFIT) accidents declined as a percentage of all accidents in the 2002–2011 period (Figure 2, p. 49). "This can be attributed to technological improvements and to increased awareness of situations which may lead to such accidents," the report says.

Similarly, accidents that involve the failure of a system or component related to the engine (SCF-PP) have decreased as a percentage of all accidents.

Since reaching a low point in 2006, loss of control–in flight (LOC-I) accidents have risen as a percentage of total accidents, and now exceed SCF-PP and CFIT.

Post-impact fire and smoke, and failure of a system or component not related to the engine, were also among leading categories of fatal accidents (Figure 3). Abnormal runway contact was the category involved in the largest number of accidents, none of them fatal.

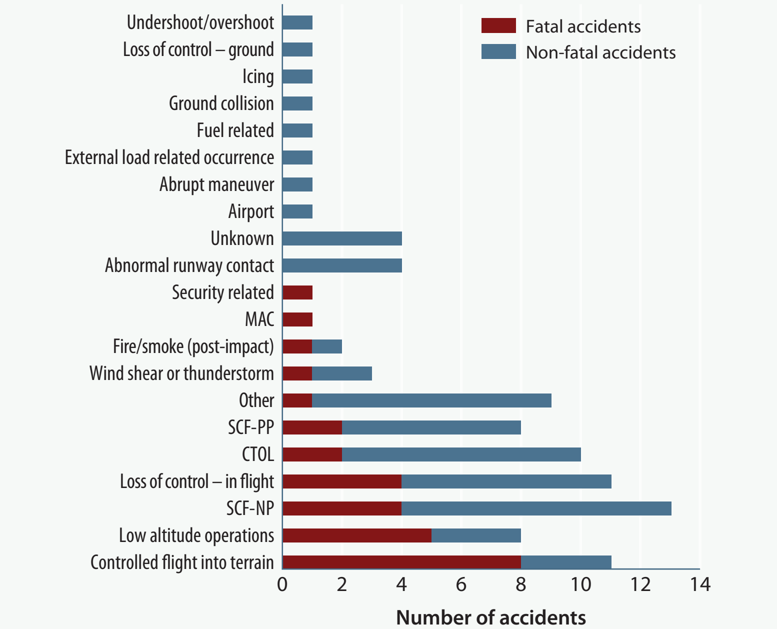
Like airplane fatal accidents, helicopter fatal accidents involving EASA MS operators increased year-over-year (Figure 4). There were two such accidents in 2011, compared with none in 2010 and an average of three per year in 2000–2009. In non-MS operations, the number increased from eight each in 2009 and 2010 to 11 in 2011 — still better than the average of 13.6 from 2002–2008.

Total EASA MS helicopter accidents also increased, from two in 2010 to six in 2011, averaging eight per year in 2000–2009.

In contrast with airplanes, CFIT figured prominently in EASA MS helicopter accidents — particularly fatal accidents in 2002 through 2011 (Figure 5). Low altitude operations–related accidents (LALT) had the second-highest number of fatal accidents. The report said, "This occurrence category includes accidents which occur while the aircraft is flown intentionally at low altitude, excluding the phases of take-off and landing."

The largest number of accidents, comprising both fatal and non-fatal accidents, were categorized as SCF-NP, system/component failure

Accident Categories, Fatal and Non-Fatal Accidents, EASA Member State Helicopters, 2002–2011

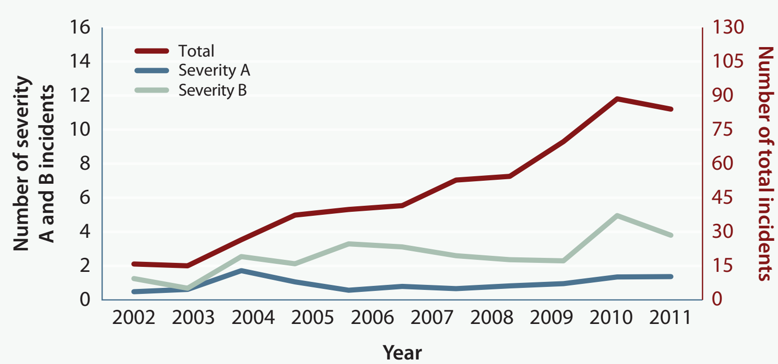


EASA = European Aviation Safety Agency; CTOL = collision with obstacle(s) during takeoff and landing ; MAC = airprox/traffic-alert and collision avoidance system alert/loss of separation/ near midair collision/midair collision; SCF-NP = system/component failure or malfunction (non-powerplant); SCF-PP = system component failure or malfunction (powerplant)

Source: European Aviation Safety Agency

Figure 5

Runway Incursions, EASA Member ATM System, 2002–2011



ATM = air traffic management; EASA = European Aviation Safety Agency

Note: Severity A incidents are categorized as serious. Severity B incidents are categorized as major. Data for 2011 are preliminary.

Source: European Aviation Safety Agency

Figure 6

or malfunction not related to the engine. That included accidents related to gearbox malfunction, the report says.

Another conspicuous category in helicopter accidents was CTOL, or collision with obstacles during takeoff and landing. The report said that referred to main or tail rotor collisions with objects on the ground.

The annual safety review includes, for the second year, a chapter on air traffic management (ATM). "The sources of the data, as well as the occurrence category definitions, differ from those of other chapters," the report says. "Instead of CICTT categories, in similar figures of this report, this chapter uses occurrence categories developed specifically for ATM since 2000."[5]

In 2011, the largest number of ATM-related accidents was in the category of GCOL, or collision with aircraft moving on the ground and a vehicle, person or obstruction. It also was the most common category for the years 2005–2011, except for "other."

The overall number of runway incursions reported has increased during 2002–2011 (Figure 6). "The rate of serious incidents (severity A) is, in 2011, at the same level as the previous year after it showed a slight increase over time," the report says. "The rate of major incidents (severity B) decreased until 2009, but the data for 2010 showed a considerable increase. However, preliminary 2011 data indicate a possible reverse, although at a higher level than 2009."

Notes

1. EASA. *Annual Safety Review 2011*. <bit.ly/N2JIDr>.
2. Accident and statistical information was provided to EASA by the International Civil Aviation Organization.
3. Accidents in this category involved aircraft with a certificated takeoff weight over 2,250 kg (4,960 lb).
4. As the alternative to EASA MS operators, the report uses the term "third country operators," which apparently includes operators in other regions worldwide. We have adopted the term "non-MS" in preference to "third country" for clarity.
5. The ATM chapter data are sourced from the Eurocontrol Annual Summary Template reporting system. Data for 2011 are preliminary.

Weather in Context

Weather-information systems should be adaptable to the needs of individual flights.

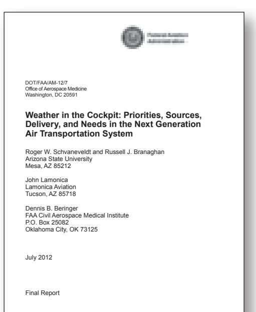
BY RICK DARBY

REPORTS

Need to Know

Weather in the Cockpit: Priorities, Sources, Delivery, and Needs in the Next Generation Air Transport System

Schvaneveldt, Roger W.; Branaghan, Russell J.; Lamonica, John; Beringer, Dennis B. U.S Federal Aviation Administration (FAA) Civil Aerospace Medical Institute (CAMI). DOT/FAA/AM-12/7. July 2012. 33 pp. Figures, tables, references.


DOT/FAA/AM-12/7
Office of Aerospace Medicine
Washington, DC 20591

Weather in the Cockpit: Priorities, Sources, Delivery, and Needs in the Next Generation Air Transportation System

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July 2012

Final Report

The FAA Next Generation Air Transportation System (NextGen) is most often discussed in connection with changes in navigation technology. This report looks at another side of NextGen: weather information and its accessibility.

"From a human factors perspective, it is vital that pilots and controllers have the right information at the right time," the report says. "These goals, along with a concern over the potential problem of 'too much information,' lead to the suggestion that weather information systems should provide information focused on the safety of flight. The information should be presented in a meaningfully integrated way, reflecting all types of weather and all sources of weather information."

The research project that led to the report was intended to document pilot needs for weather information, focusing on general aviation and scheduled air carriers, in preparation for the switch to NextGen. When NextGen is fully operational, pilots will not only be able to perform point-to-point navigation without being limited to the legacy airways, but "will be responsible for obtaining information about weather and adjusting their flight to accommodate these factors."

Providing near-real-time weather information to pilots and crews is known as "weather in the cockpit," the report says, quoting the FAA's concept: "Weather in the cockpit means we employ the aircraft as a node in the National Airspace System's communications, navigation and surveillance network. [It also means we] enable flight deck weather information technologies that allow pilots and aircrews to engage in shared situational awareness and shared responsibilities with controllers, dispatchers, flight service station specialists and others, pertaining to preflight, en route and post-flight aviation safety decisions involving weather."

Combining a review of the research literature and a new detailed study, the report's authors analyze weather hazards and their degree of priority at the sharp end. "The pilot's workload would be lighter if the information provided led directly to decisions rather than requiring interpretation and inference to arrive at the needed information," the report says.

"Ideally, weather information systems might directly indicate critical information, e.g., the location and severity of thunderstorms," the report says. "In general, the priority of weather factors together with the state of the factors in the world determines the criticality of each factor. For example, density altitude is particularly important when the temperature is high or, more generally, when the density altitude becomes too high for safe operations. Thus, density altitude only needs to be displayed when it is above the safety-critical level."

Context-specific weather information would also take into account the phase of flight. In an adaptation of earlier research by Beringer and Schvaneveldt, weather factors are cross-tabulated by the phases — planning, departure, cruise and arrival — to calculate numerical priorities, with 1 the highest.

"Aside from the planning phase, which is usually accomplished without severe time pressure, pilot concern with weather is greatest in the arrival phase (20 factors with priority 1), followed by departure (13 factors with priority 1)," the report says. "These are the times during flight when workload is highest."

Consequently, the report advocates a "need to know" criterion for information display.

"Too much information can make it difficult to locate safety-critical information," the report says. "An exhaustive presentation of all the weather from every possible source (including other aircraft) can easily hinder the ability to locate the information relevant to a particular flight at a particular time. … What is needed are integrated systems providing safety-critical information without requiring a search."

The report recommends a combination of ground-based systems that aggregate and summarize multi-sourced information, and on-board systems capable of filtering what is relevant to the flight and presenting it to pilots with just enough detail.

Present sources of U.S. weather information are plentiful, perhaps overwhelming. Many of them originate with the National Weather Service (NWS), which maintains national and regional centers and about 122 local weather forecast offices.

Some of the NWS product is tailored for aviation: "The Aviation Digital Data Service provides aviation-related weather [data]. Each weather forecast office issues terminal aerodrome forecasts for one or more airports in their jurisdiction. … Twenty-one NWS Center Weather Service Units are collocated with the FAA ARTCCs [air route traffic control centers]. Their main responsibility is to provide up-to-the-minute weather information and briefings to the traffic management units and control-room supervisors."

The NWS also operates a center that issues AIRMETS (airmen's meteorological information) and SIGMETS (significant meteorological information, such as notification of thunderstorms and turbulence).

"The technology for delivering weather information is in an extremely active state of development today," the report says. "New systems, both installed and portable, are appearing frequently." The primary delivery systems pilots can use include the Internet, including the NWS website; VHF (very high frequency) broadcast, which carries controller-to-pilot communication and automated systems such as ATIS (automatic terminal information service); and satellite, such as AFIS (automated flight information system), Sirius Satellite Radio and XM Satellite Radio.

The commercial vendors that have been getting into the picture "often provide enhanced means of presenting the information in graphical form." However, commercial

'Too much information can make it difficult to locate safety-critical information.'

sources risk overlapping NWS-provided data, the report says.

"With uncertainty over the limits to what the NWS will provide in the future, commercial innovation may be curtailed," the report says. "There is something of a quandary here because it is vital that the government does what it can to promote the safety and welfare of its citizens, which suggests that the NWS provide information in the most effective forms. At the same time, innovation in the commercial sector should be encouraged." Information systems designed around the needs of individual flights are more likely to be developed by private enterprise than by the government, the report says.

In addition, "many avionics systems now provide weather information and some rudimentary means of integrating the disparate types of information, such as overlays, picture-in-picture, split-screen views and zooming capabilities," the report says. But it asks: "Do these avionics systems provide the information the pilots need, when they need it, in a useful way?"

The researchers reviewed several weather-related avionics products: the Garmin G1000 (installed in the cockpit instrument panel) and 396/496 (portable); the Honeywell-Bendix/King AV8OR (portable); L3's SmartDeck (installed); and WxWorx (portable, for a laptop computer or tablet). These products, the report says, are designed primarily for U.S. Federal Aviation Regulations Part 91 aircraft; Part 121 carriers tend to use custom equipment. But the criteria for evaluating weather information systems could be valid for any applications. The criteria were:

- "Weather is customized by phase of flight — Different weather information should be presented or highlighted according to the phase of flight;
- "Weather source information is integrated and summarized — Weather from multiple sources should be integrated to provide the big picture, yet still enable zooming in for additional information;
- "Weather information is presented at the appropriate level of detail — Pilots should not be overwhelmed by the volume of weather information presented;
- "Hazard information is provided on an exception-only basis — Hazards should be highlighted, whereas non-hazardous weather should not be focused on unduly;
- "Weather presentation is tied to 4-D flight profile [the flight path in three-dimensional space plus time]. … Often it is more useful for the pilot to know not what the weather is like at a particular location now, but what it will be like when they get there";
- "Probabilistic forecasts are provided and the level of uncertainty of the information is indicated; [and,]
- "Recommendations are provided about how to avoid bad weather."

'Weather from multiple sources should be integrated to provide the big picture, yet still enable zooming in for additional information.'

All this can be summed up as giving the pilots the *gist* of the situation, the report says. At any point on the 4-D flight profile, the pilot needs to be able to quickly answer questions such as these: "How dangerous is the weather?" "Why is it dangerous?" "How long will the danger continue?" "What should I do about it?"

The report provides details of the researchers' analysis of the five weather-information systems. *All* the systems scored zero on two criteria, "suggestions provided to avoid bad weather" and "probabilistic information."

The report says, "Most of the products do a good job of emphasizing hazards, indicating storms in red and so on; however, they do not tie it well to a 4-D profile. Though they provide current weather along a three-dimensional profile, they fail to provide current and forecast information along a four-dimensional profile. … None of the systems provide overt suggestions for avoiding weather hazards (i.e., possible rerouting). ARTCC controllers have historically supplied this suggestion of an alternate route, and they are not likely to continue doing so during NextGen."

BOOKS

The Mind-Body Problem

The Handbook of Operator Fatigue

Matthews, Gerald; Desmond, Paula A.; Neubauer, Catherine; Hancock, P.A. (editors). Farnham, Surrey, England, and Burlington, Vermont, U.S.: Ashgate, 2012. 527 pp. Figures, tables, references, index.

While this book was being compiled, the U.S. Federal Aviation Administration was investigating three cases of air traffic controllers falling asleep on duty between January and April 2011. A university sleep specialist was quoted in a newspaper article suggesting that controllers on night shifts should be allowed to take brief restorative naps. The same article quoted a U.S. senator: "I think that is totally bogus. There are so many professions that have to work long hours."

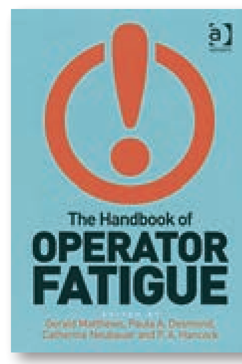
The editors comment, "Clearly, science and society do not always see the problem in the same way." Their book is a comprehensive selection of papers about how science sees the subject.

The editors describe fatigue as "one of the most puzzling enigmas in all of psychology." Superficially, fatigue seems like a simple concept. We all know what fatigue feels like and the behavioral tendencies it encourages: subpar task performance, irritability, forgetfulness and loss of enthusiasm.

Yet, the editors say, "Many experimental studies show the detrimental effects of fatigue, but sometimes individuals who appear to be highly fatigued continue to show normal levels of performance. The earliest systematic investigations showed that subjective feelings of fatigue do not necessarily correspond to objective performance loss. It is also challenging to identify the neural and psychological processes that mandate the impact of fatigue on performance. Fatigue, in part, reflects fundamental changes in neural function, but also depends critically on an operator's interest in the task and the high-level cognitive processes that regulate motivation."

Nor are the causes of fatigue as obvious as one might think. Not getting enough sleep makes us tired and craving rest or sleep — one definition of fatigue — but other sources can pitch in.

"A second source derives from the 24-hour circadian cycle in wakefulness and alertness," the editors say. "While sleep loss and circadian rhythms are distinct influences on fatigue, they are increasingly studied together. … Models of this kind provide the basis for evaluating shift systems: night workers [such as pilots on 'backside of the clock' schedules] face the dual penalty of sleep deprivation alongside the loss of alertness driven by the circadian phase during which they are forced to be active."



Other sources of fatigue cited by the editors include tasks requiring sustained attention; monotonous and high-workload performance; compromised neural functioning caused by infection, sedative drugs or nutritional deficits; loud noise; uncomfortable temperatures; even poorly designed computer displays.

"Conversely, tasks that offer high levels of challenge and intrinsic interest can be highly fatigue-resistant," the editors say.

The papers published in *The Handbook of Operator Fatigue* are divided into eight sections: an introduction, "The Nature of Fatigue," "Assessment of Fatigue," "The Neuroscience of Fatigue," "Performance Effects of Sleep Loss and Circadian Rhythms," "Fatigue and Health," "Applied Contexts for Operator Fatigue," and "Operational Countermeasures."

Air Data Spikes Trigger Upset

More than 100 people aboard the A330 were injured during a pitch excursion.

BY MARK LACAGNINA

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

JETS

Rare Computer Fault Cited

Airbus A330-300. Substantial damage. Twelve serious injuries, 107 minor injuries.

The A330 was en route with 303 passengers and 12 crewmembers from Singapore to Perth, Western Australia, when it suddenly pitched nose-down. "At least 110 of the 303 passengers and nine of the 12 crewmembers were injured; 12 of the occupants were seriously injured, and another 39 received hospital medical treatment," said the report by the Australian Transport Safety Bureau (ATSB).

The accident occurred the morning of Oct. 7, 2008. The A330 was cruising at Flight Level (FL) 370 (approximately 37,000 ft) over the Indian Ocean, about 154 km (83 nm) west of Learmonth, on the coast of Western Australia, when "one of the aircraft's three air data inertial reference units (ADIRUs) started outputting intermittent, incorrect values (spikes) on all flight parameters to other aircraft systems," said the report, issued last December.

The no. 1 autopilot disengaged, and numerous warning and caution messages were generated. Most of the messages, including stall warnings and overspeed warnings, were false. The captain hand flew the aircraft briefly, then engaged the no. 2 autopilot.

"Two minutes later, in response to spikes in angle-of-attack (AOA) data, the aircraft flight control primary computers (FCPCs) commanded the aircraft to pitch down," the report said. "Although the pitch-down command lasted less than 2 seconds, the resulting forces were sufficient for almost all the unrestrained occupants to be thrown to the aircraft's ceiling. … There was significant damage to overhead fittings in the cabin."

A peak vertical acceleration of minus 0.80 g was recorded as the A330 descended 690 ft within 23 seconds. The captain applied sidestick control inputs to arrest the descent and return the aircraft to FL 370.

Less than three minutes later, the A330 again pitched nose-down. Apparently, no further injuries occurred during the second upset. "The flight crew described the event as being similar in nature to the first event but less severe," the report said. "The captain promptly applied back pressure on his sidestick to arrest the pitch-down movement." The aircraft descended 400 ft within 15 seconds before being returned to FL 370.

The malfunctioning ADIRU was identified and disengaged. "Due to the serious injuries and their assessment that there was potential for further pitch-downs, the [flight] crew diverted the flight to Learmonth … and declared a mayday to air traffic control," the report said. "The aircraft was landed as soon as operationally practicable" about 45 minutes after the upset.

The failure mode that triggered the upset was rare and likely began when the Northrop Grumman LTN-101 ADIRU's central processor "combined the data value from one parameter with the label for another parameter," the report said. "The exact mechanism that produced this problem could not be determined."

The resulting AOA spikes were 1.2 seconds apart, which coincidentally corresponded to the monitoring interval at which the FCPC temporarily retains, or memorizes, a previous value if a discrepancy is detected in the data generated by the ADIRUs. "The FCPC's AOA algorithm could not effectively manage a scenario where there were multiple spikes such that one triggered a memorisation period and another was present 1.2 seconds later," the report said. As a result, the second in each series of data spikes was accepted as valid, and the erroneously high AOA values prompted the pitch-down commands.

"There were only three known occasions of the failure mode in over 128 million hours of unit operation," the report said. "At the aircraft manufacturer's request, the ADIRU manufacturer has modified the LTN-101 ADIRU to improve its ability to detect data transmission failures."

In addition, Airbus redesigned the FCPC software algorithms "to prevent the same type of accident from occurring again," the report said. "The occurrence was the only known example where this design limitation led to a pitch-down in over 28 million flight hours on A330/A340 aircraft."

Corrosion Causes AC Power Loss

Boeing 757-200. No damage. No injuries.

The 757 was nearly three hours into a flight from England to Cyprus the morning of Sept. 7, 2011, when the flight crew observed indications that the left AC (alternating current) electrical bus and the left generator were off line, "along with multiple failures of flight instruments," said the U.K. Air Accident Investigation Branch (AAIB) report.

The crew completed the relevant quick reference handbook (QRH) procedure, which included resetting the left bus tie to bring the left generator back on line. This restored power to the left AC bus only momentarily, however. "The second power loss was associated with a thin haze of smoke and a strong smell of electrical burning in the flight deck," the report said. "The crew responded by donning their oxygen masks and [smoke] goggles."

The crew declared an emergency, initiated a descent from FL 390 and diverted the flight to Kavala, Greece, 38 nm (70 km) south.

The auxiliary power unit (APU) was started, but it provided power to the left AC bus for only 17 seconds. "No additional attempts to supply power to the left AC bus were made, and the aircraft [was] landed without further incident," the report said. "During the final approach, it was apparent that the fumes had dissipated, and the [219] passengers were disembarked normally."

The AAIB classified the event as a serious incident. Investigators found that a similar loss of power to the left AC bus had occurred 13 flights earlier. Troubleshooting after that incident was inconclusive. "The left integrated drive generator (IDG) was disconnected, and the defect was transferred to the list of deferred defects in the aircraft's technical log," the report said.

Maintenance personnel subsequently performed wiring-continuity checks and replaced the left generator control unit, the bus power control unit, the circuit breakers for the left generator and the left bus tie. "None of these actions were successful in resolving the defect," the report said.

Troubleshooting on the morning of the serious incident revealed an open circuit between a connector at the left engine pylon and the left IDG. The wiring loom was replaced, an operational check was performed, and the left AC generating system was declared serviceable.

After the emergency landing in Greece, built-in test equipment indicated that the loads demanded by the left AC bus were not in balance with the left IDG's current output. The left generator control unit and bus power control unit again were replaced. "The aircraft's engines were ground-run for 45 minutes, during which the left and right AC power-generation systems operated correctly, and no electrical burning or smoke was apparent," the report said.

About 2 1/2 hours into the subsequent ferry flight back to England, however, the left

The crew declared an emergency, initiated a descent from FL 390 and diverted the flight.

AC bus again lost power. This time, the bus received power from the APU for the remainder of the flight.

Troubleshooting again revealed indications of an open circuit between the pylon bulkhead connector and the left IDG. The connector's backshell was found loose — a likely result of threads being stripped during previous over-tightening of the connector. "This defect allowed moisture to enter the connector, causing corrosion of the connector's internal components" and intermittent contact between two crimp terminals and their associated wiring, the report said. The connector was replaced, and no further problems with the left AC generating system had occurred when the report was published in June 2012.

Maintenance technicians found that an elevator control cable had broken and jammed the autopilot servo.

Broken Cable Blocks Elevator

Bombardier CRJ700. Minor damage. No injuries.

The CRJ was climbing to cruise altitude during a flight from Bilbao, Spain, to Paris on July 12, 2010, when the flight crew noticed that the autopilot was unable to maintain the selected vertical mode and that an "AP PITCH TRIM" caution message was being displayed.

"The crew applied the corresponding checklist, which, after another unsuccessful attempt at [autopilot] engagement, led the crew to resume manual control," said the report by the French Bureau d'Enquêtes et d'Analyses.

The CRJ was landed without further incident at Charles de Gaulle Airport. "At the stopover, the maintenance service took a variety of steps relating to the problem encountered," the report said. "No malfunctions were found. Specifically, the elevator servo operational test was performed three times, and free clearance of the controls was checked."

The aircraft was released for service, and the crew began the return flight to Bilbao with 65 passengers and four crewmembers aboard. "During this leg, the same problem occurred: the [autopilot] could not hold the vertical modes and the 'AP PITCH TRIM' caution message triggered," the report said. "The flight continued under manual control."

The pilot flying noticed that flaring the CRJ to land at Bilbao Airport required greater effort than usual, but the touchdown was normal. "While taxiing, [the crew] noticed that the elevator control blocked at halfway pitch-up," the report said. "The following flight was canceled."

Maintenance technicians found that an elevator control cable had broken and jammed the autopilot servo. Recorded flight data indicated that the cable had snapped during a coupled approach to Bilbao Airport that was conducted by another flight crew before the incident flight to Paris. The other crew had completed the approach manually after a pitch excursion occurred at 1,200 ft. "This crew did not attach any great importance to this behaviour and did not make a note of it in the logbook or mention it to the [incident] crew," the report said.

Investigators determined that the elevator control cable likely had been installed incorrectly when the vertical stabilizer was assembled by a subcontractor during the manufacture of the aircraft.

"The investigation was not able to determine with certainty the link between the appearance of the 'AP PITCH TRIM' message and the system condition during the flight," the report said. "However, it is highly probable that the caution message was linked to the trim movement by the autopilot for a period that was longer than the threshold of the caution message trigger."

Turbulence Tosses Cabin Crew

Boeing 737-600. No damage. One serious injury.

The 737 was in visual meteorological conditions (VMC) at 11,000 ft, but there were cumulonimbus clouds ahead on the approach to London Heathrow Airport the afternoon of Aug. 23, 2010. The flight crew activated the seat belt signs and performed a pre-landing public address (PA) system announcement, describing the weather and the possibility of turbulence.

"The cabin crew were securing the cabin for landing and were not restrained at the time," the AAIB report said. "Three of the four cabin crewmembers, including the purser, were not aware of the weather-related comments in the PA announcement."

The aircraft encountered light turbulence as the flight crew altered course to circumnavigate an area of precipitation displayed on the weather radar. The 737 appeared to be clear of the area when it briefly encountered severe turbulence.

"One of the cabin crew managed to sit in an empty seat but was not able to fasten the seat belt before being thrown into the air and hitting the cabin roof," the report said. "Despite this, she was uninjured.

"Another cabin crewmember, seated on a crew seat in the rear galley and making a PA [announcement] to the passengers, was also thrown into the air. She landed back on the seat and badly injured her back. The other cabin crewmembers were uninjured and attended to their injured colleague, who was in considerable pain and had to remain on the galley floor for the rest of the flight."

None of the 79 passengers was injured. After the aircraft was landed without further incident, the injured crewmember was taken by ambulance to a hospital, where she was treated for spinal injuries.

The airline required cabin crewmembers to be seated, with their seat belts fastened, when the seat belt signs are on, unless they are performing safety-related duties. "It was intended that the cabin crew should be made aware of expected en route turbulence by the pilots, although the method of doing so was not specified," the report said.

The airline also required that seat belt signs be illuminated 10 minutes before the expected landing time in all conditions. "Illumination of the seat belt sign, during the approach but because of turbulence, might therefore be misunderstood by the cabin crew without clarification from the flight deck," the report said.

An investigation by the airline's safety department identified three similar accidents in which cabin crewmembers had suffered turbulence-related injuries. "In all cases, the cabin seat belt sign had been illuminated and the crew were unsecured, preparing the aircraft for landing."

Among changes affected by the airline were a revision of communications between flight and cabin crewmembers to clarify when the cabin is secure and when both the cabin and the cabin crew are secured, and introduction of specific announcements to passengers, requesting that they help secure the cabin when cabin crewmembers are seated because of the possibility or presence of turbulence.

Loading Bridge Damages Fuselage

Boeing 757-200. Substantial damage. No injuries.

The airplane was being prepared for a flight from San Francisco International Airport the afternoon of June 11, 2011. After the 188 passengers were boarded and the cabin door was closed, the operator of the passenger loading bridge (jetway) retracted the canopy and awaited a hand signal from a ramp worker to retract the bridge itself.

"The ramp employee responsible for the airplane pushback reported that he heard the [loading bridge] bell ringing for about one minute, which he thought was enough time for the jetway to be cleared from the airplane," the U.S. National Transportation Safety Board (NTSB) report said.

According to the report, however, the bridge operator had not begun to retract the bridge, and the ramp worker did not signal the bridge operator before beginning the pushback. The 757 struck the bridge, and a 38- by 8.5-in (97- by 21.6-cm) hole was torn in the fuselage. Frame assemblies and stringers also were damaged.

The report said that the probable cause of the accident was the ramp worker's "failure to visually verify the position of the jetway before beginning the airplane pushback."

TURBOPROPS

Distracted Below Glideslope

Bombardier Q400. No damage. No injuries.

The flight crew was receiving radar vectors from air traffic control (ATC) for the instrument landing system (ILS) approach to Runway 26 at Exeter (England) Airport the afternoon of Sept. 11, 2010, when they observed a message on the engine and system integrated display (ED) that one of the aircraft's two input-output processors (IOPs) had failed.

At the time, the Q400 was descending through 3,300 ft to an assigned altitude of 2,600 ft, the minimum safe altitude for the sector. The autopilot was maintaining the selected heading and a vertical speed of 500 fpm; the altitude-hold and approach modes were armed, and 2,600 ft had been entered in the altitude selector.

The aircraft operator told investigators that IOP failures were common in its Q400 fleet.

The IOPs are part of the flight data processing system, which acquires data from various aircraft systems and sensors, and routes the data to other systems. The failure of the no. 1 IOP caused the indicated designations, or "bugs," for the approach speeds and minimum descent altitude on the commander's primary flight display (PFD) to be replaced by white dashes. There was no change to the copilot's PFD.

"There are no flight crew procedures for ED advisory messages relating to avionics failures such as an IOP failure, but maintenance action is required prior to dispatch of the next flight," the AAIB report said.

Nevertheless, the commander attempted to restore the bugs on his PFD by selecting the no. 2 air data computer (ADC). This had no effect, so he switched back to the no. 1 ADC. "The commander realised that by changing ADC selection, the approach mode had become disarmed, so … he also re-armed the approach mode," the report said. The altitude-select mode remained disarmed.

The commander then transferred control to the copilot. The report said that both pilots were distracted by continuing attempts to resolve the IOP failure when the aircraft's enhanced ground-proximity warning system (EGPWS) generated a "CAUTION TERRAIN" warning. At the time, the aircraft was descending through 1,759 ft, or 1,066 ft above ground level (AGL), in VMC. Seconds later, the EGPWS generated a "TERRAIN, TERRAIN, PULL UP" warning.

The copilot disengaged the autopilot, increased power to about 80 percent and began a shallow climb. About the same time, ATC asked the crew to confirm that they were descending on the ILS glideslope. The commander replied that they had experienced an instrument failure and were climbing to capture the glideslope.

Recorded flight data showed that the Q400 had descended to 1,417 ft (700 ft AGL) before transitioning to a climb and that it captured the glideslope at 2,200 ft. The aircraft was landed without further incident, and none of the 49 passengers or four crewmembers was injured.

The aircraft operator told investigators that IOP failures were common in its Q400 fleet. "In the majority of cases, the operator's experience is that resetting the relevant circuit breaker or re-installing the unit appears to solve the problem, and the unit remains in service," the report said. A number of IOPs found to be faulty and sent to the vendor for repair were returned with the notation "no fault found" but continued to cause problems when reinstalled in the aircraft.

The IOP that failed in the incident aircraft had failed several times previously, but the aircraft was returned to service each time after no faults were found during maintenance troubleshooting and testing showed normal operation. After the incident, the IOP was examined by the manufacturer under AAIB's supervision. X-ray tests revealed that the intermittent failures had resulted from power supply disruptions caused by cracked solder on two pins in a transformer.

Based on the findings of the investigation, the AAIB recommended that Thales Aerospace, which manufactures the IOPs, review its test procedures to improve the detection of power-supply failures, and that Bombardier Aerospace publish information in the Q400 airplane flight manual and QRH about the effects of IOP failures on the operation of the aircraft.

Gear Retracts During RTO

Piaggio P-180 Avanti. Substantial damage. No injuries.

The flight crew was preparing for a post-maintenance functional check flight from St. Petersburg-Clearwater (Florida, U.S.) International Airport the afternoon of Sept. 12, 2010, following replacement of an elevator.

Several other maintenance inspections had been performed, including an operational test of the Avanti's landing gear.

"The pilot-in-command (PIC) later stated that he could not recall observing the position of the landing gear selector during his preflight inspection but reported that he would have checked it," the NTSB report said.

As the PIC rotated the airplane for takeoff, he heard a sound similar to a tire bursting. At the same time, the cockpit voice recorder "recorded a sound consistent with the hydraulic power pack motor operating for 2 seconds, beginning gear retraction," the report said.

The PIC decided to conduct a rejected takeoff (RTO). "He reported that, as he began to retard the throttles and set the nose landing gear on the runway, he realized that the airplane had descended below the normal wheels-on-ground sight line and that the belly of the aircraft had begun to scrape the runway," the report said. "The airplane then slid for 1,000 ft [305 m] before coming to rest upright on the runway with each of the landing gear retracted."

A person who helped recover the airplane told investigators that he saw the landing gear selector in the "UP" position. After the Avanti was raised and the landing gear extended, the airplane was towed to the ramp. "Postaccident testing revealed no preaccident mechanical failures or malfunctions of the landing gear or landing gear position and warning system," the report said. "The investigation was not able to determine who placed the landing gear selector in the 'UP' position."

PISTON AIRPLANES

Magneto Fault Forces Landing

Piper Navajo. Substantial damage. Two minor injuries.

As part of his preflight preparations, the pilot checked the engine magnetos and found no anomalies before departing with three passengers from Red Lake, Ontario, Canada, for a company flight to Kashechewan the morning of Sept. 10, 2010.

After an en route stop in Pickle Lake to refuel, the Navajo was at 9,500 ft and halfway to Kashechewan when the pilot heard a "brief rumble" from the left engine, said the report by the Transportation Safety Board of Canada (TSB). "This was accompanied by a drop in cylinder head and exhaust gas temperature indications on the no. 3 cylinder."

The pilot decided to return to Pickle Lake and descended to 8,500 ft. When the flight encountered broken clouds, the pilot descended to 4,500 ft, or about 3,300 ft AGL, to remain in VMC. Turbulence was encountered at that altitude.

Shortly thereafter, the pilot heard a series of loud bangs and other noises emanating from the left engine. "In order to preclude catastrophic failure, the pilot shut the engine down … but [initially] did not increase power on the operating engine," the report said.

Airspeed decreased to 100 kt, and the aircraft began to descend. The pilot increased power on the right engine from 30 in to 35 in manifold pressure and propeller speed from 2,200 to 2,300 rpm. He also decreased airspeed to 90 kt, the Navajo's best single-engine rate of climb speed, to arrest the descent.

"Initially, the aircraft was able to maintain altitude, but the airspeed decreased to 83 kt, at which point the aircraft began to descend again," the report said. "Power was increased to 38 in manifold pressure, but in the turbulent conditions, the airspeed fluctuated, directional control became increasingly difficult, and occasional stall buffeting was encountered."

The pilot decided to conduct an emergency landing in a swampy area 30 nm (56 km) east of Pickle Lake. The Navajo was substantially damaged when it struck trees. The pilot and one passenger sustained minor injuries; the other passengers escaped injury.

The engine malfunction was traced to a loose distributor block bushing on the left magneto. The report noted that the operator of the Navajo had not complied with provisions of Teledyne Continental Service Bulletin 643B, which calls in part for checking the security of the bushing every 500 hours.

Disorientation Suspected in CFIT

Cessna 310R. Destroyed. One fatality.

About 10 minutes after deplaning five charter passengers at Bathurst Island, Northern Territory, Australia, the night of Feb. 5, 2011, the pilot departed from Runway 33 for the return flight to Darwin. "Shortly after takeoff, a number of witnesses reported hearing a loud noise or seeing a light from the direction of departure," the ATSB report said. "[The aircraft] was found to have impacted terrain approximately 1 km [0.5 nm] from the upwind end of Runway 33."

Noting that investigators found no technical deficiencies that might have contributed to the accident, the report concluded that the crash had involved controlled flight into terrain (CFIT), likely after the pilot experienced somatogravic illusion, a physiological phenomenon that can cause a pilot to mistake the sensation of acceleration as the aircraft pitching nose-up and then to react by lowering the nose. The resulting increase in acceleration compounds the spatial disorientation caused by the illusion.

"The location of the wreckage, together with the dark night conditions and the relatively light load of the aircraft suggested that it was likely that the pilot was influenced by the effects of somatogravic illusion following takeoff," the report said.

The report said that the accident highlights the importance of being aware of the conditions in which somatogravic illusion can occur and of scanning the instruments, especially the attitude indicator, to verify the aircraft's attitude and performance when flying in such conditions.

HELICOPTERS

Rain Douses Visual References

Eurocopter AS350 B2. Substantial damage. Two serious injuries, two minor injuries.

The pilot delayed departure from a work site 85 nm (157 km) northwest of Chibougamau, Québec, Canada, until a line of thunderstorms passed through the area the afternoon of Sept. 1, 2010. "When the helicopter took off … the sky had cleared and the rain had stopped," the TSB report said. "As weather conditions were VMC at the work site, the pilot did not think it necessary to call for a weather update. The return flight to Chibougamau was expected to take approximately 50 minutes."

The helicopter was at 1,000 ft AGL when it encountered heavy rain and thunderstorms about 20 nm (37 km) from the destination. Shortly thereafter, visibility decreased to about 1 mi (1,600 m), and the pilot decided to conduct a precautionary landing on a gravel road.

"On final approach, while approximately 70 ft AGL at low airspeed over trees, the pilot lost all visual reference with the terrain due to heavy rain," the report said. "While in a hover over the trees, the helicopter descended without the pilot realizing it and struck the trees, then the ground, coming to rest on its left side." The pilot and the front-seat passenger were seriously injured; the other two passengers sustained minor injuries.

Carb Heat, Mixture Controls Confused

Robinson R22. Substantial damage. No injuries.

Two certificated rotorcraft pilots were conducting a ferry flight the morning of Aug. 11, 2011. The pilot flying held an airline transport pilot license and had 2,365 flight hours, including 1,177 hours in type. The other pilot held a private pilot license and had logged 54 of his 220 flight hours in R22s.

The helicopter was on approach for a refueling stop in Titusville, Florida, U.S., when the pilot flying asked the other pilot to apply carburetor heat. "The private pilot inadvertently pulled out the engine mixture control with the mixture control guard, which resulted in an immediate total loss of engine power," the NTSB report said. "The helicopter was at an altitude between 300 and 400 ft when the [pilot flying] entered an autorotation while the private pilot attempted to restart the engine."

The engine did not restart before the helicopter struck trees and a fence, and flipped over. The R22's airframe and main rotor and tail rotor drive systems were damaged on impact, but both pilots escaped injury.

Preliminary Reports, July 2012

<table>
<tr><th>Date</th><th>Location</th><th>Aircraft Type</th><th>Aircraft Damage</th><th>Injuries</th></tr>
<tr><td>July 1</td><td>Edgemont, South Dakota, U.S.</td><td>Lockheed C-130H</td><td>destroyed</td><td>4 fatal, 2 serious</td></tr>
<tr><td colspan="5">The C-130 air tanker, operated by the U.S. Air Force, was engaged in wildfire suppression operations when it crashed under unknown circumstances.</td></tr>
<tr><td>July 3</td><td>Olancho Province, Honduras</td><td>Piper Cheyenne II</td><td>destroyed</td><td>1 fatal, 1 serious</td></tr>
<tr><td colspan="5">The pilot was killed when the Cheyenne crashed under unknown circumstances.</td></tr>
<tr><td>July 4</td><td>Buenos Aires, Argentina</td><td>Rockwell Sabreliner 75A</td><td>substantial</td><td>9 NA</td></tr>
<tr><td colspan="5">The Sabreliner’s left main gear collapsed on landing at El Palomar Airport. No fatalities were reported.</td></tr>
<tr><td>July 4</td><td>Tallahassee, Florida, U.S.</td><td>Robinson R44</td><td>substantial</td><td>1 none</td></tr>
<tr><td colspan="5">Night visual meteorological conditions prevailed when the pilot inadvertently initiated a descent while reaching for the circuit breaker box under his seat in response to the illumination of the clutch actuator warning light. The pilot heard the low-rotor-speed warning horn when he raised the collective control, and the R44 continued descending until it struck a lake.</td></tr>
<tr><td>July 6</td><td>Espinosa, Brazil</td><td>Embraer 820C Navajo</td><td>destroyed</td><td>1 fatal, 2 minor</td></tr>
<tr><td colspan="5">The pilot was killed during a forced landing in a densely wooded area after both engines lost power during a low-altitude survey flight.</td></tr>
<tr><td>July 7</td><td>Karnack, Texas, U.S.</td><td>Beech E90 King Air</td><td>substantial</td><td>1 fatal</td></tr>
<tr><td colspan="5">The King Air was on a night visual flight rules positioning flight at 14,500 ft when the pilot reported to air traffic control that he had encountered heavy precipitation. The airplane was in a right turn and descending when radar contact was lost. The wings and stabilizers apparently separated from the airplane before it struck terrain. Residents reported a severe thunderstorm in the area at the time of the accident.</td></tr>
<tr><td>July 9</td><td>São Paulo, Brazil</td><td>Cessna 208 Caravan</td><td>substantial</td><td>1 fatal, 2 serious, 1 none</td></tr>
<tr><td colspan="5">Three parachutists exited the Caravan at 14,000 ft. Then, as the pilot was conducting a descent, the aircraft’s left wing struck the parachutists, killing one and seriously injuring the other two.</td></tr>
<tr><td>July 9</td><td>Rangali Island, Maldives</td><td>de Havilland DHC-6-300</td><td>substantial</td><td>17 none</td></tr>
<tr><td colspan="5">The Twin Otter’s left float collapsed when it struck a dock while taxiing during a scheduled flight.</td></tr>
<tr><td>July 11</td><td>Broome, Western Australia, Australia</td><td>Piper Seneca</td><td>?</td><td>1 fatal</td></tr>
<tr><td colspan="5">The Seneca crashed under unknown circumstances shortly after departing for a night charter flight to Port Hedland.</td></tr>
<tr><td>July 11</td><td>São Paulo, Brazil</td><td>Robinson R22</td><td>destroyed</td><td>2 fatal</td></tr>
<tr><td colspan="5">Both pilots were killed when the helicopter crashed out of control into a building during a local flight.</td></tr>
<tr><td>July 12</td><td>Angra dos Reis, Brazil</td><td>Embraer 121A1 Xingu</td><td>destroyed</td><td>3 fatal</td></tr>
<tr><td colspan="5">Low visibility in heavy rain prevailed when the aircraft descended out of control into the sea on final approach.</td></tr>
<tr><td>July 12</td><td>Nouakchott, Mauritania</td><td>Harbin Yunshuji Y-12II</td><td>destroyed</td><td>7 fatal</td></tr>
<tr><td colspan="5">The twin-turboprop airplane, operated by the Mauritanian air force, crashed shortly after taking off for a flight to the Tasiast Gold Mine.</td></tr>
<tr><td>July 13</td><td>Nice, France</td><td>Gulfstream G-IV</td><td>destroyed</td><td>3 fatal</td></tr>
<tr><td colspan="5">The G-IV was on a positioning flight from Côte d’Azur Airport when it veered off the left side of Runway 13 at Le Castellet Airport and struck trees.</td></tr>
<tr><td>July 20</td><td>Kampong Triso, Malaysia</td><td>Eurocopter EC120-B</td><td>NA</td><td>3 fatal, 1 none</td></tr>
<tr><td colspan="5">The helicopter was ditched in a river under unknown circumstances. All four occupants survived the ditching, but the three passengers subsequently drowned.</td></tr>
<tr><td>July 22</td><td>Pushchino, Russia</td><td>Let 410UVP-E3</td><td>substantial</td><td>2 NA</td></tr>
<tr><td colspan="5">Both pilots were injured when the aircraft veered off the runway after the nose landing gear collapsed on touchdown.</td></tr>
<tr><td>July 26</td><td>Sedona, Arizona, U.S.</td><td>Beech B60 Duke</td><td>substantial</td><td>3 fatal</td></tr>
<tr><td colspan="5">Witnesses said that the Duke experienced engine anomalies before overrunning the runway on takeoff and crashing in a ravine.</td></tr>
<tr><td>July 28</td><td>Juiz de Fora, Brazil</td><td>Beech B200 King Air</td><td>destroyed</td><td>8 fatal</td></tr>
<tr><td colspan="5">The King Air struck power lines and trees on final approach in dense fog.</td></tr>
</table>

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.

Selected Smoke, Fire and Fumes Events, May–July 2012

Date	Flight Phase	Airport	Classification	Subclassification	Model	Operator
May 3	Cruise	—	Air distribution fan	Smoke	Boeing 747	Atlas Air
A burning smoke odor was noticed in the cabin area for approximately 10 minutes. Shortly thereafter, the engine indicating and crew alerting system status message for the lower left recirculation fan indicated a failure, the circuit breaker for the recirculation fan tripped and the odor dissipated. The crew consulted the quick reference handbook and continued with the flight. After landing, maintenance inspected the lower recirculation fan, found it inoperative and replaced it.						
May 4	Cruise	—	Equipment/furnishings wiring	Smoke	Boeing 757	Continental Airlines
Heavy smoke and an acrid odor appeared around forward passenger seats. When electrical power was shut off, the smoke dissipated. The flight was diverted. A "smoke in the cabin" questionnaire was completed. Maintenance found a passenger's cell phone jammed on the seat track.						
May 14	Cruise		Rate of climb indicator	Smoke	Bombardier DHC-8	Henson Aviation
Smoke was detected in the cockpit during flight. The pilots performed the emergency checklist. The smoke did not dissipate. The pilots declared an emergency and the aircraft was landed normally. Maintenance found the captain's instantaneous vertical speed indicator (IVSI) inoperative and the screen blank. The IVSI was replaced.						
May 14	Cruise	Palm Springs, California	Auxiliary power unit core engine	Smoke	McDonnell Douglas DC-9	American Airlines
The flight attendants reported odor and smoke in the cabin. The pilots declared an emergency and the flight returned to Palm Springs and landed without incident. The aircraft was removed from service. Maintenance placarded the auxiliary power unit (APU) and accomplished a pack burn. The APU was replaced and a system ground check showed normal operation.						
May 15	Descent	—	Exterior lighting	Smoke	Boeing 717	Southwest Airlines
During arrival, a check captain pushed in the switch for the left ground floodlight, and smoke started coming out from behind the switch. Maintenance found that the left ground floor circuit breaker had tripped. They removed and replaced the switch according to the maintenance manual.						
May 19	Cruise	—	Data transmission auto call	Smoke	Embraer EMB-190	JetBlue Airways
Smoke came out of the cockpit printer in flight. It appeared that jammed paper was smoldering. Maintenance performed an inspection and positively identified the source of the smoke and burning odor as an internal printer component. The printer was removed and replaced. An operational check was normal.						
May 24	Cruise	—	Passenger compartment lighting	Smoke	Embraer EMB-145LR	Atlantic Southeast Airlines
Flight attendants reported smoke in the cabin near a forward row and the galley coming from ceiling panels. The aircraft returned to the departure airport where it was landed without incident. Maintenance inspected the aircraft and found the forward galley light burned out, with no other evidence of burns or damage. They replaced the forward galley light bulb and operationally tested it, noting no defects. The aircraft was approved for return to service.						
June 4	Descent	—	Air distribution system	Smoke	Bombardier CL-600	Delta Air Lines
Smoke was seen in the flight deck and cabin during final approach. Maintenance inspected the aircraft for evidence of the source of the smoke and found ceiling lights at forward rows showing signs of overheating. Both air conditioning packs were run isolated and together on each engine bleed source. No evidence of smoke was found.						
June 4	Climb	—	Engine	Fluid loss, smoke	Embraer EMB-145XR	Atlantic Southeast Airlines
The cabin crew reported smoke in the lavatory. The aircraft was returned to the departure airport and landed without incident. The engine was leaking; maintenance replaced the no. 2 engine.						
June 6	Climb	—	Passenger compartment lighting	Overheating, smoke	Bombardier CL-600	Atlantic Southeast Airlines
The cockpit filled with electrical fumes in flight. There was a consistent dispersion increase and decrease with the thrust levers. An emergency was declared, and the flight was diverted. Maintenance found the galley light ballast had overheated. They replaced the light ballast in accordance with the aircraft maintenance manual.						
June 11	Cruise	—	Cabin cooling system	Smoke	Airbus A319	Spirit Airlines
After liftoff, smoke was detected from ducts in the flight deck. Cabin crewmembers also saw smoke from outlets. No electronic centralized aircraft monitoring faults or smoke warnings were triggered. After the pilots selected pack no. 1 to "OFF," smoke dissipated in the flight deck and cabin. Pack no. 2 remained on for the entire flight. Maintenance accomplished an operational test of pack no. 1 in accordance with the aircraft maintenance manual. An overheat message was observed during troubleshooting.						
July 3	Climb	—	Air distribution fan	Smoke	Cessna 560XL	Executive Jet Aviation
After takeoff, climbing through 10,000 ft, the cockpit recirculation fan was selected on "HIGH." A strong odor of burning and melted plastic was noted. The fan was turned off, but the odor continued and seemed to get stronger. No smoke was noted. The copilot noted a rattling sound coming from the recirculation fan when it was on. Maintenance performed an engine run, with no noticeable odor of melted plastic in the cockpit or cabin. However, the cockpit recirculation fan had a defective bearing unit. Maintenance ordered new fan assembly and replaced the cockpit recirculation fan in accordance with the maintenance manual. An operational check was normal.						

Source: Safety Operating Systems and Inflight Warning Systems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