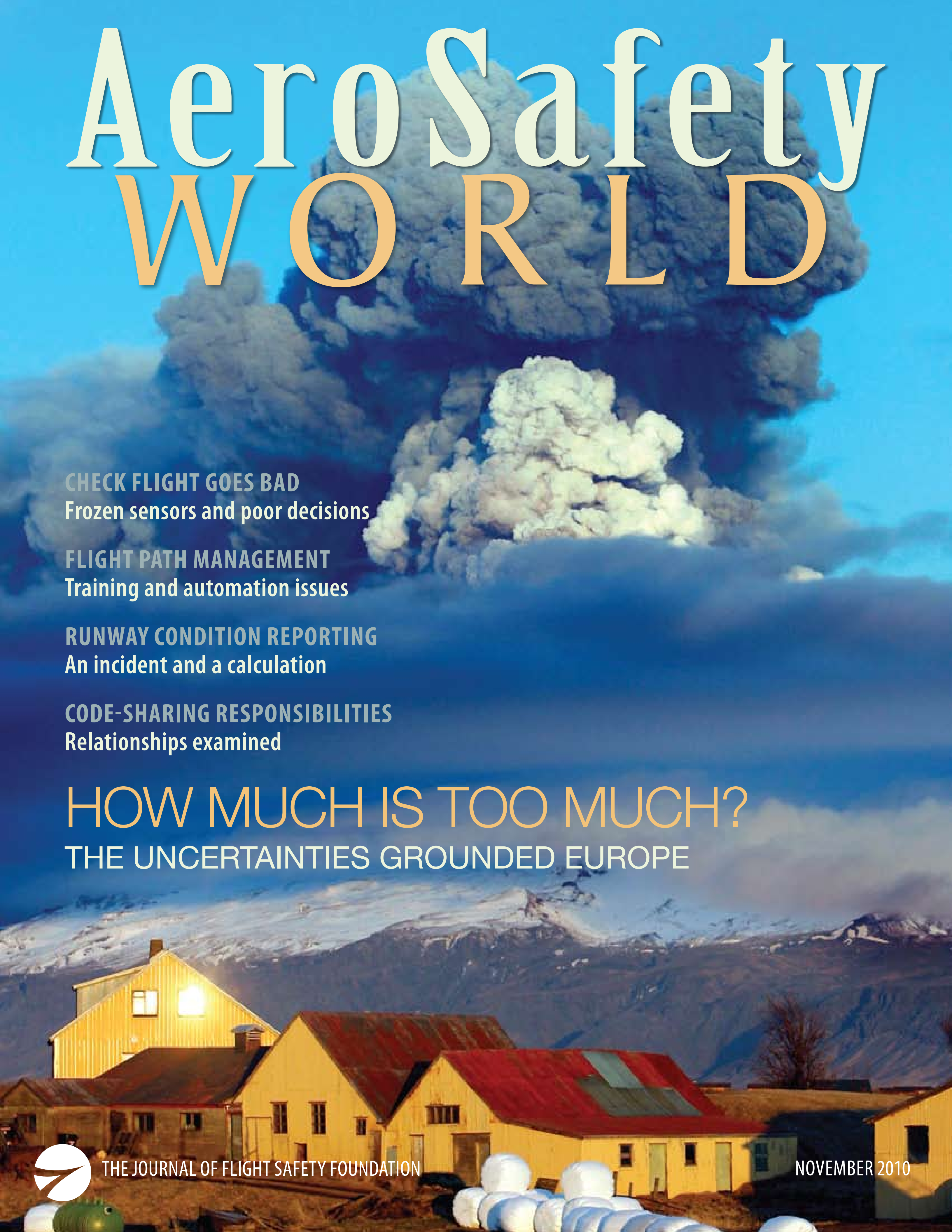
AeroSafety WORLD



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THE JOURNAL OF FLIGHT SAFETY FOUNDATION

NOVEMBER 2010


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NEW CHALLENGES
New Friends

This is my last column for 2010, so I thought I would relate some impressions from my last couple months of travel.

Let's start in Istanbul, Turkey, where I spoke at a conference hosted by Airports Council International Europe. Attitudes were upbeat, reflecting that region's improving economy. Things also were upbeat in the safety arena, as several airport operators showed a real sense of responsibility and sophistication when it came to safety management systems.

St. Petersburg, Russia, was another great stop. I participated in an implementation meeting of the Global Aviation Safety Roadmap. Operators from across the Commonwealth of Independent States at that meeting accepted some challenging jobs, including requiring loss-of-control training and implementing a SAFA (safety assessment of foreign aircraft) ramp inspection program. These are difficult technical and political challenges, but the industry there is ready to step forward. The only worry is that the economic downturn has crippled government regulators in that region.

At The Hague, Netherlands, I participated in a conference on just culture, and the discussion was dominated by representatives from the fields of medicine and child services. It was good to see the basic ideas that we hold dear being embraced by a broader community. One thing I noticed, not only in The Netherlands but also across Europe, was a bleak attitude about national budget worries and, consequently, a potentially serious reduction of government resources.

The Foundation's International Air Safety Seminar in Milan, Italy, was a great success, thanks in large part to the help of the 8 October Foundation, a group made up of people who lost loved ones in the 2001 runway incursion crash at Milan Linate Airport. The group is dedicated to supporting advances in aviation safety. They were fantastic partners. Further, having those wonderful people there reminded all of us how important our safety work really is.

As I moved on to Asia, I saw that the recession there is just a memory; airlines are booking record profits, bonuses are being paid and $50 million corporate jets are being ordered by the handful. I had a meeting in Singapore, where we worked to build up the business aviation safety community and help regulators adapt to all those shiny new jets.

In India, I worked with a foundation and a university cooperating to educate India's first generation of aviation lawyers. The future there is bright, and continued growth is a given; the only question is how to keep up with the safety challenges.

Finally, I moved on to see old friends in Taipei. I thought that, due to that economy's dependence on U.S. trade, they might still be struggling. I was wrong. The economy there is booming. Freight is up and the new cross-strait flights are generating more traffic than anyone ever imagined.

So what does this suggest for 2011? The predicted shift of the center of aviation activity toward the developing economies is happening. In 2011, it will be hard for anyone to miss. At the same time, however, we are going to see regulators fall on hard times. Industry will have to become increasingly self-reliant. It is time to make room for a new generation of professionals in a new set of places. There will be new friends and new challenges, and that will be good for all of us.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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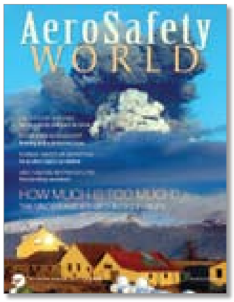

About the Cover
Learning from the uncertain dangers that shut down Europe.
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Sales Contacts

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

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

Asia Pacific, Western USA
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Regional Advertising Manager
Arlene Braithwaite, arlenetbg@comcast.net, tel. +1.410.772.0820

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telephone: +1 703.739.6700

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

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

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

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

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

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

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

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

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

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

DISTRUSTING Luck

Maybe it's a consequence of too much information about the calamities that can befall this planet — comet and asteroid impacts, dramatic climate shifts, violent solar flares, volcanic winters and the like — that increasingly I view the rarity of extreme versions of such upheavals over the past several millennia to be a matter of luck. Not that I'm a pessimist, but I think some planning should be undertaken to mitigate those events where interventions can make a difference in their impact on humanity.

And so it follows that I conclude we need to pay attention to volcanoes. Clearly, we can't stop volcanoes from erupting. We can, however, take steps to minimize the threats such events present to aviation. This is the clear take-away from last spring's Icelandic eruption that snarled traffic within, to and from Europe. As stories in this issue of *ASW* relate, the amount of information we had about that situation was dwarfed by what we didn't know. This is a problem we need to address with some sense of urgency. While there never has been a crash or a fatality related to eruptions, the threat they pose to aviation is undeniable.

First, standards need to be set on what density of volcanic ash is the danger threshold (See "Very Fine Ash," p. 15).

Second, responsibility for avoiding danger areas must be assigned to institutions in good positions to make informed decisions. The failed procedures used in Europe last year vested that responsibility in the hands of air navigation service providers (ANSPs), which, in the absence of facts, opted for caution in what seems to have been excessive amounts. And International Civil Aviation Organization guidance to ANSPs, which directs them to "take extreme care to ensure that aircraft do not enter volcanic ash clouds," is flawed, and not only by the lack of definitions.

Third, the world's equipment manufacturers — mostly the powerplant folks — must quantify the hardware consequences of ash encounters, develop procedures to be used in unexpected encounters and explore if any design changes can mitigate the risk of engine failure and then the long-term mechanical consequences of ingesting ash, realizing that major investments in this regard may be difficult to justify given the rarity of such events.

And, fourth, detection technologies and procedures must be improved. In a presentation at our recent International Air Safety Seminar, Ed Pooley, principal consultant for The Air Safety Consultancy, discussed existing options:

"Satellite remote sensing can provide periodic density mapping but not particle size; vertical density discrimination is poor.

"Direct sampling by manned research aircraft is limited by the need to avoid ash-induced engine malfunction and maintenance costs.

"Direct sampling of air columns can measure ash density variation and in some cases detect particle size using: airborne or ground-based LIDARs (light detection and ranging), daylight only; laser CBRs (cloud base recorders), useful to about 3000 m (9,800 ft) above ground level; radio sondes, radio tracked balloon-borne instrument packs; and drop sondes, instrument packs attached to parachutes deployed from aircraft."

We also are aware of an infrared-based detection system named AVOID (Airborne Volcanic Object Identifier and Detector) that easyJet planned to test.

We should not turn away from working on the challenges presented by volcanic eruptions simply because there are no troublesome eruptions at the moment.

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

Adding Another Barrier Against Incorrect Takeoff Data

The account headed “Late Change Disrupts Preflight” (*ASW*, 9/10, p. 57) talks about an aircrew taking off with invalid takeoff data due to human error. Probably everybody knows a few more examples of this. I think that there is one more “slice of Swiss cheese” one should consider establishing to make this type of event less likely.

In order to calculate correct takeoff data and takeoff thrust settings, entry of the correct weights in the charts or computer programs is essential. Although there are multiple procedures in effect to ensure entry of valid weights, there is always the chance for human error — for example, taking wrong weights by accident, like in this case; mistyping the weights, like in Brisbane; or maybe the loaders providing a wrong measurement.

At present, if the crew uses wrong weights for calculation, and does not detect the error before takeoff, it is too late to react. Once you select takeoff power, the aircraft indicates the calculated N_1/engine pressure ratio, and you can only observe whether the calculated value has been reached … but not whether this value is correct.

My idea to solve that issue: Calculate takeoff data to achieve a certain speed at a certain point to ensure sufficient stopping distance remaining at V_1 and to obtain a specific climb gradient later on. In other words, takeoff data and thrust settings generate a specific acceleration along the runway. If the aircraft is heavier than the numbers used for the calculation, the aircraft won’t reach the required acceleration. If one could calculate the minimum acceleration required for a takeoff and measure it while still in the slow-speed regime, one could take corrective action in time based on data rather than a feeling that an error had occurred.

I see two options to accomplish that: (1) Calculate the maximum distance you travel along the runway to reach the check speed. If one reaches the check speed and has traveled a longer distance, then the selected thrust setting was too low. If one reaches the speed early, the error was on the safe side. The problem with this method is that every runway would need to have a “runway remaining” marker in order to precisely analyze the acceleration.

(2) Calculate the maximum time allowed to reach check speed. If one reaches check speed too late, again, the thrust setting was too low; if you reach it early, you are good to go. The advantage of this procedure is that no additional signs have to be erected along the runways.

Basically, I am suggesting that one should find a method to perform a validity check of the takeoff data during the takeoff run. This method should be simple and should not increase the workload of the pilots or unduly change their crosscheck. Furthermore, the validity check should be done in the early stages of the run.

Volker Pechau

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

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

CALL FOR PAPERS ➤ International Winter Operation Conference: "Safety Is No Secret." Air Canada Pilots Association. Oct. 5–6, 2011, Montreal. Capt. Barry Wiszniowski, <bwiszniowski@acpa.ca>, +1 905.678.9008; 800.634.0944, ext. 225.

NOV. 15–19 ➤ Aviation Lead Auditor Training. ARGUS PROS. Denver. <John.Darbo@argus.aero>, <www.pros-aviationservices.com/alat_training.htm>, +1 513.852.1057.

NOV. 20–22 ➤ Safety Management System Course in Spanish. Total Resource Managment. Toluca, Mexico. Víctor Manuel del Castillo, <info@smsenespanol.aero>, <www.factoreshumanos.com>, +52 722.273.0488.

NOV. 21–25 ➤ Crew Resource Management Instructor Training Course. Integrated Team Solutions. London. <sales@aviationteamwork.com>, <www.aviationteamwork.com/instructor/details_atticus.asp?courseID=7>, +44 (0)7000 240 240.

NOV. 23 ➤ Cabin Safety Inspector Theory (Initial Training). U.K. Civil Aviation Authority International. London Gatwick. Sandra Rigby, <training@caainternational.com>, <www.caainternational.com/site/cms/coursefinder.asp?chapter=134>, +44 (0)1293 573389.

NOV. 24–26 ➤ Safety Oversight Seminar. International Centre of Excellence for Space and Aviation. Harare, Zimbabwe. <boikiem.tripod.com/icesa/id5.html>.

NOV. 29–DEC. 1 ➤ CANSO Caribbean and Latin American Conference. Civil Air Navigation Services Organisation. Willemstad, Curaçao. Anouk Achterhuis, <anouk.achterhuis@canso.org>, <www.canso.org/caribbeanlatinamerica>, +31 (0) 23 568 5390.

DEC. 2–3 ➤ CANSO Caribbean and Latin America ATM Safety Seminar and Benchmarking Seminar. Civil Air Navigation Services Organisation. Willemstad, Curaçao. Anouk Achterhuis, <anouk.achterhuis@canso.org>, <www.canso.org/caribbeanlatinamerica>, +31 (0) 23 568 5390.

DEC. 3–4 ➤ Overview of Aviation Safety Management Systems Workshop. ATC Vantage. Tampa, Florida, U.S. <info@atcvantage.com>, <atcvantage.com/sms-workshop-December.html>, +1 727.410.4759.

DEC. 7–9 ➤ Basic HFACS Training and Super-User Training. HFACS. Las Vegas. <www.hfacs.com/workshops/dates>, +1 386.295.2263.

DEC. 7–9 ➤ HFACS Workshop: Managing Human Error in Complex Systems. Wiegmann, Shappell & Associates. Las Vegas. <www.hfacs.com>, 800.320.0833.

DEC. 8–9 ➤ Regional Airline Association (RAA) Fall Meeting. RAA. Washington, D.C. Staci Morgan, <morgan@raa.org>, <www.raa.org/RAAHome/RAAFallMeeting/tabid/125/Default.aspx>, +1 202.367.1170.

DEC. 8–9 ➤ Fourth EASA Rotorcraft Symposium. European Aviation Safety Agency. Cologne, Germany. Marina Spinello, <marina.spinello@easa.europa.eu>, <easa.europa.eu/events/events.php?startdate=08-12-2010&page=Fourth_EASA_Rotorcraft_Symposium>, +49 221 89990 4110.

JAN. 4–6 ➤ Basic HFACS/HFIX Training and Super-User Training. HFACS. Houston. <www.hfacs.com/workshops/dates>, +1 386.295.2263.

JAN. 10–14 ➤ Safety Management Systems Complete Course. Southern California Safety Institute. San Pedro, California, U.S. Mike Doiron, <mike.doiron@scsi-inc.com>, <www.scsi-inc.com/safety-management-systems-complete.php>.

JAN. 17–19 ➤ Middle East Conference: Transforming ATM Performance. Civil Air Navigation Services Organisation. Abu Dhabi, United Arab Emirates. Anouk Achterhuis, <events@canso.org>, <www.canso.org/middleeastconference>, +31 (0)23 568 5390.

JAN. 17–21 ➤ Investigation in Safety Management Systems Course. Southern California Safety Institute. San Pedro, California, U.S. Mike Doiron, <mike.doiron@scsi-inc.com>, <www.scsi-inc.com/ISMS.php>.

JAN. 24–28 ➤ Cabin Accident Investigation Course. Southern California Safety Institute. San Pedro, California, U.S. Denise Davalloo, <registrar@scsi-inc.com>, <www.scsi-inc.com/CAI.php>.

JAN. 25 ➤ EASA Part M Training Course. Avisa Gulf and CAA International. Gatwick Airport, England. <www.avisa-ltd.com/training/coursetypes/caa-international.html>.

JAN. 27 ➤ Part 145 Maintenance Organisation. Avisa Gulf and CAA International. Gatwick Airport, England. <www.avisa-ltd.com/training/coursetypes/caa-international.html>.

JAN. 31–FEB. 2 ➤ Human Factors in Aviation Maintenance Course. Southern California Safety Institute. San Pedro, California, U.S. Mike Doiron, <mike.doiron@scsi-inc.com>, <www.scsi-inc.com/HFAM.php>.

JAN. 31–FEB. 4 ➤ SMS Principles Course. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Page McCanless, <mpthomps@mitre.org>, <www.mitremai.org/MITREMAI/sms_course/sms_principles.cfm>, +1 703.983.6799.

JAN. 31–FEB. 9 ➤ SMS Theory and Application Course. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Page McCanless, <mpthomps@mitre.org>, <www.mitremai.org/MITREMAI/sms_course/sms_application.cfm>, +1 703.983.6799.

FEB. 14–15 ➤ 1st Business Aviation Safety Conference. Aviation Screening. Munich, Germany. Christian Beckert, <info@basc.eu>, <www.basc.eu>, +49 (0)7158 91 34 420.

FEB. 15–16 ➤ Risk Management Course. ScandiAvia. Stockholm. Morten Kjellesvig, <morten@scandiavia.net>, <site3.scandiavia.net/index.php/web/artikkel_kurs/risk_management_course>.

FEB. 22 ➤ EASA Part M Training Course. Avisa Gulf and CAA International. Manchester Airport, England. <www.avisa-ltd.com/training/coursetypes/caa-international.html>.

FEB. 24 ➤ Part 145 Maintenance Organisation. Avisa Gulf and CAA International. Manchester Airport, England. <www.avisa-ltd.com/training/coursetypes/caa-international.html>.

MARCH 7–10 ➤ Safety Management Course. ScandiAvia. Stockholm. Morten Kjellesvig, <morten@scandiavia.net>, <site3.scandiavia.net/index.php/web/artikkel_kurs/management_sto_2011_01>.

MARCH 15–17 ➤ Safety Management Systems Implementation and Operation Course. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Page McCanless, <mpthomps@mitre.org>, <www.mitremai.org/MITREMAI/sms_course/sms2.cfm>, +1 703.983.6799.

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

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Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 1,050 individuals and member organizations in 150 countries.

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

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Member enrollment — ext. 102
Ahlam Wahdan, membership services coordinator — wahdan@flightsafety.org

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Web site — ext. 117
Karen Ehrlich, webmaster and production coordinator — ehrlich@flightsafety.org

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

Paul Fox, regional director — fox@flightsafety.org

Safety News

SMS for Airlines

The U.S. Federal Aviation Administration (FAA) has proposed requiring most commercial airlines to establish a safety management system (SMS) to "give operators a set of business processes and management tools to examine data from everyday operations, isolate trends that may be precursors to incidents or accidents, and develop and carry out appropriate risk-mitigation strategies."

The new notice of proposed rulemaking (NPRM) follows a previous NPRM to require FAA-certified airports to establish an SMS for airfield and ramp areas.

©Jakub Jirsák/Dreamstime.com

"We need a holistic approach to safety that allows us to spot trends in aviation and make necessary changes to help avoid incidents and accidents," said FAA Administrator Randy Babbitt. "Safety management systems are a critical piece of a successful safety culture."

The NPRM would give scheduled air carriers operating under U.S. Federal Aviation Regulations Part 121 three years to implement an SMS. The FAA emphasized that the SMS requirement "would not take the place of regular FAA oversight, inspection and audits to ensure compliance with existing regulations."

Technological Upgrade

The Australian Civil Aviation Safety Authority (CASA) is seeking public comments on its 10-year plan to introduce new technology for aircraft communication, navigation and surveillance.

The proposal calls for the gradual installation of equipment to allow the use of satellite navigation by all aircraft capable of flight under instrument flight rules.

"There is a clear responsibility to the traveling public to transition to the new technology as both aviation safety and efficiency can be improved," CASA said.

The public-comment period was to end Nov. 30.

Design Review

The U.S. National Transportation Safety Board (NTSB), citing two accidents that were blamed on a passenger's inadvertent movement of the fuel flow control lever in a Eurocopter AS 350B, is asking two civil aviation authorities to require Eurocopter to review the lever's design.

The NTSB cited the April 15, 2008, crash of an AS 350B2 about 34 nm (63 km) east of Chickaloon, Alaska, that killed the commercial pilot and three passengers and seriously injured a fourth passenger (*ASW*, 5/10, p. 63).

The NTSB found that the probable cause of the accident was the loss of engine power following an overspeed of the turbine engine — an event that was "precipitated by the inadvertent movement of the fuel flow control lever (FFCL) by the (front-seat) passenger."

The NTSB also identified as a causal factor "the manufacturer's design and placement of the FFCL, which made it susceptible to accidental contact and movement by passengers." The FFCL is on the floor of the helicopter, near the front-seat passenger's right foot. In the Alaska crash, the passenger's backpack was on the floor, and the accident report said it was likely that either the backpack or the passenger's foot bumped the FFCL out of its correct position.

A similar accident occurred April 4, 1994, near High Prairie, Alberta, Canada, when the front-seat passenger "inadvertently moved the FFCL from the flight detent to the stop detent while trying to adjust a knapsack placed under his right knee." The helicopter lost power, and the helicopter touched down hard and

© Christopher Ebdon/Flickr

rolled onto its left side after the pilot conducted an autorotation. No one was injured, but the helicopter was substantially damaged.

In its recommendations to the European Aviation Safety Agency (EASA) and the U.S. Federal Aviation Administration (FAA), the NTSB said that those two accidents, as well as other similar accidents and incidents, aroused concern that more accidents could occur because of the FFCL design. The NTSB asked both agencies to require Eurocopter to review the design of the FFCL or its detent track or both and to modify the device "to ensure that the FFCL is protected to prevent unintentional movement out of its detents and that it does not move easily to an unintended position."

A second recommendation asked the FAA to evaluate other helicopter models with similar FFCL designs and require similar modifications.

Uncommanded Trim

Airbus should alert A320-series operators of the possibility that an electrical problem could result in uncommanded operation of the rudder trim, the U.K. Air Accidents Investigation Branch (AAIB) says.

The AAIB cited an Aug. 24, 2010, electrical malfunction in an A321 during a scheduled night flight from Khartoum, Sudan, to Beirut, Lebanon.

"The more significant symptoms included the intermittent failure of the captain's and co-pilot's electronic displays and the uncommanded application of left rudder trim," the AAIB said in Special Bulletin S2/2010. "The flight crew also reported that the aircraft did not seem to respond as expected to control inputs."

The problems included flickering and blanking out of displays, including the primary flight display, navigation display and electronic centralized aircraft monitor (ECAM), the report said, adding that master caution annunciations and other messages appeared on the ECAM.

The uncommanded rudder trim resulted in a left-wing-low attitude and a deviation left of the planned track, the AAIB said.

After reading an ECAM message that said "ELEC GEN 1 FAULT," the crew turned off the no. 1 generator, and normal functions resumed, the report said. Turning the generator back on led to a resumption of the problems, so it was again turned off and the airplane was flown manually to Beirut, where the crew landed without further difficulty.

A review of data from the flight data monitoring program confirmed some of the crew's reports, and data analysis was continuing.

The report said that the problems "were believed to be attributable to an electrical power generation system fault" and that "the ECAM did not clearly annunciate the root cause of the malfunction and no information or procedures were available to assist the flight crew in effectively diagnosing the problem."

The AAIB recommended that Airbus alert operators of A320-series airplanes to "the possibility that an electrical power generation system fault may not be clearly annunciated on the ECAM and may lead to uncommanded rudder trim operation."

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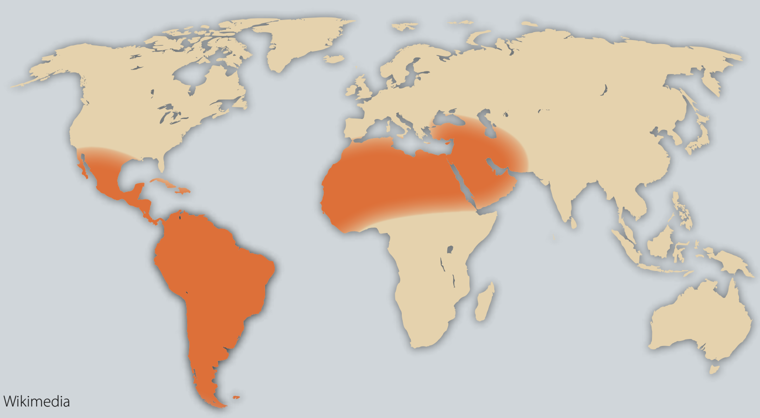
Regional Challenges

Coordinated efforts are needed to respond to growth-related challenges in the Middle East and North Africa, whose air carriers now handle 11 percent of global air traffic, compared with 5 percent one decade ago, said Giovanni Bisignani, director general and CEO of the International Air Transport Association (IATA).

As air traffic has increased, so has the accident rate, Bisignani said, citing data that show 3.32 accidents per 1 million flights in 2009, compared with zero accidents in 2006.



Wikimedia

"At 4.6 times the global average of 0.71, that is a concern," Bisignani said, urging nations in the region to require their air carriers to undergo IATA's safety audits. Thirty-five carriers in the region already are on the registry for IATA's Operational Safety Audit (IOSA).

Assessing the state of the industry in Latin America, Bisignani said that aviation safety presents a "constant challenge" to both the industry and government regulators. He cited the region's hull-loss rate, which has fluctuated dramatically.

"A decade ago," IATA said, "the … rate for Western-built jet aircraft was seven times the global average. By 2009, that had improved to a perfect record of zero. Four tragic accidents in the first 10 months of 2010 have seen the accident rate increase to 3.2 times higher (2.36 Western-built jet hull losses per 1 million flights) than the 0.73 global average."

Bisignani said priorities for Latin America are increasing performance-based navigation procedures and addressing issues associated with runway excursions and congested airspace.

Aging Aircraft

In an effort to prevent aging aircraft from incurring structural damage, the U.S. Federal Aviation Administration (FAA) has finalized a rule requiring manufacturers to specify the number of flight cycles or flight hours that a commercial airplane may be operated.

Manufacturers have between 18 and 60 months to meet that requirement. After the limits are established, operators will have between 30 and 72 months, depending on the model, to incorporate those limits into their maintenance programs. After the limit has been incorporated into an operator's maintenance program, an airplane may not be flown beyond that limit without FAA approval.

"We've addressed the problem of aging aircraft with numerous targeted regulations and 100 airworthiness directives over the years," said FAA Administrator Randy Babbitt. "This rule is a comprehensive solution to ensure the structural safety of today's airliners and the airplanes of tomorrow."

The FAA said it is working with the European Aviation Safety Agency and national civil aviation authorities to harmonize rules in this area.

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In Other News …

Japan and the United States have signed a memorandum of understanding designed to lead to establishment of an **"open skies"** agreement between the two countries. The agreement is intended to expand air service, encourage competitive pricing by airlines and protect aviation safety and security. … John McCormick, director of the Australian Civil Aviation Safety Authority, says his agency is on track to complete the modernization of aviation safety **regulations** by the end of 2011. About half of the required "refined" regulations already have been implemented, he said. … Eurocontrol has submitted to its member states a preliminary version of its specifications for **harmonized rules** for flight under instrument flight rules. Eurocontrol's goal is for the rules to be implemented around October 2011.

Airport Initiative

Airports worldwide are set to begin a safety initiative intended to focus on runway safety improvements and to reduce runway accidents.

The Airports Council International said that its new program — Airport Excellence in Safety (APEX) — is "designed to unite all regions in a proactive global safety improvement initiative, which will focus on a management systems approach."

Key elements of the initiative will include documentation, training and an "airport-to-airport mentoring program," ACI said.

Nightryder84/Wikimedia

Ad Rutten, CEO of Amsterdam Airport Schiphol, said the "compelling case" for adoption of the initiative includes findings from audits conducted from 2005 through 2010 by the International Civil Aviation Organization, which found that 58 percent of the audited countries do not have procedures for airport certification and 69 percent do not have runway safety programs.

Rutten also cited Flight Safety Foundation data showing that 30 percent of all major damage accidents worldwide from 1995 through 2008 were runway-related.

Compiled and edited by Linda Werfelman.

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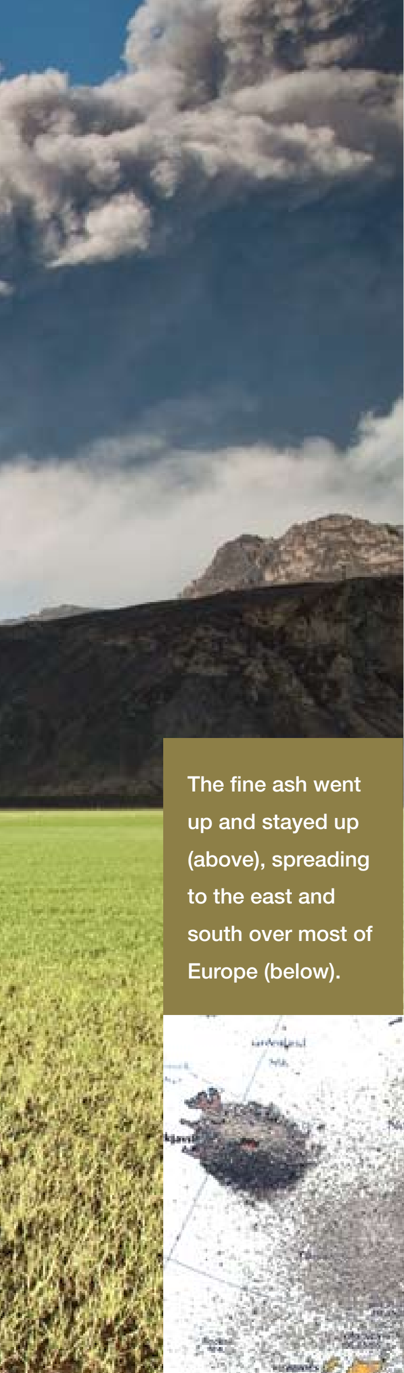
Clearing the Air

Reconsidering how to respond to ash clouds.

BY THOMAS WITHINGTON

April 14, 2010, will be remembered in aviation history as the day that European airspace stood still. Not since the terrorist attacks of Sept. 11, 2001, had European and trans-Atlantic aviation witnessed so much disruption, triggered this time by the eruption of the Eyjafjallajökull volcano in Iceland, which caused the progressive shutdown of airspace across the continent.

More than 20 nations emptied their skies and more than 300 airports closed, leading to the cancellation of around 100,000 flights and the grounding of up to 10 million passengers until Europe's airspace was reopened beginning April



The fine ash went up and stayed up (above), spreading to the east and south over most of Europe (below).

© Nikita Zabellevich/Dreamstime

20. Air travel was again disrupted, with delays and re-routing, during the weekend of May 8–9. Spanish air traffic control was forced to close seven airports on May 9, although they were reopened soon afterward, but as late as May 17, the U.K. Civil Aviation Authority imposed a no-fly zone comprising London Heathrow, London Gatwick and London City airports, among others.

No sooner had the skies been closed and aircraft grounded than the assignment of blame began to be discussed in the media. Seemingly oblivious to the danger that volcanic ash can present to airliners, angry passengers waiting in overcrowded terminals voiced their belief to television reporters that local air traffic control authorities, including Eurocontrol, had over-reacted.

Contingency Planning

However, said Bo Redeborn, director of cooperative network design at Eurocontrol in Brussels, Belgium, "Our contingency planning was not designed to cope with this kind of situation, where you have to close such a large section of airspace. We are ready to deal with crises, we are ready to deal with contingencies, but we were not ready to deal with the kind of situation that occurred in April."

The airline industry also was quick to add its voice, noting the effect that the disruption was having on its bottom line. Giovanni Bisignani, director general and CEO of the International Air Transport Association (IATA), on April 19 said that the airline industry was losing $250 million each day that the airspace remained closed — IATA later calculated that the industry had lost $1.8 billion while airliners were grounded.

Was the decision to close almost all of Europe's airspace that weekend an over-reaction? William R. Voss, president and CEO of Flight Safety Foundation, believes that, based on industry knowledge at the time, it was not. "We could have found ourselves in a situation, had appropriate action not been taken, of trawling the North Atlantic for flight recorders," Voss said. "The fact remains that there was a major volcanic eruption in a high-density traffic area."

The threat of ash to airliners is very real. On Dec. 15, 1989, the pilots of a Boeing 747-400 operated by KLM Royal Dutch Airlines made an emergency landing at Anchorage (Alaska, U.S.) International Airport when compressor stalls occurred in all four engines after ingesting volcanic ash from Mount Redoubt. During the 2010 Icelandic eruption, four Boeing F-18C/D aircraft of the *Ilmavoimat* (Finnish Air Force) experienced damage to their engines from ash ingestion.

Clear Danger

As the event involving the KLM 747 illustrates, volcanic ash poses a clear and present danger to aircraft. It is almost impossible for a flight crew to see the ash because it is usually too fine to be observed by on-board weather radar, giving the crew no way of knowing if they are flying through a dust cloud. Once in the ash cloud, the aircraft's engines ingest the fine particles, which melt into a sticky glass-like substance. This substance can disrupt compressor and turbine stator and blade

The eruption of Eyjafjallajökull has provided the European aviation community … with a wealth of experience.

aerodynamics, and block the blades' cooling holes, causing a corresponding rise in temperature and the risk that the engine will overheat. As if this were not serious enough, the ash particles can be abrasive, causing further damage to engine nozzles and fan blades. Could jet engines be designed to withstand the rigors of volcanic ash? Perhaps, but the design and manufacturing costs might become exorbitant. (See "Very Fine Ash.")

In Europe, eruptions of Eyjafjallajökull's magnitude are mercifully rare, with Italy and Iceland the only two nations on the continent that are home to regular major volcanic activity. But why was the disruption in Europe so acute compared with the effect on commercial air travel of eruptions in the Pacific region?

The answer is that Europe's airspace is not only extremely crowded but is also a chokepoint in terms of the global route network. "So much was shut down by this volcano," said Geoffrey Lipman, special adviser to the United Nations World Tourism Organization secretary general, "and this volcano was on the heaviest air routes in the world. There have been volcano impacts before, but in markets with much thinner traffic, and where the distances between destinations have been huge. When you close Europe, you close for a certain time all the rest of the routes in the world."

A Lesson

Nevertheless, the eruption of Eyjafjallajökull has provided the European aviation community — including airlines, aircraft manufacturers, air traffic service providers and regulatory authorities — with a wealth of experience about how to approach a similar, or even larger, disruption in the future.

"The aviation industry, and aviation authorities, were caught sleeping, as there was great uncertainty in how to deal with the issue at the scientific, political, business and consumer levels," said Icelandair's CEO Birkir Holm Gudnason.

Gudnason noted that it is important for airlines to be prepared for such an eventuality.

"We were aware of the possibility that an eruption could cause a great disruption in aviation, and we had studied models showing probable distribution of an ash cloud," he said. "We also had plans in place to deal with a crisis, and we found our staff very quick to respond to this situation."

This planning enabled Icelandair to continue operations despite the disruption caused by the airspace closure.

"We made the decision to maintain our scheduled operation through the eruption and, as airspace closed down, we made regular schedule changes," Gudnason said. "For 10 days, we moved our hub from Iceland to Glasgow, Scotland. Throughout the days of disruption, we were able to operate 80 percent of our schedule and were never grounded."

One way to determine where the ash is positioned, and its density, could be found through increasingly sophisticated air sampling equipment that can provide an accurate gauge of the extent of dust contamination in a section of airspace. The Climate and Atmosphere Department of the Norwegian Institute for Air Research has developed a system called the Aircraft-Mounted Passive Infrared Volcanic Ash Detector, or Avoid. Avoid detects areas of particularly heavy ash concentration to allow aircraft to fly around them. However, the ability to see the ash is not the only capability that may make it safer and easier to continue operations during a future eruption of a similar magnitude.

Engine Ash Tolerance

Obtaining more detailed information from engine manufacturers about the ash tolerance of their powerplants could enable air traffic authorities to draft more accurate regulations to specify which sectors of airspace are safe to fly through, based on their ash density. While some sections may be too ash-saturated, other less-affected sectors could remain open. This would help to move away from a blanket grounding of all flights and to a more targeted closure of airspace in the most seriously affected areas.

Moreover, the ability to predict volcanic eruptions is improving thanks to advances in volcanology and the global seismic monitoring network. "To predict future eruptions is not so

Very Fine Ash

The root of the troubles produced by the eruption of the *Eyjafjallajökull* volcano in Iceland was the very fine ash that persisted in the atmosphere and drifted in an unusual direction, according to Ed Pooley, principal consultant for The Air Safety Consultancy.

Speaking at Flight Safety Foundation's International Air Safety Seminar in Milan, Italy, in November, Pooley said the consequences of the ash dispersal were exacerbated by an International Civil Aviation Organization (ICAO) standard created for the much larger ash particles and higher ash densities associated with eruptions around the Pacific Rim, conditions unlike those that were experienced over European air routes this past spring.

From a volcanology point of view, the Icelandic eruption was a modest affair: "One-tenth of Mount St. Helens and one-100th of Mount Pinatubo," Pooley said, "not powerful enough to break through the tropopause," the upper boundary of the troposphere, the lowest region of Earth's atmosphere. "It was not going to circle the world like Mount Pinatubo. … With the prevailing weather we have in this part of the world, normally that ash is going off to the east-northeast and maybe the northeast." This time the drift was southeast.

The combination of weather and ash size meant that the ash stayed around: "Gravity will make sure the big stuff comes to earth. What you're left with is much smaller stuff," Pooley said, "and if the weather situation is stable, you're going to get the ash in layers and it's going to persist … . There [also] was no rain to wash it out."

Responding to ash encounters in the Pacific Rim, the civil aviation community studied the threat, and "in 2001, we had the issue of the ICAO Document 9691 [*Manual on Volcanic Ash, Radioactive Material and Toxic Chemical Clouds*], which is a very good manual with a lot of the solid detail," Pooley said.

"ICAO [saw] ash as an air traffic management problem. When this happened in Europe, everybody was told it was a rule from ICAO that you had to stay clear of all volcanic ash. Actually, it was a recommendation," similar to the recommendation to avoid low-level wind shear.

Pooley

Wayne Rosenkrans

Another shortcoming of the ICAO guidance is its failure to specify what level of ash is dangerous. "That was never addressed by ICAO, even though the expert groups that have been meeting for the last decade have been saying we need to define what is the limit of volcanic ash," he said. And while the advice was to avoid ash clouds, "frankly, nobody really knows what an ash cloud is; nobody has actually defined it."

Ash densities encountered also were not on a scale previously experienced: "The ash density in the 1980s events — where engines were compromised [over] Alaska and Indonesia — was 2 million micrograms per cubic meter," he said. In ash clouds over Europe this past spring, "there never was more than about 300 [micrograms per cubic meter]."

And the particles were quite fine. "Volcanic ash is pretty large," starting in size at 2,000 microns — a micron is 1 millionth of a meter — and smaller. Fine ash is defined as less than 50 microns, Pooley said, "but even that [size] is going to start dropping out pretty quickly… The majority of the [particle sizes] recorded [in the Icelandic event] was around about 3 microns.

"Most of what comes out of most volcanoes … is silicates, volcanic glass … with melting temperatures lower than the temperatures reached in the hottest parts of modern high-bypass turbine engines … probably about 800 to 1,200 degrees C (about 1,470 to 2,200 degrees F)," Pooley said. "At cruise thrust, the temperature in the turbine is about 1,650 degrees C (about 3,000 degrees F), well above the melting range. As this stuff passes through [the engine], it is quite likely to melt. It depends on the quantity and a lot of other things, but [when it melts] it's going to cool onto some of the surfaces that are critical to the function of the engine.

"But eventually, if that part of the engine is cooled, it's going to largely drop off. That's because it's settling on the surface in a crystalline form, which is less likely to adhere to the surface at a cooler temperature. So this is why the crew responses are important — if they're quick enough to get back to idle thrust or if the engine is run down, then the effect will be very similar." The severe damage incurred by a KLM Royal Dutch Airlines Boeing 747-400 after ingesting ash from Mount Redoubt in Alaska in 1989 happened when the crew "tried to power out of an ash cloud — which is the very last thing you want to do," he said.

The nature of the threat presented by this ash chemistry remains unknown. "There is some work to be done by the scientists, and there's a recognition that we have to have a system which can cope with the amount of hazard that very fine ash represents when it is up to almost a week old … still there in densities which are measurable," he said. "Whether those measurable densities matter is something that we have to resolve."

In the end, Pooley said, "it's very important to recognize that the ICAO system we had to guide us did not take account of the nature of the risk that we faced in Europe." Further, "I think it's very important to recognize the quite ridiculous burden placed on the air navigation service providers, to ensure that aircraft avoid this sort of ash hazard. That is unrealistic."

— J.A. Donoghue

Flavijus Piliponis/Fotolia

difficult now because observation installations exist on many volcanoes," said Evgeny Gordeev, director of the Institute of Volcanology and Seismology at the Russian Academy of Sciences. However, he cautioned, "estimates of the duration, maximum power and the size of the volcano eruption are not so easy."

Anticipating a volcano's behavior is a particularly challenging exercise and contributed to the uncertainty about how long the flight bans would remain in place in Europe after the airspace closures began on April 14.

"The biggest challenge is in modeling the level of volcanic activity in Iceland, as this was largely reliant on the very difficult task of compiling accurate and continuous observations of the volcanic eruption by the Iceland Meteorological Office," said Ian Lisk, volcanic ash coordination program manager at the U.K. Meteorological Office. "The other two major challenges relate to how the information being provided is interpreted and then used by a variety of stakeholders with differing levels of understanding, and availability of standardized, real-time, high-quality volcanic ash observational data."

Lisk emphasized the importance of ascertaining what levels of ash are safe to fly through

as one of the important lessons resulting from the eruption in Iceland.

"The U.K. Meteorological Office is heavily involved in initiatives to better define international volcanic ash requirements," Lisk said, adding that efforts to improve the clarity of information are moving forward. "There has been an enhancement of volcano-observing capabilities [following the eruption] in Iceland in collaboration with the Icelandic Meteorological Office, British Geological Survey and the U.K. National Centre of Atmospheric Science."

Density Standards

"If ever you wanted a lesson on how important standards are, even if they are not always precise, I think we have it here," said Flight Safety Foundation's Voss. "The absence of any standard levels of ash concentration in which it was safe or unsafe to fly left everyone in confusion. It's not as if that density has to be worked out to the third or forth decimal point. If we had just been able to work out a rough figure, there could have been spectacular decreases in the size of the no-fly zones."

'The absence of any standard levels of ash concentration in which it was safe or unsafe to fly left everyone in confusion.'

David Karnå/Wikimedia

Eurocontrol is also looking at its own processes for coping with a similar future situation. "Everybody needs to deal with this in a more harmonious way," Redeborn said. "The fact that each state takes a decision on how they deal with such a situation, how they close airspace, how they transmit information, makes it absolutely impossible for airlines and the public to deal with. Everybody should use information from the same source, and apply an agreed-on set of harmonized criteria."

Problems with information flow also were noted by the airport operators. Henrik Littorin, head of public affairs at Swedavia, Sweden's airport operator, recalls that "the information provided to air traffic control authorities, and to airlines, about which airspace was open and which was closed seems to have been adequate, but the information provided to passengers was lacking a bit in the first days of the eruption."

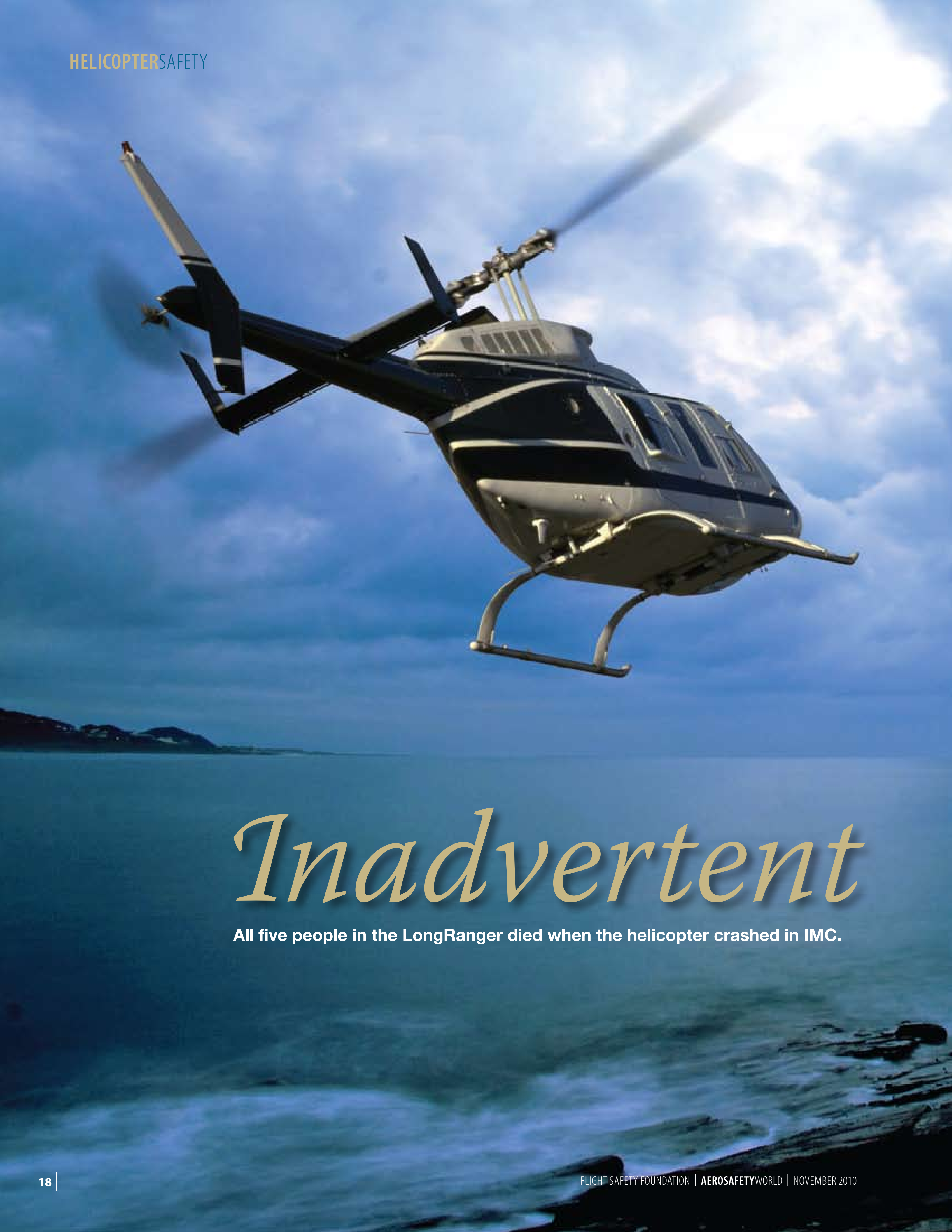
Redeborn noted that Eurocontrol's plans for dealing with volcanic ash clouds have been revised and continue to be revised, along with the guidelines used by the International Civil Aviation Organization. Moreover, Redeborn believes that it is vital to have "detailed information regarding every engine in the air and the level of ash that engine can cope with. It also would have been useful to know a limit in terms of ash concentration that it is safe to fly in."

Coordinated Messages

"It's easy to say that airspace should have been opened up quicker," said Lipman of the World Tourism Organization, "but if you are the person with the finger on the button, and the consequence of error could be a plane crash, you would want to take every precaution possible." Similarly, Swedavia's Littorin cautioned against adopting a "one size fits all" approach to dealing with future eruptions of this scale in Europe: "All crises are unique. We've been very focused on plane crashes, terrorism and strikes. The lesson learned was that other crises tend to be very short, and then you have to cope with what happens afterward to get operations running. Furthermore, there is an absolute need for coordinated messages from different stakeholders."

As a *force majeure*, volcanoes remind humans that there are natural forces more powerful than themselves. Whether the closure of Europe's airspace was an overreaction seems to be a matter for the general media to fight out. However, the decision to close the airspace to prevent the loss of an aircraft, based on insufficient data and standards, defaulted to conservative standards. As Eurocontrol's Redeborn noted, "There have been a number of situations involving aviation and ash, but no one has been killed, yet."

Thomas Withington is an aviation journalist in the United Kingdom. On the day that Europe's airspace closed, he was on assignment at Freidrikshavn, Denmark, waiting to board a German naval helicopter to visit a French aircraft carrier. He recalls the helicopter crew's difficulty in obtaining accurate and non-conflicting information about which national airspace around Denmark was closed, the severity of the ash cloud and how long flight restrictions were likely to remain in place.



Inadvertent

All five people in the LongRanger died when the helicopter crashed in IMC.

Low clouds and low visibility permeated an area in the Gulf of Mexico when a Bell 206L-4 LongRanger crashed en route to an offshore drilling platform, killing the pilot and all four passengers.

The U.S National Transportation Safety Board (NTSB) said in its final report on the accident that the probable cause was the pilot's "failure to maintain clearance from the water," and that a contributing factor was the inadvertent encounter with instrument meteorological conditions (IMC).

The report also noted that there was no indication that the pilot "had obtained a formal weather briefing from a recorded source."

The pilot met his four passengers in Sabine Pass, Texas, U.S., the morning of the accident. Witnesses saw him perform a preflight inspection and prepare for the flight to the offshore drilling platform — West Cameron 157 — where he planned to drop off the passengers, all employees of Island Operating Co.

At 0722 local time, the helicopter departed from Sabine Pass on the 20-minute flight, and at 0725, the pilot contacted the Rotorcraft Leasing Co. (RLC) communications center to file a flight plan. He estimated the helicopter would arrive at the platform at 0742.

The pilot was required by company policies to contact the communications center with a position report every 15 minutes. When he failed to make the anticipated report, the dispatcher tried unsuccessfully, by radio and telephone, to contact him at the destination platform and the departure platform, and then, about eight to 13 minutes after the position report had been due, notified the dispatch supervisor.

Company helicopters began searching for the missing helicopter, and between 0912 and 0917, company representatives notified the Coast Guard, which then joined the search. The accident helicopter was found around 1100, about 2 nm (4 km) offshore — or about 6 nm

BY LINDA WERFELMAN

Encounter

Photo composite: Susan Reed
Helicopter: © Chris Sorensen Photography
Seascape: © Izak/Dreamstime.com

(11 km) south of Sabine Pass — in 13 to 15 ft of water. The wreckage was moved to Broussard, Louisiana, for examination.

Investigators discovered no preimpact anomalies that would have interfered with the helicopter's performance, the report said.

The accident pilot had a commercial pilot certificate, with helicopter and instrument ratings last issued in May 2007, and a second class medical certificate issued in May 2008.

The pilot's logbook could not be located, but according to the résumé he submitted to RLC in October 2008, when he was hired, he had at least 3,450 flight hours, including 3,390 hours in single-engine helicopters and 73 hours in simulated or actual IMC. Company records indicated that he had 220 hours of offshore flight time.

Company records also indicated that the pilot received initial training, consisting of 15.8 hours in Bell 206B and 206L-3 models in October 2008 and received satisfactory ratings in all tested areas, the report said. The same month, he completed water survival/helicopter underwater egress training.

During his two months with RLC, the pilot flew at least 77 hours in Bell 206s. The report said that the company's director of operations, chief pilot and safety officer told accident investigators that "the pilot had good flight skills and demonstrated good situational control during flight. The pilot had not been involved in any previous events or activities that would have raised question as to his judgment or ability."

Although the pilot had an instrument rating, he was not instrument-current and he was not approved for instrument flight under the air taxi requirements of U.S. Federal Aviation Regulations Part 135, the report said.

'No Track Record'

The pilot typically flew a different helicopter that had a flight tracking system that was engaged when the master switch was on. In the accident helicopter, however, a separate switch activated the flight tracking system.

"This variation was not in the checklist," the report said. "According to company records, the pilot had been flying the accident helicopter for two or three days prior to the accident. During this time, there was no track record for the helicopter, which is consistent with the pilot not activating the helicopter's flight tracking system."

After the accident, RLC issued a safety alert to inform pilots of the variation, the report said.

The accident helicopter was manufactured in 1994. It was registered to and operated by RLC, which maintained it according to an approved inspection program. Maintenance records showed that its last inspection was completed Nov. 30, 2008, at an airframe total time of 6,331 hours. After the inspection, the helicopter was flown an additional 29 hours before the accident occurred.

The helicopter was equipped with a skid flotation system, parts of which separated from the fuselage as a result of the crash. Investigators could not determine whether the floats had been deployed by the pilot, but the report noted that the float arm toggle switch was "found in the secured position."

The toggle switch was located on the pilot's collective control, and could be moved from the secured position to the armed position only after the pilot lifted a red gate, designed to prevent inadvertent arming of the floats during cruise flight. "To deploy the floats, after arming the floats, the pilot has to push a button next to the float arm switch," the report said. "When the red gate is pushed down, the float arm switch is automatically moved to the off position."

RLC began conducting offshore air taxi operations in 1998, with corporate headquarters in Broussard and numerous bases, both onshore and offshore, in several states.

At the time of the accident, the company had about 90 helicopters and employed about 200 pilots. The company required each pilot to have a minimum of 1,500 flight hours before being hired, including 500 hours as pilot-in-command.

Company policy called for pilots to check weather, perform a preflight check of their helicopter and make a go or no-go decision for the flight. At the time of the accident, RLC did not have a formal risk-assessment program. Instead, its pilots were trained on the use of the "I'm safe" checklist, designed to encourage pilots to evaluate their health and well being before a flight.[1]

After the accident, RLC began a formal risk-assessment program that required pilots to consult with a lead pilot or supervisor and/or use a detailed matrix in making a decision on whether to launch a flight. The new process has been included in the company's operations manual.

IMC Warnings

A strong cold front had moved across the area the previous night, bringing with it restricted visibility in light rain. Mixed freezing precipitation had fallen in the early morning, followed by snow. Winds at the time of the accident were from the northwest at 30 kt.

A special weather report issued at 0736 at the Southeast Texas Regional Airport in Beaumont/Port Arthur, 21 nm (39 km) north of the accident site, reported visibility of 10 mi (16 km), broken ceilings at 1,200 ft and 4,600 ft, an overcast at 12,000 ft and wind from 300 degrees at 12 kt.

Offshore, however, ceilings were lower and winds were stronger.

The offshore forecast issued at 0500 called for scattered to broken clouds at 1,000 ft, broken clouds at 2,500 ft and cloud tops at 5,000 ft, with occasional broken clouds at 700 ft and visibility in those areas of 3 to 5 mi (2 to 8 km) in rain and mist.

Airmen's meteorological information (AIRMET) reports warned of moderate icing conditions, moderate turbulence and instrument flight rules conditions with ceilings of less than 1,000 ft and/or visibility of less than 3 mi in precipitation and mist.

Satellite images at 0732 and 0745 showed "low-level, stratus-type clouds over the Gulf of Mexico in the vicinity of the accident location," and RLC said that the weather had caused other flights in the area to be canceled or delayed.

One of the search-and-rescue pilots said that weather at the accident site during the search included an overcast at 700 ft, visibility of more than 10 mi and northwest winds at 30 kt with gusts to 35 kt. The air temperature was 40 degrees F (4 degrees C). Other meteorological reports placed the water temperature at 64 degrees F (18 degrees C).

Witnesses saw the accident pilot using a computer to obtain weather information before the flight, but he did not obtain a briefing from a U.S. Federal Aviation Administration (FAA) flight service station or through the Direct User Access Terminal System (DUATS), an Internet-based FAA-contracted weather information service.

Flotation Devices Required

Autopsies concluded that the cause of death for each of the four passengers was "asphyxia due to drowning," probably complicated by cold water shock — which can cause involuntary inhalation of water, an increase in blood pressure and cardiac arrest — and hypothermia — an abnormally low body temperature. The pilot's autopsy found that he died of a "crushed chest, complicated by asphyxia due to drowning," the report said.

RLC said that all charter passengers were required to watch a safety video before boarding for the first time; among the topics covered were how to wear and activate personal flotation devices and how to use safety belts. Similar information was printed on a safety card found in each helicopter.

RLC policy also called for the pilot to conduct a safety briefing — including a discussion of the use of safety belts and flotation equipment and a mention of the location of survival equipment.

"Both the pilot and passengers were required to wear personal flotation devices during all phases of overwater flight," the report said. "Most companies who employ RLC for charter purposes provide water survival and helicopter underwater egress training to their employees before they participate in overwater operations. The swimming ability of the pilot and passengers was not determined."

The pilot and two passengers were found wearing personal flotation devices; however, the passengers' devices had not been inflated. The two other passengers were not wearing flotation devices, but the report said that two devices were found at the accident site that "showed signatures consistent with use. One had been partially inflated and the second had been entirely inflated."

All of the personal flotation devices had been inspected less than three weeks before the accident, on Nov. 24, 2008.

Investigators could not determine whether the delay in contacting the Coast Guard "contributed to the severity of injuries" of the crash victims, the report said.

This article is based on NTSB accident report No. CEN09FA086 and accompanying public docket material.

Note

1. The "I'm safe" checklist asks pilots to evaluate themselves for symptoms of illness, stress and fatigue and for the presence of medication or alcohol in their systems, and to determine whether they have eaten enough healthy food to be adequately nourished for a flight.

BY MARK LACAGNINA

Check Flight

© Stefan Sonnenberg/Airliners.net

Goes Bad

The crew was unaware that the A320's angle-of-attack sensors were frozen.

The no. 2 angle-of-attack sensor vane is circled. The sensor body, shown in the diagram, is not heated — a factor involved in the accident.

An Airbus A320-232 was undergoing a series of functional checks required by a lease agreement when it stalled and descended into the Mediterranean Sea near Perpignan, France, the afternoon of Nov. 27, 2008. The airplane was destroyed, and all seven occupants were killed. In a final report published in September 2010, the French Bureau d'Enquêtes et d'Analyses (BEA) said that the flight crew was not aware that the angle-of-attack sensors had been blocked by ice. They lost control of the airplane while performing low-speed checks at a relatively low altitude.

Among the factors that contributed to the accident was the flight crew's lack of training and experience in performing functional check flights, the report said.[1] Investigators also found that the angle-of-attack sensors had not been shielded properly when the airplane was rinsed to remove accumulated dust, which resulted in water entering at least two of the three sensors and later freezing during the accident flight.

The A320 had been leased in 2006 from Air New Zealand (ANZ) by XL Airways Germany (GXL). The lease was expiring, and the German charter airline had ferried the airplane to EAS Industries at Perpignan's Rivesaltes Airport on Nov. 3, 2008, for a 30-month maintenance check and for repainting, which — along with the functional check flight — were required by the lease agreement before the airplane was returned to ANZ.

'Atypical Team'

The report said that there was an "atypical team" of three airline pilots in the cockpit for the check flight. The captain and copilot were from GXL. The captain, 51, had 12,709 flight hours, including 7,038 hours in type. He was hired by the airline in February 2006 as a captain and as head of air and ground operations. He was qualified as an A318/A319/A320/A321 instructor and type-rating examiner. The copilot, 58, had 11,660 flight hours, including 5,529 hours in type. He was hired by GXL as a copilot in April 2006.

The other pilot was an ANZ captain with 15,211 flight hours, including 2,078 hours in type. Hired in 1986, he had served as an A320 captain since September 2004. During the check flight, he occupied the cockpit center seat to observe and record the results of the checks. He also had been designated to command the subsequent ferry flight to Auckland, New Zealand.

Also aboard the airplane were three ANZ engineers, who had supervised the maintenance performed in Perpignan, and a representative of the New Zealand Civil Aviation Authority, whose responsibilities included issuing a new airworthiness certificate before the airplane was returned to its owner. These passengers were aboard for transport to Frankfurt, Germany, at the end of the check flight.

The captain and the copilot had not flown together in 2008, and neither pilot had flown with the ANZ pilot. The report said that inadequate coordination among the three pilots during the check flight was a factor that contributed to the accident. The cockpit voice recorder (CVR) transcript indicates that some of the communication between the captain and copilot was in German. The ANZ pilot did not speak German.

The report also said that the performance of the GXL pilots during the check flight might have been affected by fatigue. The captain and the copilot had begun the commute to Perpignan from Frankfurt International Airport, their home base, at 0530 local time (also Perpignan time) with a taxi ride to Frankfurt–Hahn Airport, about 130 km (81 mi) west of Frankfurt International, to board a flight to Montpellier, France. There, they rented a vehicle for the drive to Perpignan, about 160 km (99 mi) southwest. They arrived in Perpignan at 1200.

'Disguised Test Flight'

The flight was scheduled to begin at 1330 but was delayed until 1544. The pilots met for an hour before takeoff to review the flight plan. Airbus did not publish guidance for operators on conducting functional check flights. Therefore, ANZ had developed a list of items selected from the Airbus *Customer Acceptance Manual*, which prescribes checks that typically are performed by Airbus pilots, with a customer's pilot aboard, before delivery of an airplane to the customer. At least one of the flight crewmembers must be a qualified test pilot, and an Airbus test engineer must be aboard to rebrief the pilots on the check procedures and expected parameters, and to record the results of the checks.

The report noted that although the GXL captain had participated in an A320 customer acceptance flight in 2004, neither he nor the copilot had received specific training to conduct functional check flights. Furthermore, although the ANZ pilot was included on the list of company pilots who could perform check flights, he had not actually performed such a flight.

When the A320 departed from Perpignan, visual meteorological conditions (VMC) prevailed, with light and variable surface winds, 10 mi (16 km) visibility in light rain, a few clouds at 3,300 ft and a broken ceiling at 5,100 ft.

The airplane was flown northwest, into airspace controlled by a regional air traffic control center (Figure 1). When the center controller received the A320's flight plan, he called the Perpignan approach controller. "He wanted to ensure that the crew had the necessary authorizations to undertake what he described as a 'disguised test flight,'" the report said. "He thought this flight had not been the subject of an appropriate request by the operator."

An almost identical flight plan had been filed earlier that day for a Boeing 737-800 operated by GXL. The flight plan specified an unscheduled air transport flight; however, "test flight" had been inserted in the flight plan box for miscellaneous information. "The crew of this flight … had asked on several occasions to perform maneuvers that had required coordination between the different control sectors," the report said. Although the center had accommodated the 737 crew's requests, the controller involved told investigators that the flight should have been conducted in airspace reserved for test flights.

Soon after the A320 copilot established radio communication with the center controller, he asked for clearance to perform a 360-degree turn. This time, the controller refused to accommodate the crew. "The controller explained to the crew that this type of flight could not be undertaken in general air traffic and that the flight plan was not compatible with the maneuvers requested," the report said.

The crew did not contest the controller's decision, but "the controller's refusal of the request to perform maneuvers nevertheless disturbed the course of the rest of the flight," and the crew had to "adapt and improvise in order to be able to complete their task," the report said.

Immobile Vanes

The captain requested and received clearance to climb to Flight Level (FL) 320 (approximately 32,000 ft) and to maintain a 320-degree heading for about 20 minutes before turning back toward Perpignan. Recorded flight data indicated that shortly after the airplane reached that flight level, the vanes on the no. 1 and no. 2 angle-of-attack sensors stopped moving. The water that had entered the sensor bodies during the rinsing three days earlier had frozen on internal bearings, immobilizing the vanes for the remainder of the flight in positions corresponding with cruise angles-of-attack — 4.2 and 3.7 degrees, respectively.

The no. 1 and no. 2 angle-of-attack sensors are part of the air data system for the captain's and copilot's instruments, respectively. The no. 3 sensor is part of the standby air data system. The external vanes, which align in flight with the relative wind, are heated automatically with alternating electrical current when the engines are running; the interiors of the sensor bodies are not heated.

The A320 maintenance manual requires the application of adhesive tape to mask the gaps between the bases of the sensors and the fuselage plates to which they are attached before the airplane is washed or rinsed. This helps prevent water from entering the sensor bodies and causing corrosion, faulty electrical connections or icing in flight. Airbus warns that the sensors must not be exposed directly to high-pressure water, even when the sensors are properly masked. The report said that the sensors on the accident airplane likely were not masked properly before the airplane was rinsed with water delivered under high pressure.

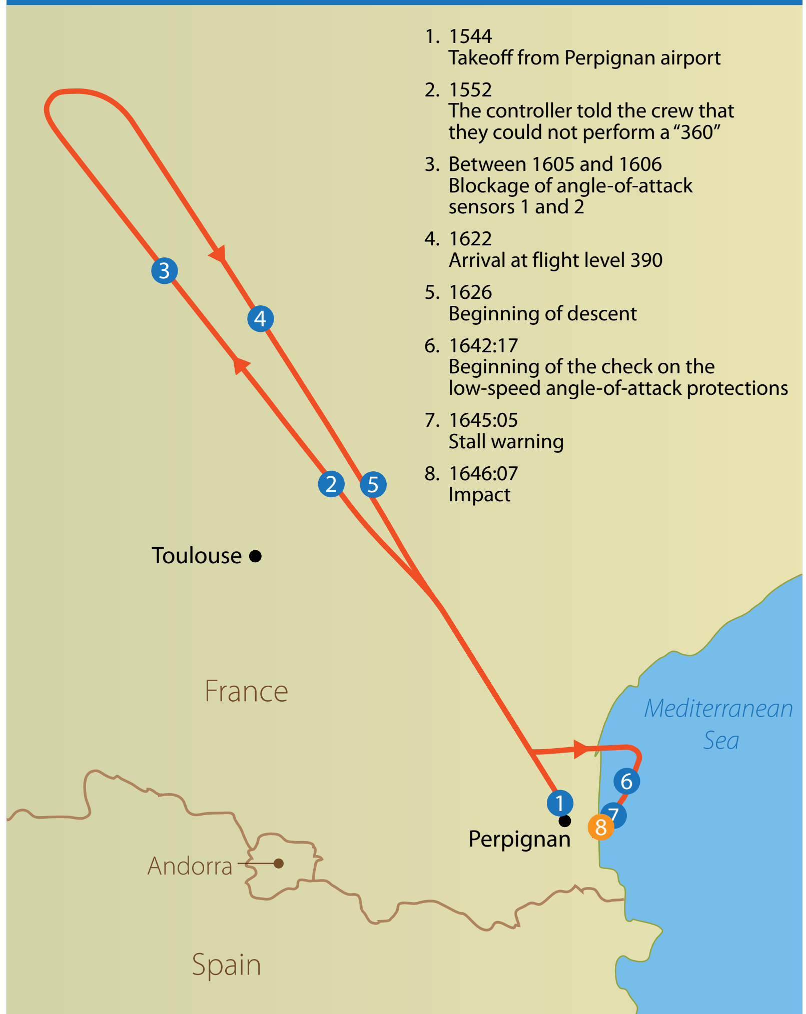
Control Laws

The CVR transcript indicates that the crew performed several checks "in a relaxed and professional manner" before turning back toward Perpignan at 1612, the report said. The crew requested and received clearance to climb to FL 390, where they performed an auxiliary power unit starting check. During the subsequent descent to FL 130, the crew performed checks of the wing anti-icing system and the overspeed-protection system.

The ANZ pilot then told the captain that the next item was a check of the flight controls in *alternate law*, which is among the flight control laws that govern the A320's fly-by-wire system. "The airplane is [hand] flown using two sidesticks whose movements are transmitted in the form of electrical signals to computers that transform them into orders to the actuators of the various [control] surfaces," the report said. Ordinarily, the system is governed by *normal law*, which provides a number of automatic "protections" against exceeding flight envelope parameters. Under certain conditions, including subsystem failures, the fly-by-wire system will revert to *alternate law* or to *direct law*, both of which provide fewer protections. For example, a dual air data computer failure will cause the system to revert from normal law to alternate law; a triple air data computer failure will cause a reversion from normal to direct law.[2]

At 1633, the crew established radio communication with a Perpignan approach controller and requested radar vectors for the instrument landing system (ILS) approach to Runway 33. The copilot told the controller that the approach would terminate with a go-around and that the flight would then proceed to Frankfurt. The controller told the crew to fly a heading of 090 degrees and to descend to FL 80. This heading took the A320 out over the sea. "The crew

A320 Flight Path



Source: Adapted from BEA by Susan Reed

Figure 1

performed the check on the flight controls in alternate law before beginning the descent," the report said.

By the Book

The captain and the ANZ pilot then briefly discussed the procedures for the next item: the low-speed checks. However, they did not review the altitude or airspeed limits appropriate for the checks, as prescribed by the Airbus *Customer Acceptance Manual*.

The manual also says that the low-speed checks must be performed in VMC and no lower than FL 100, and that icing conditions should be avoided beforehand. The airplane must be in normal control law and in landing configuration. Prior to deceleration, the test engineer must brief the pilots on the minimum airspeeds that correspond to the airplane's weight and configuration. "The crew must anticipate the incorrect functioning of the system under test and must define the manner in which the test or the check is to be stopped," the report said.

The purpose of the low-speed checks is to determine if the *angle-of-attack protections* — or *alpha protections* — activate at the corresponding airspeeds calculated by the flight augmentation computers and shown on the primary flight display (PFD) speed tapes. The automatic "protections" — which include retraction of the speed brakes, inhibition of the autotrim system and selection of takeoff/go-around thrust — are designed to prevent angle-of-attack from reaching the value at which the airplane will stall.

According to the Airbus manual, the pilot flying first stabilizes airspeed at V_{LS} (the lowest selectable airspeed), then reduces thrust to idle and adjusts pitch to achieve a deceleration rate of one kt per second. As the airplane decelerates, angle-of-attack increases to a value called *alpha prot*, which corresponds to the indicated airspeed $V\alpha_{PROT}$ near the bottom of the PFD speed strip (Figure 2). At this point, the crew should notice that the autotrim system has been inhibited and/or that the speed brakes, if deployed, have been retracted — both protections again exceeding *alpha prot*. "With no input on the sidestick, the angle-of-attack remains at this value," the report said.

However, to continue the check, the pilot flying moves the sidestick aft to achieve further deceleration and an increase in angle-of-attack to the *alpha floor*. This is not shown on the PFD speed strip, but the automatic application of maximum thrust indicates that the protection against exceeding the *alpha floor* is functioning.

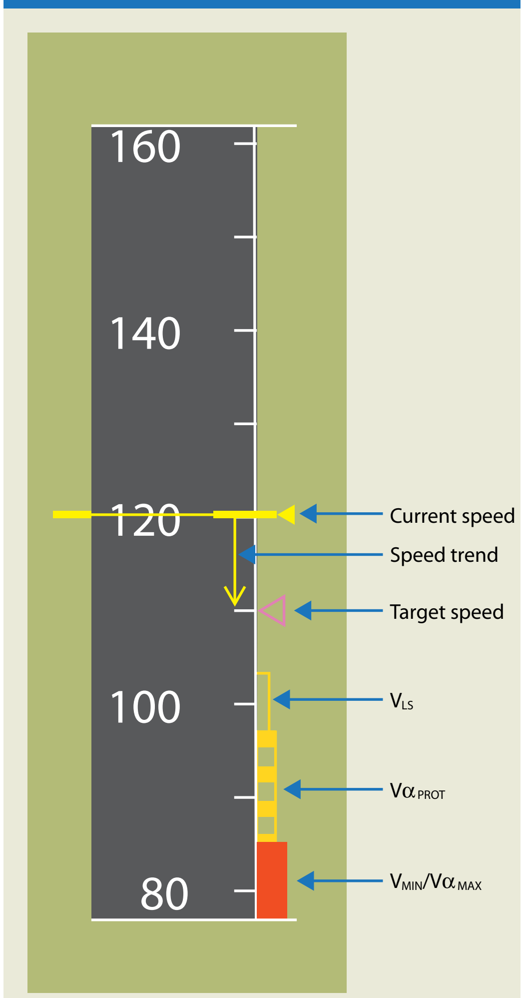
To complete the check, the crew disengages the autothrottle, and the pilot flying moves the sidestick to the aft stop. "The airplane can only decelerate to a limit angle-of-attack called *alpha max*," the report said. "Its [corresponding] speed (V_{MIN} or $V\alpha_{MAX}$) is maintained with an adapted flight path. The value of this angle-of-attack is lower than that of the stall angle-of-attack."

No Protections

At 1640, the approach controller told the crew to turn right to a heading of 190 degrees, a vector toward an initial approach fix, and to maintain 180 kt. She then cleared the crew to conduct the ILS approach and told them to descend to 5,000 ft.

Likely concerned that the airplane was in instrument meteorological conditions and that they had been cleared for the approach, the captain told the ANZ pilot that they would postpone the low-speed checks until the flight to Frankfurt or not perform them at all. However, after receiving a further descent clearance to 2,000 ft and encountering VMC, the captain discontinued his approach briefing, and the flight crew began configuring the airplane for the low-speed checks. "The captain asked for speed values from the Air New Zealand pilot, who answered, 'Just … come right back to alpha floor activation,'" the report said.

Primary Flight Display Speed Strip



V_{LS} = lowest selectable airspeed; $V\alpha$ = airspeed corresponding to α_{PROT} angle-of-attack; $V_{MIN}/V\alpha_{MAX}$ = airspeed corresponding to α_{MAX}, or limit angle-of-attack

Source: Adapted from BEA by Susan Reed

Figure 2

The airplane was descending through 4,080 ft over the sea when the crew began the low-speed checks. Airspeed decreased rapidly from 167 kt, and the captain pulled his sidestick all the way back, anticipating the activation of the angle-of-attack protections. However, the angle-of-attack protections never activated. "The blockage of the angle-of-attack sensors made it impossible for these protections to trigger," the report said.

As the airplane decelerated, the autotrim system gradually moved the horizontal stabilizer to the full nose-up position. Pitch angle was 18.6 degrees and airspeed was 99 kt when the no. 3 angle-of-attack sensor generated a stall warning at 1645. The captain moved the thrust levers to the takeoff/go-around detent and attempted to pitch the airplane nose-down. A series of roll and pitch oscillations occurred, with bank angles reaching maximums of 59 degrees left and 97 degrees right, and pitch attitudes varying from 52 degrees nose-up to 45 degrees nose-down.

According to the report, the asymmetric roll and pitch movements resulted in airspeed data divergences, which were interpreted by the flight control system as a failure of all three air data computers. Consequently, the flight control law reverted automatically from normal to direct. The most critical result was the disengagement of the autotrim system, which was indicated by a message displayed on the PFDs: "USE MAN PITCH TRIM." Nevertheless, the captain did not reduce thrust or use the manual pitch-trim system to move the horizontal stabilizer from its full nose-up position.

"Under the combined effects of the thrust increase, the increasing speed and the horizontal stabilizer still at the pitch-up stop, the airplane was subject to a pitch-up moment that the captain could not manage to counter, even with the sidestick at the nose-down stop," the report said. "The exchanges between the pilots at this time show that they did not understand the behavior of the airplane."

Airspeed dropped to 40 kt before increasing rapidly as the airplane descended into the Mediterranean near Canet-Plage. "The last recorded values were a pitch of 14 degrees nose-down, a bank angle of 15 degrees to the right, a speed of 263 kt and an altitude of 340 ft," the report said.

The loud acceleration of the engines had drawn the attention of many witnesses. "A few seconds after the increase in the engine rpm, all the witnesses saw the airplane suddenly adopt a pitch-up attitude that they estimated as being between 60 and 90 degrees," the report said. "The majority of the witnesses saw the airplane disappear behind a cloud layer. The noise generated by the engines was still constant and regular. The airplane reappeared after a few seconds with a very steep nose-down angle. … Some witnesses remember a very loud 'throbbing' that they heard until the impact."

The upset had occurred rapidly. "Between the time the stall warning sounded for the first time and the moment the recordings stopped, 62 seconds had passed," the report said.

Among the recommendations generated by the BEA's investigation of the accident was that the European Aviation Safety Agency (EASA) "undertake a safety study with a view to improving the certification standards of warning systems for crews during reconfigurations of flight control systems or the training of crews in identifying these reconfigurations and determining the immediate operational consequences."

BEA also recommended that EASA work with manufacturers to "improve training exercises and techniques related to approach-to-stall to ensure control of the airplane in the pitch axis."

The asymmetric roll and pitch movements resulted in airspeed data divergences, which were interpreted by the flight control system as a failure of all three air data computers.

This article is based on the English translation of the BEA report titled "Accident on 27 November 2008 off the Coast of Canet-Plage (66) to the Airbus A320-232 Registered D-AXLA Operated by XL Airways Germany." The full report is available at <bea.aero/en/enquetes/perpignan/perpignan.php>.

Notes

1. Flight Safety Foundation will host a symposium on the challenges and best practices related to functional check flights Feb. 8–9, 2011, in Vancouver, Canada (see p. 28).

2. Airbus. *A319/A320A321 Flight Deck and Systems Briefing for Pilots*. September 1998.

Functional Check Flight Symposium

Hosted by

FLIGHT SAFETY FOUNDATION

February 8–9, 2011
The Westin Bayshore, Vancouver, Canada

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Some recent accidents and incidents have highlighted the higher risk associated with conducting functional check flights. These flights are vital to insuring safe, reliable and airworthy aircraft. How these flights are conducted, who conducts them, exactly what is to be accomplished on these flights and how it is to be accomplished are major issues that must be addressed by any organization that conducts functional check flights. This symposium will provide a forum to discuss challenges and best practices related to functional check flights.

Commercial aircraft manufacturers, regulators and operators will discuss the challenges to be addressed and current best practices for conducting functional check flights. Commercial aircraft manufacturers will discuss important items to consider when conducting functional check flights. Regulators from the U.S., Europe, Canada and Brazil will discuss their views and current and potential future regulations and several operators will discuss their current policies, procedures and some of the best practices they utilize in conducting functional check flights.

For on-line registration and hotel reservations, go to:

http://flightsafety.org/aviation-safety-seminars/functional-check-flight-symposium

or contact Namratha Apparao, +1 703.739.6700, ext. 101, apparao@flightsafety.org.

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Preliminary Agenda

Monday, February 7

1800 Opening Reception

Tuesday, February 8

0900–0915 Welcome and Symposium Opening — James M. Burin, director of technical programs, Flight Safety Foundation

0915–0945 Keynote Address — Capt. David Morgan, chief pilot and general manager, Air New Zealand

Session I Manufacturer's Perspective

Session Chairman: Capt. Dave Carbaugh, chief pilot flight operations safety, Boeing Test and Evaluation

0945–1030 Airbus Perspective — Harry Nelson, experimental test pilot; and Jean Michel Roy, experimental test pilot, Airbus S.A.S.

1030–1100 Boeing Perspective — Capt. Gary Meiser, chief pilot, production flight test, Boeing Commercial Airplanes

1100–1130 **Refreshments**

1130–1200 Bombardier Perspective — Sam Gemar, chief, flight test operations and safety, Bombardier Flight Test Center

1200–1230 Embraer Perspective — Capt. João Braile, Embraer 170/E145 production flight test pilot coordinator; and Eng. Fabrizio Sabioni, Embraer 170/E145 production flight test engineer coordinator

1230–1300 Questions and Answers for Manufacturers

1300–1400 **Lunch**

Session II Regulator's Perspective

Session Chairman: Capt. Claude Lelaie, senior vice president, product safety officer, Airbus S.A.S.

1400–1430 ANAC Presentation — Capt. Homero Montandon, flight test pilot, ANAC–National Civil Aviation Agency–Brazil

1430–1500 Transport Canada Presentation — Walter Istchenko, chief of flight test, Transport Canada

1500–1530 **Refreshments**

1530–1600 EASA Presentation — Yves Morier, head of product safety, EASA Rulemaking Directorate

1600–1630 FAA Presentation — Jerry Ostronic, aviation safety inspector, U.S. Federal Aviation Administration

1630–1700 Questions and Answers for Regulators

1700–1715 Summary of Day 1

Wednesday, February 9

Session III Operator's Perspective

Session Chairman: Jacques Nadeau, chief liaison pilot, Bombardier Aerospace

0900–0920 Delvin Young, chief pilot, flight test, American Airlines

0920–0940 Sel Laughter, manager, flight test, United Airlines

0940–1000 Operator to be announced

1000–1040 **Refreshments**

1040–1100 Steve Smith, manager flight technical services, Cathay Pacific Airlines

1100–1120 Operator to be announced

1120–1200 Question and Answer Session for Operators

1200–1330 **Lunch**

Session IV Panel Discussion

Moderator: Capt. David Morgan, chief pilot and general manager, Air New Zealand

1330–1500 Panel Discussion — Symposium Presenters

1500–1530 Question and Answer Session for Panel

1530–1600 Summary of Symposium

Despite wet snow on the runway, the A321 crew expected normal winter landing conditions.

SLIDING AWAY

BY DAVID THOMAS

On the evening of March 26, 2006, an Airbus A321 operated by My Travel Scandinavia was involved in a serious landing incident at Sandefjord Airport Torp in southern Norway. Although damage was minimal, the aircraft stopped about 65 degrees off the runway heading with the nosewheel against the concrete base of an antenna and the right main wheel approximately 2 m (7 ft) from the end of the runway (*ASW*, 4/10, p. 56).

This crew's experience illustrates the problem of detecting and describing braking action on contaminated runways that has become the subject of significant discussion.

During the preflight preparation for the midday departure from Tenerife, Canary Islands, Spain, crewmembers had received a company briefing pack containing a snow notice to airmen (SNOWTAM) indicating that the runway at Torp was wet with good braking action, and a terminal area forecast calling for snow with deteriorating visibility as the afternoon progressed.

Just before descent, the automatic terminal information service indicated that the runway was dry with good braking action and visibility was 2.5 km (1.6 mi) in light snow. There was broken cloud at 500 ft, the temperature was minus 2 degrees C (28 degrees F), and the dew point was minus 3 degrees C (27 degrees F). Although the wind, from 030 degrees at 6 kt, marginally favored the nonprecision approach to

Runway 36, the instrument landing system approach to Runway 18 was in use. On descending through Flight Level 100 (approximately 10,000 ft), an additional 5 kt was added to the approach speed based on a formula that took into account the icing conditions.

As the aircraft descended, snow began to settle on the runway. Three minutes before landing, the air traffic control tower informed the crew that the runway was contaminated with 8.0 mm (0.3 in) of wet snow and the friction coefficients indicated medium braking. A glance at the actual landing distance (ALD) figures in the quick reference handbook indicated that the 72-tonne (158,733-lb) aircraft would require an ALD of 1,812 m (5,945 ft), with maximum manual braking after touchdown. The landing distance available (LDA) was 2,569 m (8,429 ft).

The aircraft touched down softly 357 m (1,171 ft) beyond the touchdown point, and both the reversers and spoilers were promptly deployed. The captain thought that the autobrake had disarmed because of the lack of braking action. Eight seconds later, the first officer applied full manual braking and shortly afterward, when they still were unable to feel any braking action, the captain took control and applied the parking brake. The aircraft was still decelerating as it approached the end of the runway. The first officer indicated that the terrain looked more even to the left of the runway, and the captain responded by turning the nosewheel steering toward the left.

The first assumption one might make after reading this brief account is, considering that the crew touched down 357 m down the runway, the incident must have been the result of a mishandled approach and landing. Case closed or not?

The aircraft had been slightly above the glideslope below 250 ft, crossing the runway threshold 10 ft high and carrying an extra 5 kt for icing; the extra speed might not have been necessary. These deviations can be easily understood considering the short notice to the crew about the change in runway condition and the crew's mindset of medium braking action. In normal line operations on a dry runway, both the extra height and the extra speed would have been insignificant.

The flight data recorder indicates that the autobrake was armed but may have been disengaged accidentally. Aerodynamic braking and engine reverse produced a deceleration of 0.16 g, increasing to 0.20 g when manual braking was applied at 110 kt.

In calculating landing performance using Airbus tables, 8 mm of wet snow was considered equivalent to ¼ in of slush. Airbus takes into account contaminant drag and uses varying effective Mu[1] (friction) values that are groundspeed-dependent for fluid contaminants. It is, therefore, difficult to establish an equivalent average aircraft braking coefficient (ABC) value.

After landing on a snow-covered runway in Torp, Norway, the A321 stopped with its nosewheel against an antenna's concrete base.

Accident Investigation Board Norway

In contrast, Boeing does not consider contaminant drag and uses an average (groundspeed-independent) ABC value for each contaminant.

Below 110 kt, the ABC was approximately 0.05; this reduced to 0.04 after the parking brake was set at 70 kt and the wheels locked. If Airbus used the same methodology as Boeing, the crew would have been aware before touchdown that 8 mm of wet snow corresponds to an average (groundspeed-independent) ABC value of 0.05 — associated with poor braking action. Why did such a recently completed runway friction test suggest the braking action was medium?

The airport's winter regulations in 2006 said that it was a priority to offer a runway free of snow and ice and that when runway friction decreased below poor, the affected areas were to be closed until satisfactory braking action could be re-established.

Both Airbus and Boeing support the view that friction readings from ground friction-measuring devices may not represent actual ABC. In a number of countries, friction-measuring devices can only be used on compacted snow and ice or on a bare runway. The Accident Investigation Board Norway (AIBN) has highlighted the uncertainty of friction measurements from friction-measuring devices. Their findings suggest tolerances on fluid contaminants of plus or minus 0.20; on dry contaminants, tolerances are plus or minus 0.10. The friction-measuring device used at Torp was certified for use only in up to 3.0 mm (0.1 in) of wet snow. However, considering the fluid contaminant tolerances, this was not seen as a contributory factor.

The unreliability of ground friction-measuring devices is not the sole reason for the incorrect braking action report. Other factors are the air temperature and dew point. The AIBN has investigated 30 incidents and accidents that occurred on contaminated runways over the last 10 years and has highlighted a number of coinciding factors. The most common — evident in 21 of the 30 occurrences — was a difference of 3 degrees or less between the air temperature and the dew point.

The narrow temperature–dew point split indicates that the relative humidity of the air mass will be at least 80 percent. Given these conditions, with an air temperature at or below freezing, the air mass immediately above the runway surface is close to, or at, saturation, causing freezing on contact with the runway surface.[2] This phenomenon was derived from findings by the AIBN and is referred to as the 3-Kelvin-Spread Rule. The AIBN has concluded that poor braking action often is associated with moist low-level atmospheric conditions. Although the rule is not an absolute, it is a good indicator of hazardous conditions. It is likely that at Torp, the lower layers of wet snow had frozen to form ice on the runway.

Four years after the accident, have things changed?

As a result of a Dec. 8, 2005, runway excursion accident involving a Southwest Airlines 737-700 at Chicago Midway International Airport (*ASW*, 2/08, p. 28),[3] the U.S. Federal Aviation Administration issued Safety Alert for Operators 06012 and a related advisory circular. The agency also formed the Takeoff and Landing Performance Assessment (TALPA) Aviation Rule-Making Committee. Although the committee's recommendations have not been adopted, a primary provision is the runway safety matrix, designed to produce a standardized reporting method, developed from different types of surface condition reports and aircraft data (see "Unveiling the Matrix," p. 33).

Airbus released a letter in mid-2010 advising operators to add safety margins to its ALDs, in line with the committee's proposals. As an interim solution, Airbus has settled on a plan to factor its ALDs to calculate an operation landing distance (OLD), which is designed to reflect the actual performance achieved by a line pilot.

If the TALPA matrix had been available for use on the evening of the Torp runway incident, the crew would have factored their 1,812 m ALD to obtain an OLD of 2,563 m (8,409 ft) — 6 m (20 ft) less than the LDA.

David Thomas is a captain with a major U.K. airline.

Notes

1. Airbus uses the term *effective Mu*, while other manufacturers, including Boeing, use *ABC*, referring to the percentage of the airplane's weight on the wheels (W-L), which is converted into an effective stopping force. For example, an airplane with a W-L of 100,000 lb (45,360 kg) would create 20,000 lb (9,072 kg) of stopping force for an ABC of 0.20. ABC depends on tire pressure, tire wear, aircraft speed, aircraft weight and anti-skid system efficiency.
2. Water vapor can change to ice without becoming liquid. This is likely if the air is saturated and is cooled below the freezing point. The process is known as sublimation.
3. As it skidded off the runway, through an airport fence and onto a road, the 737 struck two cars, killing one passenger. Another occupant of a vehicle received serious injuries, and three others received minor injuries. Of 103 people in the airplane, 18 received minor injuries. The U.S. National Transportation Safety Board said the probable cause of the accident was the flight crew's failure to promptly apply reverse thrust. The pilots were distracted by the airplane autobrake system, which they had not used before, the NTSB said.

Unveiling the Matrix

A new tool for assessing and reporting runway condition.

BY PATRICK CHILES

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Government and industry members of the Takeoff and Landing Performance Assessment Aviation Rulemaking Committee (TALPA ARC) provided some welcome insights into their findings and recommendations for improving the safety of operations on contaminated runways at an October 2010 presentation to Boeing's Performance and Flight Operations Engineering Conference. The presentation included a briefing on progress in developing a decision-making tool that is informally called the "Runway Condition Matrix." The matrix enables the correlation of various criteria to prepare a runway condition report for pilots in readily understood terminology.

The TALPA committee was formed by the U.S. Federal Aviation Administration (FAA) following the Boeing 737-700 overrun at Chicago Midway International Airport in 2005 — and a subsequent attempt to mandate before-landing performance assessments that was dropped in favor of a comprehensive review of the safety issues involved in operations on contaminated runways.

As is often the case with a tragic event, the Midway accident drove regulators to search for deficiencies within their own policies and guidance. While the landing field length margins for dispatch seem quite generous, the safety provisions of the "60 percent rule" diminish if the expected runway is changed or if conditions deteriorate.[1] Unless landing distances are recalculated before arrival based on existing conditions, operators sometimes are exposed to considerable risk.

Back-Door Legislation

Within months of the Midway accident, an FAA internal review team proposed two requirements: that manufacturers provide landing data for contaminated runways; and that operators conduct landing performance assessments before arrival that include a 15 percent safety margin.[2]

The proposed requirements were issued as a "notice of policy statement," which was met with sizeable resistance. Many operators expressed concern at what they saw as subversion of the public rule-making process — requiring new OpSpecs (operations specifications) without a supporting regulatory framework. Charter and fractional ownership operators were alarmed that the practical effect of the requirements would be to shut them out of the smaller airports where their businesses thrive.

The FAA eventually replaced the notice of policy statement with a safety alert for operators (SAFO) that "urgently recommends" that operators develop procedures for flight crews to perform a before-landing assessment that incorporates the 15 percent safety margin.[3] At the same time, the TALPA committee was chartered to begin work on formal rule making. Its task was threefold: establish airplane certification and operating standards for contaminated runways; create distance assessment and safety margin requirements; and improve standards for runway surface condition reporting. The solution would not just be on the operator's shoulders; manufacturers, airport operators and air traffic service providers also would be affected.

It soon became clear that, in terms of runway contamination, there in fact were no common terms. Current surface reporting methods have suffered from nonstandard descriptions and different measurement techniques, and they are inherently subjective. Braking action reported as "good" by the crew of a Cessna Citation might be entirely different for the crew of a widebody Boeing following in trail. Further, runway friction reports — Mu reports — can be deceptively imprecise because they don't directly correlate with an airplane's braking friction tables; they are, in fact, measuring different values of friction.

The only commonality was that all these methods have shortcomings. This led the committee to devise a combination of the best attributes of each method while attempting to correct their known deficiencies.

Enter, the Matrix

The Runway Condition Matrix is a result of the committee's efforts.[4] The matrix is an attempt to correlate the various types of surface condition reports with a given aircraft's contaminated-runway landing data in a standardized and easily understood reporting method (Table 1). This has been an elusive goal primarily due to different frames of reference: an airport's measurement — or, more often, *estimate* — of Mu is a wheel-to-pavement friction value, whereas an aircraft manufacturer's Mu represents internal friction between wheels and brakes.

The matrix is not yet a finished product; the FAA is still working to develop better characterizations of runway conditions. A limited round of beta testing was completed last winter; further testing will be performed this winter with two aircraft operators and 13 airports. The final results may be presented in different formats depending on the user, but the terminology and relationships between values will be the same for operators, airports and aircraft manufacturers. The matrix eventually will present reliable information to pilots and dispatchers in an unambiguous decision-making tool. It will also provide airport managers and aircraft manufacturers with common reference points for surface conditions and related braking effectiveness.

Clearer Coding

Accurately reported runway conditions with common definitions will be the linchpin of this effort. The scheme will rely to a great extent on the airport operators who adopt the new reporting conventions.

Several changes are being proposed for notice to airmen (NOTAM) coding. Abandoning the use of terms such as "patchy," "thin" and "trace," airport operators would, instead, use terminology that is more in line with airplane flight manual (AFM) contaminated-runway terminology. They would report runway conditions in terms of contaminant type, depth and percentage of runway coverage in a manner more consistent with the International Civil Aviation Organization (ICAO) recommendation of a numbering system that varies from zero for wet ice to six for a dry runway. For example, Table 1 shows that a runway condition report of "4/4/3" would indicate that frost or compacted snow (Code 4) covers the first two-thirds of the runway, while the final third is covered with dry or wet snow deeper than 1/8 in (Code 3). This would also be equivalent to a pilot report of "good-to-medium" braking action.

Standardization also means that airports could continue using Mu

Proposed Runway Condition Matrix, October 2010

Assessment Criteria		Downgrade Assessment Criteria		
ICAO Code	**Runway Condition Description**	**Mu (μ)**	**Deceleration and Directional Control Observation**	**Pilot Reports Provided to ATC and Flight Dispatch**
6	Dry		—	Dry
5	Wet (smooth, grooved or PFC runway) 1/8 in or less depth of: Water Slush Dry snow Wet snow	40 or higher	Braking deceleration is normal for the wheel braking effort applied. Directional control is normal.	Good
4	Frost At or below –15°C outside air temperature: Compacted snow	30–39	Braking deceleration and controllability are between good and medium.	Good to medium
3	Wet ("slippery when wet" runway) Dry snow or wet snow (any depth) over compacted snow Greater than 1/8 in depth of: Dry snow Wet snow Warmer than –15°C outside air temperature: Compacted snow		Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be noticeably reduced.	Medium
2	Greater than 1/8 in depth of: Water Slush	21–29	Braking deceleration and controllability are between medium and poor. Potential for hydroplaning exists.	Medium to poor
1	Ice		Braking deceleration is significantly reduced for the wheel braking effort applied. Directional control may be significantly reduced.	Poor
0	Wet ice Water on top of compacted snow Dry snow or wet snow over ice	20 or lower	Braking deceleration is minimal to nonexistent for the wheel braking effort applied. Directional control may be uncertain.	Nil

ICAO = International Civil Aviation Organization; Mu = runway friction measurement; ATC = air traffic control; PFC = porous friction coating

Source: U.S. Federal Aviation Administration

Table 1

measurements and pilot reports to support their assessments but would cease issuing these directly. The information will be part of the data set used to substantiate a condition report, not the report itself. In particular, Mu measurements and pilot reports can contribute to the *downgrading* — or modification — of a prior assessment (i.e., from bad to worse) based on contaminant type and depth, alone, but not to upgrading it. Direct observations of the runway and measurements of contaminant depth are required to upgrade an assessment.

Safety Margin

As expected when the SAFO was published in 2006, airline operators will be required to conduct before-landing performance assessments that incorporate the 15 percent safety margin. The safety margin largely is considered necessary because it will be applied to *operational* distances that contain no other adjustment factors and typically include credit for the use of thrust reversers. The AFM numbers used for *dispatch*, on the other hand, are based on an entirely different set of assumptions, which already confirm that the airplane can stop within 60 percent of the available runway without reversers. *ASW* readers might recall that misunderstanding the differences in operational and dispatch landing performance contributed to the Midway accident (*ASW*, 2/08, p. 28).

Before-landing assessments will not be required if the condition of the intended runway has not changed or deteriorated while en route, but takeoff performance assessments will have to consider contaminant reports.

After some initial objections, TALPA ARC members representing the airlines eventually concluded that the proposed 15 percent safety margin is "arbitrary but reasonable." However, due to different operating environments and philosophy, agreement was not reached between air carrier and business jet operators. For this reason, the 15 percent margin will be proposed only for U.S. Federal Aviation Regulations (FARs) Part 121 air carrier operators; it will not affect Part 135 air taxi/commuter operators, Part 91K fractional ownership operators or Part 125 operators, which operate airplanes with 20 or more passenger seats or with a maximum payload capacity of 6,000 lb (2,722 kg) or more.

Airline participants on the committee have pointed out that better guidance and training, and changes to fundamental thought processes will be needed to make this effort successful. In particular, differences among manufacturers in air-distance assumptions — basically, the assumed length from the approach threshold to the touchdown point on the runway — can have a significant effect on actual landing lengths. Pilots should be encouraged to treat contaminated runways as if they were "short fields" — not allowing their airplanes to "float" for a softer touchdown and being ready and willing to go around if they are unable to touch down as planned.

More Data Needed

Operators, of course, won't be able to do any of this without new data from the manufacturers, which will face significant changes in airplane certification standards and requirements for the related FAA-approved AFMs. In the United States, performance data for contaminated runways are not required and are typically not included in the AFM, although such data may be provided in unapproved operating manuals or performance software.

Other than evolving from advisory to approved status, this is not an entirely new concept. European authorities already insist that contaminants be compared against approved dry or wet numbers for landing and takeoff. New flight testing is not expected; manufacturers will be able to develop the data from calculations based on adapting the current European Aviation Safety Agency (EASA) CS-25 transport category airplane certification standards. The data will assume uniform coverage of contaminants on the runway and include specific braking coefficients for each coded surface condition. Effects of contaminant-displacement and -impingement drag, and hydroplaning also must be considered for each contaminant type and depth, across the spectrum of braking actions from "poor" to "good."

All new and existing airplanes certificated under FARs Part 25 would be affected, as well as new Part 23 commuter and multiengine turbojets, and some existing Part 23 models. After the final rule goes into effect, manufacturers will have two years to bring in-production aircraft into compliance. Four years will be allowed for out-of-production models.

Rule-Making Logjam

The TALPA ARC charter expired after the committee presented its final recommendations in October 2009. The FAA has begun the rule-making process but has yet to reach some decisions on content, scope or timing. The committee's total-system approach, although admirable, unfortunately has made new performance rule making enormously complex, intertwining multiple lines of authority across the FAA, which recently has been burdened further by congressional mandates for new crew rest and scheduling rules. Resolution has become limited by available resources.

Readers should bear in mind that no formal action has been taken on the recommendations of the TALPA committee; the final results may appear different. The FAA expects to move on the committee's recommendations in 2011, barring any further congressional intervention.

Patrick Chiles is a member of Flight Safety Foundation's Corporate Advisory Committee and the Society of Aircraft Performance and Operations Engineers.

Notes

1. The "60 percent rule" refers to FARs Part 121.195, Part 135.385 and Part 91.1037, which basically prohibit a large turbine airplane operated by an air carrier, a commuter or on-demand operator, or a fractional ownership operator, respectively, from departing unless its weight at the expected time of arrival at the destination airport allows a full-stop landing within 60 percent of the effective length of the intended runway.
2. A "15 percent safety margin" means, for example, if a flight crew calculated an actual landing distance of 5,000 ft based on the conditions existing upon arrival, they would have to ensure that the available landing distance on the intended runway is at least 5,000 times 1.15, or 5,750 ft.
3. SAFO 06012. "Landing Performance Assessment at Time of Arrival (Turbojets)." Aug. 31, 2006.
4. The official title of the matrix has undergone several changes and currently is the "Paved Runway Condition Assessment" table.

Code-Sharing Collectivism

© Chris Sorensen Photography

BY WAYNE ROSENKRANS

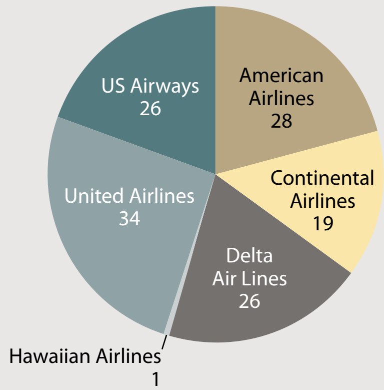
Launching the agency's first code-sharing safety symposium, moderator Deborah Hersman, chairman of the U.S. National Safety Board (NTSB), reminded panelists, "The overall focus is not to revisit previous accidents and incidents." Given controversies surrounding the nation's run of regional airline accidents since 2000, some could not resist.

They ultimately left unsettled, however, the question of when commercial agreements among airlines should be identified as a latent cause.

Titled "Airline Code-Sharing Arrangements and Their Role in Aviation Safety," the event on Oct. 26–27, 2010, in Washington was designed "to elicit information on the structures, practices and oversight of domestic and international code-sharing arrangements; gain insight into [the exchange of] best practices information between airlines and their [code-share] partners; and explore the role that a major airline would have in the family disaster assistance response for an accident involving a [code-share] partner," Hersman said. The context was five accidents in which regional airlines operated under code-sharing agreements, she said.[1]

Code-sharing in the United States is a marketing arrangement in which one air carrier's two-letter designator code— assigned by the International Air Transport Association (IATA) — in ticketing systems is used to identify a flight operated by another carrier, following Department of Transportation regulations.[2] The rules specify advance disclosures to passengers about which airline has operational control of a given flight, and block anti-competitive contracts.

Active U.S. Code-Sharing Agreements



Notes: Numbers indicate agreements by which the air carriers shown sold tickets on U.S. regional, U.S. mainline and non-U.S. air carriers, Oct. 1, 2009–Sept. 30, 2010.

Source: U.S. Federal Aviation Administration

Figure 1

The Federal Aviation Administration (FAA) has responsibility for the safety of operations involving code-sharing, but requires that only non-U.S. air carriers be audited by the U.S. marketing carrier selling tickets for the code-sharing flights, officials said.

To do this, the FAA uses system safety principles, safety attributes, risk management and structured-system engineering practices — a risk-based process that "looks at the characteristics of the air carriers, their safety performance and the environment that they operate in, and then tailors the oversight system to those air carriers," said John Duncan, manager, FAA Flight Standards Service.

"Regional carriers are their own operating entity," said Ken Hylander, senior vice president, corporate safety, security and compliance, at Delta Air Lines. "Regulations do not require extraordinary mainline-carrier oversight of [other] U.S. certificated air carriers. This is based upon the premise that the FAA provides necessary oversight [of compliance with] the Federal Aviation Regulations [FARs]. … However, [the marketing airlines also] spend a lot of time in collaboration with partners defining exactly what a robust safety program looks like, and then ensuring that it exists."

As of October, the FAA was monitoring 134 active domestic and international code-sharing agreements involving six U.S. air carriers, added John Barbagallo, manager, international programs and policy, at the FAA (Figure 1). "The agreements involve carriers from 53 countries," he said.

Conflicting Viewpoints

In symposium sessions about domestic operations, opposing views of the latent-cause question emerged concerning the crash of a Bombardier Q400 in February 2009 (see "Flight Path Management," p. 40). One representative of families of air crash victims — John Kausner, whose daughter, Elly, was one of 50 people killed in that accident — told the NTSB that he considers FAA standards to be insufficient for the licensing, training and flight experience of FARs Part 121 air carrier pilots. "Why wouldn't a major carrier require its code-share partners to train and hire pilots with the same level of competence that they require of their own pilots?" he asked. "I think code-sharing is a good concept that may have some terrible consequences."

Two of the airline safety specialists conceded that they "had not laid out a firm standard for our alliance partners" on pilot hiring and qualifications. "We have not defined a standard for our partners, but through avenues like our flight operations and training forum, we have discussed the standards, the approach to hiring and what our expectations are for pilots at Delta and at Delta Connection," said Delta's Hylander. "When we get nine airlines — Delta and the partners — together, there always can be different views of what works best. That is part of the reason why the FAA mandates that each carrier have its own certificate."

A representative from US Airways concurred. "Basically, we are not hands-on in [code-share partners'] training programs, but we provide expertise," said Paul Morell, vice president, safety and regulatory compliance, US Airways. "What is important when we look at a training program is that it's based upon … the environment pilots are flying in, the type of airplanes they're flying, what type of experience they have, and all the data coming into our advanced qualification program."

Code-sharing itself is not a safety issue, said John Prater, a captain and president of the Air Line Pilots Association, International. He called lift capacity-purchase agreements, which he termed "fee-for-departure" and "outsourcing," factors that leave a regional airline an "extremely limited ability to change its revenue." His concerns included potentially increased risks caused by rapid shifts of regional airline pilots from familiar to unfamiliar operating environments, significantly less training for regional airline first officers to become qualified as captains than for mainline carrier pilots, and "many carriers … driven to flying the most fatiguing combinations of schedules in the entire industry."

Airline and airline-alliance presenters explained how they address independent, but mutually supportive, safety responsibilities. All operate under FARs Part 121. "As the passengers expect, there is one level of safety," said Roger Cohen, president of the Regional Airline Association. "It is unfair [to imply] without any factual basis that any carrier out there is practicing anything or would do anything to cut costs that would reduce safety."

Some presenters countered stereotypes of entry-level qualifications of regional airline pilots. "When pilots arrive at Compass, they have an average of more than 3,200 flight hours of pilot experience and, of that, 1,300 hours as pilot-in-command; nearly 80 percent have prior FARs Part 121 [crew] experience," said Mark Millam, director of safety and compliance, Compass Airlines, a Delta code-share partner.

In U.S. domestic operations, a growing number of regional airlines undergo the IATA Operational Safety Audit (IOSA) every two years, share IOSA audit reports with mainline code-share partners and maintain IOSA registration, the airlines' representatives said. Most also submit to U.S. Department of Defense audits of quality and safety standards for charter airlift.

"We encourage the use of IOSA and whatever other mechanisms of that kind help the operator to deal with their legal responsibility to operate at the highest level of safety," the FAA's Duncan said. If non-IOSA-registered code-share partners are acceptable, U.S. mainline airlines typically conduct IOSA-like audits of them.

For example, American Eagle, in the process of IOSA audit preparations as of October, was the only code-share partner of American Airlines without IOSA registration, said David Campbell, vice president, safety, security and environment, at American Airlines. Ric Wilson, vice president, safety and compliance, at American Eagle, said that his company had considered IOSA registration unnecessary before the past two years' news stories questioning regional airline safety.

Code-sharing arrangements have introduced safety program requirements that the FAA cannot, airline presenters said. Mainline carriers are free to assess, for example, safety management systems, aviation safety action programs, flight operational quality assurance, line operation safety audits, internal evaluation programs and fatigue risk management systems. They also perform unannounced audits/inspections if warranted by safety or business developments, such as leadership changes, company restructuring or a fine proposed by the FAA.

"If warranted, we will suspend the code-share," said Michael Quiello, vice president, corporate safety, security and environment, United Airlines. "I recently suspended a code-share with Thai Airways [until they were able to get an IOSA registration renewal] because they did not meet the IOSA audit timeline. It doesn't mean they were not safe; they couldn't do it because of civil unrest in Bangkok, but the standard is the standard."

Another example cited was American Airlines terminating all its code-sharing agreements with Mexican airlines, as required by the FAA International Aviation Safety Assessments Program. From July 30–Dec. 1, 2010, the program downgraded Mexico to Category 2 — meaning that the FAA judged the country as not currently compliant with International Civil Aviation Organization standards.

At Delta, infrastructure for code-sharing safety has been spelled out in the *Delta Connection Carrier Non-Regulatory Safety Programs Standards Manual*. This manual specifies, for example, that each partner must have a system for tracking unstable approaches, enhanced ground-proximity warning system alerts, and pilot compliances with resolution advisories from traffic-alert and collision avoidance systems.

Teams comprising all the airlines' directors of safety in a code-sharing arrangement typically have formal exchanges of safety data, experience and expertise, other representatives said. For example, the US Airways Directors of Safety Alliance developed a flight safety index, which gives an overall quantitative score to events that could affect safety as a result of a mechanical condition or a flight operations irregularity, such as an unstable approach, altitude deviation, navigation error, runway incursion, air traffic control clearance deviation or rejected takeoff, said US Airways' Morell.

Notes

1. Hersman cited the Feb. 12, 2009, Continental Connection flight operated by Colgan Air near Buffalo, New York (*ASW*, 3/10, p. 20); the April 12, 2007, Northwest Airlink flight operated by Pinnacle Airlines near Traverse City, Michigan (*ASW*, 10/08, p. 20); the Feb. 18, 2007, Delta Connection flight operated by Shuttle America in Cleveland (*ASW*, 9/08, p. 22); the Aug. 27, 2006, Delta Connection flight operated by Comair in Lexington, Kentucky (*ASW*, 11/07, p. 38); and the Oct. 19, 2004, American Connection flight operated by Corporate Airlines in Kirksville, Missouri (*ASW*, 12/07, p. 47).

2. Requirements for approval are in FARs Part 257, "Disclosure of Code-Sharing Arrangements and Long-Term Wet Leases," effective Jan. 1, 2003. Requirements were tightened effective Aug. 1, 2010, by the Airline Safety and Federal Aviation Administration Extension Act of 2010.

Flight Path MANAGEMENT

BY WAYNE ROSENKRANS | FROM MILAN

Concerted action is needed to address vulnerabilities in average pilots' capabilities to safely monitor their flight path, conduct a missed approach, avoid stalls and maintain control of highly automated commercial jets, aviation specialists say. Several of 33 speakers at the Flight Safety Foundation International Air Safety Seminar, Nov. 2–5 in Milan, Italy, spoke with uncharacteristic urgency about these re-emerging risks — long thought to have been mitigated.

"Major improvements have been made in the design, training and operational use of onboard systems for flight path management … and their associated flight crew interfaces," said Kathy Abbott, chief scientific and technical adviser for flight deck human factors at the U.S. Federal Aviation Administration (FAA). "Incident and accident reports suggest that flight crews continue to have problems interfacing with these systems and have difficulty using these flight path management systems."

New evidence of vulnerabilities challenges comfortable assumptions about airline pilot training and automation.

J.A. Donoghue

She presented a few of the preliminary findings and recommendations of the Flight Deck Automation Working Group formed in 2001 by the Performance-Based Aviation Rulemaking Committee (PARC) and the U.S. Commercial Aviation Safety Team (CAST). Abbott prefaced her remarks by noting the airline industry's "impressive safety record" overall and the clear evidence that, in many cases, the expected interventions of flight crews have "saved the day" by successfully mitigating the resurgent risks discussed.

The final report in early 2011 will be a comprehensive update to the FAA's June 1996 report titled "The Interfaces Between Flightcrews and Modern Flight Deck Systems," this time looking in depth at 200 subcategories of data, some not considered previously. Data sources included pilot reports representing 734 incidents submitted in 2001–2009 to the Aviation Safety Reporting System (ASRS) of the U.S. National Aeronautics and Space Administration; reports on 26 accidents and 20 major incidents; and aggregated data from flight deck observations in 2001–2009 of 9,165 flights worldwide, all normal operations, in the line operations safety audit (LOSA) database of the LOSA Collaborative.

"We found vulnerabilities in [automation] mode and energy-state awareness, manual handling, and managing system malfunctions or failures," Abbott said. "These included failures anticipated by designers, [failures] for which there were no flight crew procedures, and [failures] in flight management system (FMS) programming."

To enable comparisons of disparate data sources, statistical techniques were used to normalize them. In the subcategory of manual handling errors, for example, comparisons revealed that approximately 25 percent of LOSA flights had a manual handling error, compared with slightly more than 60 percent of flights in which a manual handling error was identified by an investigative board as a factor in an accident.

Manual handling errors comprised 30 percent of the major incidents and less than 10 percent in the ASRS data, Abbott said. Errors included lack of recognition of autopilot or autothrottle disconnects; lack of monitoring or maintaining energy or speed; incorrect upset recovery; inappropriate control inputs; and dual side-stick inputs. Another area of vulnerability was programming errors and incorrect use of the FMS. No priority, frequency or relative importance was assigned to these.

A number of flight crews mismanaged system malfunctions. "Slightly over 30 percent of normal flights, according to the LOSA data, had a malfunction or a minimum equipment list [MEL] item as a threat in the flight," she said. "About 15 percent of the accidents, but over 50 percent of the major incidents … had a malfunction present as a threat."

About 42 percent of the selected flights revealed inadequate pilot knowledge of the flight director, autopilot, autothrottle/autothrust or FMS. Knowledge gaps, or inability to retrieve required information, extended to the understanding of systems and their limitations. Knowledge of standard operating procedures (SOPs), need for confirmation and cross-check, and mode transitions and understanding of airplane behavior were other concerns.

"We are recommending that operational policies be put into place that focus on flight path management," Abbott said. "The top recommendation for pilot training is improved industry practice and [new FAA] regulatory guidance and requirements for flight path and energy management, including for upset recovery."

Rebuilding Stall Defenses

Assumptions about a pilot's capability to deal with the rare occurrences of stalls in line operations cannot be based solely on a pilot's experience, said Dave Carbaugh, a captain and chief pilot, flight technical and safety, Boeing Commercial Airplanes. "Stalls can occur when performing a wide variety of maneuvers," he said. "The wing will stop flying when the critical angle-of-attack is exceeded and, therefore, performance will decrease. The natural reaction of flight crews is to continue to pull on the [control] column or [side-stick]."

Robust Go-Arounds

Since the late 1990s, advocacy of timely go-around decisions and correct go-around maneuvers has been a core element of a global campaign to further reduce risk during the approach and landing phases of flight. Possible explanations of why a few airline flight crews recently have failed to take these actions or to safely complete landings were offered by Bertrand de Courville, an Airbus A330 and A340 captain for Air France and co-chairman of the European Commercial Aviation Safety Team.

He presented insights, based on reviews of research reports and safety investigations, to the Flight Safety Foundation International Air Safety Seminar. "Formal criteria and informal, undocumented criteria [exist] for deciding to go around but, in the end, any pilot should discontinue the approach or landing whenever he or she perceives that safety is going to be compromised," de Courville said. "We have [from 2005 industry data] an average of one to two go-arounds per 1,000 flights. This means, for short-range pilots, less than one go-around per year, and for long-range pilots, about one go-around in five to 10 years. … Compared with [this small] number of go-arounds flown, the ratio of incidents during go-arounds is much too high — but we can make it safer."

An International Air Transport Association safety report for 2005 also showed that 34 percent of go-around decisions were related to air traffic control (ATC) issues, 22 percent were related to meteorological factors and 16 percent were related to unstabilized or destabilized approaches, he said.

"Every year, 30 percent of fatal accidents are related to a situation where some criteria for go-arounds were present," de Courville said. "This does not mean that the pilots in each event were aware of those criteria, [rather] that afterwards, during the investigation, it was possible to identify that those criteria could have been present and could have been part of the knowledge of the crew. … A go-around could have been decided if the crew had been aware enough of the situation they [encountered] — usually at a very low height above ground."

Predominant meteorological factors included braking issues and rapidly changing visibility and wind.

"Despite relevant conclusions, well thought-out recommendations and findings have not made much of a dent in the numbers of those accidents," de Courville said. "Something has to be done using [a strategic] perspective: Seeing the go-around as a defense. … We have to understand the weaknesses and develop solutions to make go-arounds more robust."

The Transportation Safety Board of Canada has suggested that cutting the accident rate 25 percent in commercial air transport would be possible if flight crews performed much better in both the go-around decision and the maneuver. "No other single defense could have this impact," de Courville said.

Factors observed affecting the initial stage of go-arounds include effective flight crew teamwork, communication and empowerment; the quality and timeliness of weather-related runway condition information; and the flight crew's ability to quickly assess the situation to identify risks and decide to discontinue the approach.

"In the final phase of the approach, the time pressures are much higher, the workload is high, and there is little or no [time] for communication between pilots other than standard callouts," he said. "The decision to go around must be immediate, and this decision will depend on very precise synchronization of human performance and the capacity to react quickly."

Effects of the visibility actually encountered often must be acknowledged as the most critical threat. "In some weather environments, such as heavy rain showers or fog patches, the crew may continue an approach without being aware that the

Go-Around Maneuver

Decision and "Go-Around" Callout

- Rotate toward 12.5° (A340) or 15° (A330) and set takeoff/go-around thrust
- Retract flaps one stage

Initial phase
(Speed equal to or greater than target final approach speed)

- Verify positive rate of climb
- Retract landing gear
- Select heading mode and set heading

Final phase

- At thrust-reduction altitude (default 1,500 ft above ground level) and with LVR CLB on the flight mode annunciator, select climb thrust (CLB)
- Climb accelerating toward green dot (minimum clean speed)
- At equal to or greater than F speed, select flaps stage 1
- At S speed, select maximum continuous thrust (MCT)
- At equal to or greater than S speed, select flaps stage 0
- When flaps and slats are retracted, set altimeter (if above transition altitude)
- Conduct after-takeoff checklist during climb

Note: This Airbus A330 and A340 go-around maneuver applies when all engines are operating.

Source: Bertrand de Courville

horizontal visibility they will face at the end of the approach — or beyond the runway threshold — will be less than the minimum required," de Courville said. "When this happens close to the ground, below decision altitude or minimum descent altitude, [even] with the approach and runway lights in sight, pilots may think they still have sufficient cues to continue the landing. In fact, the horizontal visibility may have reduced to a few hundred meters, which is not sufficient to accurately detect and correct deviations [from the required flight path]. … Many runway overruns, lateral excursions or landing-short accidents have been related to this type of situation."

The go-around maneuver itself — an initial climb and often a level-off — also can be deceptively simple. "At low altitude and low speed, sometimes very close to the ground, the reduced [safety] margin gives little time to perform and to react in case of deviation — change of altitude/flight path, aircraft configuration and trim balance — and in some cases, ATC called during the go-around," de Courville said. Mode changes in aircraft automation also affect the actual complexity, he added.

De Courville called for replacing the industry training practice of flight crews periodically performing only a one-engine-out go-around from decision altitude or minimum descent altitude. "Very rarely is it flown [in simulators] from a different altitude, and very rarely is it flown with all engines available," he said.

Other issues addressable through training include maintaining an instrument scan — without over-emphasizing guidance from the flight director to the detriment of airmanship — and making pilot responses to ATC the third priority after aircraft control and navigation.

— WR

If that initial reaction is not averted or corrected in time, the aircraft enters the full-stall regime of the lift curve, where safe recovery from loss of control becomes more difficult, he said.

Most importantly, specialists now recommend a specific, uniform response to the earliest indications of a stall that contradicts the technique used for decades, and still is taught by instructors who have not learned/adopted the current best practice.

"There needs to be a forward movement of the column or stick to reduce the angle-of-attack," Carbaugh said. "This may be intuitively difficult when the airplane is nose-low already and the altimeter shows altitude decreasing rapidly."

Training organizations today have to reject the discredited recovery technique known as "powering out" (selecting maximum thrust) and adjusting pitch for constant altitude or minimum loss of altitude, he said. That technique has been proven to dangerously extend the duration of a stall.

Today's stall recovery procedure has been built and exhaustively tested around the concept of pitch reduction only — immediate reduction of angle-of-attack — to restore smooth airflow to the wing as quickly as possible in any situation, he said.

Generic Stall Recovery

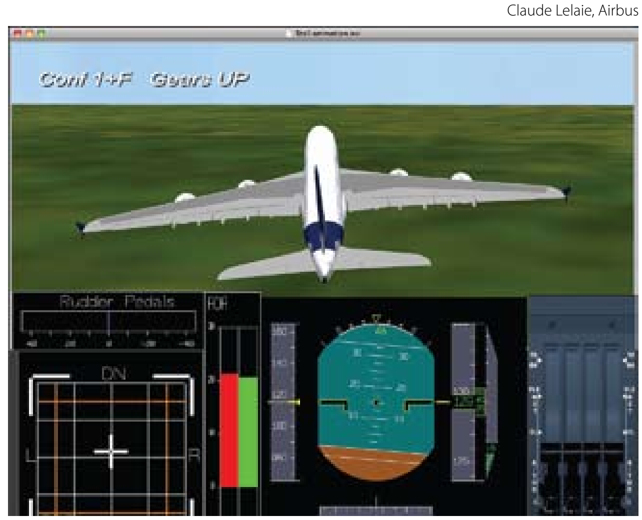
Various techniques for identifying stall onset and for recovering from stalls in commercial jets over the years have filtered down from the design, engineering and flight test experience of airframe manufacturers, said Claude Lelaie, a captain and retired Airbus test pilot who is now an adviser to the company's CEO.

As members of the FAA-Industry Stall/Stick Pusher Working Group, Airbus, ATR, Boeing, Bombardier and Embraer recently collaborated in creating a generic stall recovery procedure valid for all types of airplanes by agreeing on basic recovery principles and the order of steps to be accomplished, he said.

"Any manufacturer building a new aircraft can use that [generic procedure] directly," Lelaie said. "This procedure will be applicable in all cases except for liftoff, where we may have different procedures according to the manufacturer. The first [pilot] action is to disengage the autopilot and autothrottle.

"The second action is nose-down pitch control … applied until out of the stall with nose-down pitch trim as needed. … The priority is to reduce the angle-of-attack, and in some cases where

Claude Lelaie, Airbus



An animation from Airbus A380 test flight data showed stall recovery with pitch only.

New Life After Tragedy

Wayne Rosenkrans

Pettinaroli

Flight Safety Foundation's 63rd International Air Safety Seminar (IASS) in Milan, Italy, benefited from a first-time partnership with Italian hosts who have advocated safety reforms for nine years. "We are unique as the only air crash victim organization in the world to host the IASS," said Paolo Pettinaroli, president of the Fondazione 8 Ottobre 2001, an 8,300-member nonprofit foundation dedicated to preventing accidents and improving society's response to crash victims' families. "The final result of our hard work on IASS … the interest from all over the world … was the best that could ever happen," he said. If discussions and decisions at the November seminar lead to positive changes that "land on the runways of all the airports of the world … that would be, for us, the biggest satisfaction," he added.

The impetus for creating Fondazione 8 Ottobre 2001 was a fatal runway incursion in Milan on that date. A Scandinavian Airlines System Boeing MD-82, taking off from Runway 36R at Milano Linate Airport, collided with a Cessna Citation 525A that had been taxied in fog-induced visibility of 50 to 100 m (164 to 328 ft) onto the active runway (*Accident Prevention,* 4/04). In all, 118 passengers, crewmembers and airport workers were killed, and both airplanes were destroyed.

Although the Italian Agenzia Nazionale per la Sicurezza del Volo (ANSV) cited the runway incursion by the Cessna crew as the immediate cause, the accident investigation body also listed 18 contributing factors, issued 18 safety recommendations and commented that "the system in place at Milano Linate airport was not geared to trap misunderstandings, let alone inadequate procedures, blatant human errors and faulty airport layout."

The first meeting of victims' families, as an informal committee, was held one month after the accident, Pettinaroli said. "It was a very difficult moment because these people desperately needed some economic help," he said. "They were [mainly] people in small industries who had to close their shops and factories. … The committee gathered all the families of the victims in order to get an immediate result. Thanks to the committee, we did get a lot of help from the government, from the City of Milan and from [insurance companies and other] institutions."

Over the years, member families closely followed the criminal trial of air traffic controllers in an Italian court. "During this time, we found out that we had to do something more to prevent another accident from happening," Pettinaroli said. "We wanted to give some suggestions for better safety in air transportation, but how? We decided that the only way was to organize ourselves with some high-level technical experts. We found 15 of them and organized our technical task force, which … monitors what is happening [in aviation safety] worldwide, but especially in Italy. Every time something happens, or anytime we find something that does not work properly, we denounce the operation. We let the press know and [inform] public opinion of what is going on so the persons involved will take some action. It is never easy to involve those responsible for safety, to do what will make things better. People always think that safety is too expensive … but they don't know how expensive it is when something happens — in economic terms and, from a moral point of view, in [emotional] terms."

The Fondazione efforts proved influential in the installation of an advanced surface movement guidance and control system at Milano Linate, and the technical task force still monitors investigations of other accidents to develop positions advocating new safety improvements, he said.

To make its work known widely, the Fondazione has established a memorial, launched a website in Italian and English,[1] conducted annual safety conferences in Italy, funded a scholarship program and issued technical publications. Although an original goal of preventing more fatal runway incursions at Milano Linate has been met, a recent proposal to disband next year was rejected at the ninth annual conference of the Fondazione, he said.

Newly elected to the FSF board of governors, Pettinaroli brings empathy for affected families and their interests from his own experience. "I lost my son, Lorenzo, a young manager who had lived in London the three years previous [to takeoff aboard the accident MD-82]," he recalled. "He had received a promotion and had come back to Italy to live while he was traveling up and down Europe." Echoing the IASS speech[2] by Deborah Hersman, chairman of the U.S. National Transportation Safety Board, he noted that the first 48 hours after an accident can be the most difficult period that the families ever face.

"Our families asked in 2001, 'What do we do? How do we survive in this situation?'" Pettinaroli recalled. In his own case, the moment when he heard that no passengers or crewmembers had survived the Milano Linate collision was "the beginning of a new life," he said. "At that moment, I decided my life was finished, and I had to do something in order that nobody else should suffer," he said. "I resigned from my job, and I dedicated myself to this."

— WR

Notes

1. The English version is at <www.comitato8ottobre.com/home.asp?language=en>.
2. The speech is at <www.ntsb.gov/speeches/hersman/daph101102.html>.

the control column or the side-stick does not [provide] enough [authority], pilots use the trim. The bank angle is wings level … to orient the lift vector."

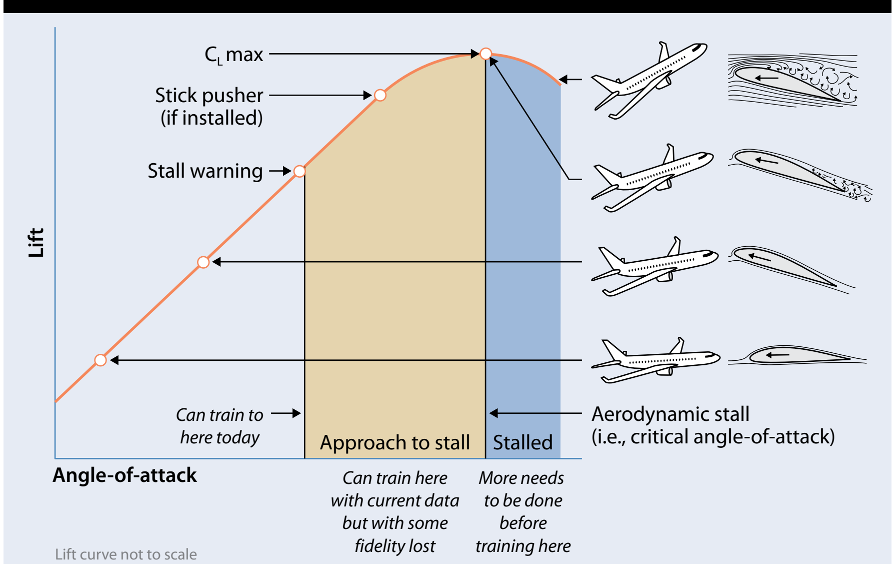
The stall working group re-examined the question of using thrust. "Sometimes, the flight crew is stalling with almost maximum thrust, which is the case at high altitude," Lelaie said. "The first priority is not to deal with thrust. So we have put 'as needed' in the procedure to show that sometimes the crew doesn't touch the thrust, and sometimes they select idle thrust. It may help to go to idle if they have an engine below the wing and very low speed [to counteract] a pitch-up motion. So [thrust setting] is really dependent on the circumstances of the stall." The generic procedure finally calls for "speed brakes — retract" and a return to the desired flight path.

Acceptable Simulator Fidelity

Airlines and other training organizations can now implement these best practices with resources they already have, said David McKenney, a Boeing 737 captain for United Airlines who is co-chairman, with the FAA's Abbott, of the FAA PARC-CAST Flight Deck Automation Working Group and previously co-chairman of the FAA-Industry Stall/Stick Pusher Working Group.

"We have evidence right now, from incidents and accidents, that pilots are not responding correctly [to unexpected stall or stick pusher events] even though they have been trained," McKenney said. "Almost all events had a couple things in common: The airplanes were established on an instrument landing system [ILS] final approach, coupled up with the autopilot and with autothrottles selected. Very few pilots, if any, have ever trained [for] stalls with the autopilot on. Yet that is where most of our pilots are encountering stalls, and one of our [final] recommendations will be to include that in recurrent training."

Simulator Fidelity for Stall Training



Note: The g-break is the moment of reduction of vertical load — expressed as gravitational acceleration (g) — as the maximum coefficient of lift ($C_L$max) is passed during airplane deceleration.

Source: David McKenney

Figure 1

An exaggerated aerodynamic lift curve (Figure 1) illustrates the stages of progression to g-break/full stall in relation to the fidelity of current full flight simulators to represent them in a new generation of training scenarios.[1]

The startle factor also must be addressed in stall-related training, as it has in airplane upset recovery training, he added. "It can cause confusion and other psychological effects, and actually cause the pilots to overreact by [applying] too much pressure on the controls," McKenney said, noting that secondary stalls have occurred in this context. Startle training enables flight crews to overcome instinctive human responses. Suppressing a knee-jerk reaction, the trained pilots consciously take a half second to a second to assess and confirm the situation. "They then apply a measured and proportional response [without] overcorrection," he said.

Simulator instructors also have opportunities to surprise crews with indications of a stall during unrelated flight simulator sessions. "We suggest that crews do the stalls on the ILS at 1,000, 2,000 and 3,000 ft above ground level … and in other realistic scenarios where they are turning toward the runway at a low altitude, in a configuration with the gear down and the flaps down," McKenney said. "For recurrent stall training, a maximum of a three-year cycle is recommended."

The working group developed, and has urged the FAA to publish this year, an advisory circular revising stall training.

To read an enhanced version of this article, go to <flightsafety.org/asw/nov2010/flightpath.html>.

Note

1. Presenters defined *g-break* as the point of maximum lift on the lift curve.

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where's the EXIT?

Despite a briefing and illustrated safety cards, passengers on an Embraer 195 were unsure of what to do while using an overwing exit.

BY LINDA WERFELMAN

The U.K. Air Accidents Investigation Branch (AAIB) has recommended design reviews and modifications of emergency exits on public transport aircraft following an emergency landing in which passengers in an Embraer 195 became confused about how to use an overwing exit.

The AAIB issued the safety recommendations as a result of its investigation of the Aug. 1, 2008, incident that prompted the emergency landing at Ronaldsway Airport on the Isle of Man. Five of the 95 people in the airplane received minor injuries during the evacuation.

About 10 minutes after takeoff on a scheduled passenger flight from Manchester, England, to Belfast, Northern Ireland, the no. 1 air cycle machine (ACM) failed, sending fumes onto the flight deck. The cabin crew reported an unusual odor and a haze in parts of the cabin.

The pilots donned oxygen masks and, because the commander was concerned about the possibility of fire, declared an emergency and diverted to Ronaldsway. The fumes and smoke intensified during the surveillance radar approach, and the captain "considered that he would probably conduct an evacuation on landing," the report said.

He did not notify the cabin crew or air traffic control because "he thought that to tell them anything at this late stage of the flight might cause confusion should he decide not to order an evacuation," the report said.

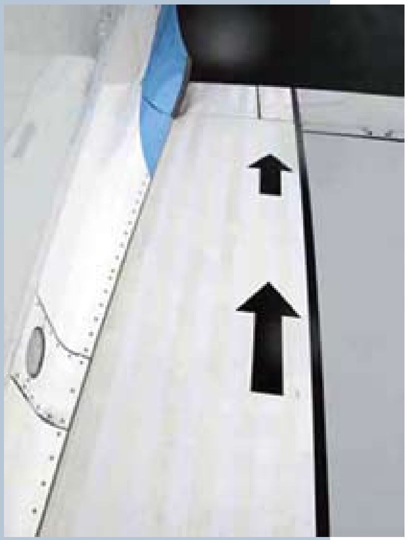
© Lotfi Mattou/Fotolia

After completing the approach and landing on Runway 26, the commander turned the airplane into the wind and stopped at a runway intersection, telling the cabin crew first to stand by and, seconds later, to evacuate (Figure 1, p. 48).

Cabin crewmembers responded by opening their assigned doors. Passengers opened the left overwing exit door; the right overwing exit door could not be opened because the forward upper part of the door trim was jammed beneath the ceiling edge panel (Figure 2, p. 49).

The escape slides inflated automatically, but the slide at Door 1 Left had not fully inflated when the first passenger arrived at that exit, and, as a result, the senior cabin crewmember (SCCM) initially directed passengers away from that exit. After the slide inflated, the SCCM "had to push himself past the flow of passengers" to cross the aisle to Door 1 Right and open it, the report said.

Passengers did not realize that the arrows on the wing denoted an evacuation route.



U.K. Air Accidents Investigation Branch

Passengers said later that the slides were "very steep," and they were "surprised by the speed at which they slid down them," the report said. "The slides also ended without any round-out at the bottom, causing passengers to slide straight onto the ground at speed. This, and attempts by passengers to slow themselves on the slides, were the principal causes of injury reported."

The report said that when the cabin crew became aware of the problems, they "tried to reduce injuries by instructing passengers to sit down as they got onto the slide and by controlling the flow of passengers down the slides."

At the left overwing exit, passengers became confused about how to move from the wing to the ground.

"A 61-cm-wide [2-ft-wide] walkway was demarcated at the wing root in black paint, with arrows pointing towards the trailing edge," the report said. "This was not noticed by some passengers; one passenger thought that the markings denoted an engineers' walkway rather than an escape route. The overriding comment from passengers who evacuated onto the wing was that it was not obvious to them that they were meant to climb off the wing via the trailing edge."

Two male passengers who used the overwing exit jumped from the rear of the wing to the ground — a "considerable drop" of about 1.7 m (5.6 ft), the report said — helped other passengers to the ground. They told investigators that, without their help, some passengers might have been seriously injured trying to climb down off the wing.

A review of each passenger's seat position and his or her choice of exit showed that none of the passengers used Door 1 Right.[1] The report speculated that this was probably partly a result of the "staggered layout" of that exit and the Door 1 Left exit, which would have been the first exit that passengers reached as they moved forward from their seats.

The report also noted that a cabin crewmember was positioned next to Door 1 Left to assist passengers there, while Door 1 Right was unattended. "Passengers would have therefore had to find and use [Door 1 Right] at their own initiative," the report said.

The cabin crew estimated that all passengers were evacuated within one minute. At that time, two cabin crewmembers checked that no passengers remained in the airplane and evacuated through Door 2 Left.

Passenger Briefings

The investigation found that before departure, cabin crewmembers had briefed the passengers seated next to the overwing exits on their operation. Similar instructions — including "the depiction of an arrow apparently guiding passengers towards the trailing edge of the wing" — were on the seatbacks in front of these passengers, and each passenger had a safety card that contained a diagram depicting passengers "climbing off the trailing edge of the wing onto the ground," the report said.

After the incident, the operator modified the safety briefing for passengers seated next to the overwing exits "to make them aware that the arrows on the wing indicate direction of evacuation (i.e., aft over trailing edge of the wing)," the report said.

Previous Incident

The report noted the previous AAIB investigation of an April 1, 2002, incident in which passengers in a Fokker F28 experienced similar problems using overwing exits during an emergency evacuation after the cabin filled with smoke while the airplane was taxiing for takeoff from Manchester International Airport.[2]

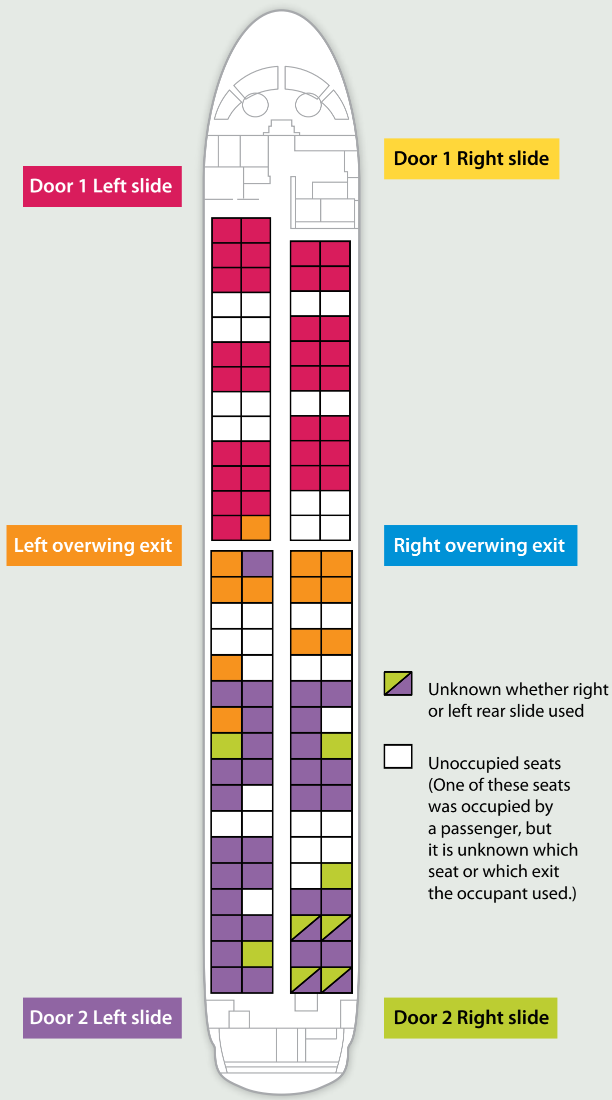
The final AAIB report on the 2002 incident said that passengers using the left overwing exit "congregated on the wing looking for a way down" and that some passengers eventually "slid or jumped from the wing tip and leading edge (a drop of some 7 to 8 ft), instead of sliding off the wing trailing edge down the extended flaps."

As a result of its investigation of the Fokker incident, the AAIB recommended that the U.K. Civil Aviation Authority (CAA) and the European Joint Aviation Authorities (JAA) review "the design, contrast and conspicuity of wing surface markings associated with emergency exits on public transport aircraft with the aim of ensuring that the route to be taken from wing to ground is marked unambiguously."

The report said that the CAA accepted the recommendation, but there was no response from the JAA.

As a result of the more recent Embraer incident, the AAIB re-issued the safety recommendation, directing it this time to the European Aviation Safety Agency (EASA), which now has responsibility for aircraft certification throughout Europe.

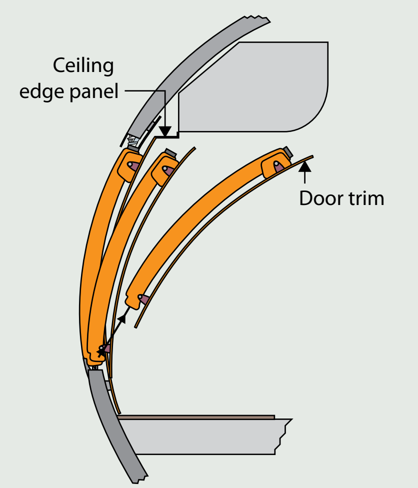
Evacuation Routes



Source: U.K. Air Accidents Investigation Branch

Figure 1

Overwing Emergency Exit



Source: U.K. Air Accidents Investigation Branch

Figure 2

"It is apparent from this incident that the issue of ambiguous overwing escape route markings … still exists," the AAIB said. "It is therefore appropriate that this matter is re-examined."

Door Jam

A post-incident examination of the right overwing emergency exit door found insufficient clearance between the top edge of the door trim and the ceiling edge panel. "Over most of its length, the clearance was just sufficient to accommodate insertion of a credit card, but near the forward corner of the door, where the door trim had jammed, the clearance was only 0.003 in [0.076 mm]," the report said.

No clearance had been specified, but after the AAIB informed the manufacturer of the incident, Embraer issued Service Bulletin (SB) 190-25-0092, calling for inspections and replacement of the ceiling edge panel if the clearance is less than 2.00 mm (0.08 in). Similar inspections were introduced during manufacturing to ensure a minimum 2-mm clearance.

The AAIB's subsequent evaluation of the SB's effectiveness found that a 2-mm clearance was insufficient to prevent jamming of the door trim behind the ceiling edge panel "if the door was lifted during the initial stages of opening or if it was opened energetically, such as might be the case in an actual emergency," the report said. "It was concluded that [although] the SB reduced the probability of a jam, the potential for a jam had not been eliminated."

The report traced the problem to the EASA's certification of the Embraer 195 — "largely on the basis of its similarity to the Embraer 190."

However, the report added, "during Embraer 195 development, the ceiling edge panel manufacturer introduced changes to the configuration and dimensions of the cutouts around the overwing exit aperture, reducing the clearance between the ceiling panel and the door trim. These changes were not notified to the aircraft manufacturer."

Current aircraft certification requirements do not discuss the potential for jamming, "except that there must be provisions 'to minimize the probability of jamming of emergency exits resulting from fuselage deformation in a minor crash landing,'" the report said.

The AAIB recommended that the manufacturer "modify the overwing emergency exits … to eliminate the possibility of the exit door jamming due to interference between the door trim panel and the ceiling edge panel."

Source of Trouble

The report traced the airplane's problems to the no. 1 air conditioning pack; investigators determined that the no. 1 ACM rotor had seized. At the time of the incident, the no. 2 air conditioning pack was inoperative, and the airplane was being operated without it in accordance with the minimum equipment list. It had been damaged four days before the incident in another event that involved smoke in the cabin.

Examination of both ACMs revealed that Stage 2 turbine blade failures had occurred in each unit, causing the turbine blade tips to come in contact with the ACM casings; this produced fine metallic particles, which were released into the cabin air system, "creating the reported symptoms of smoke and fumes inside the aircraft," the report said.

The report quoted the airplane manufacturer as saying that this incident was "the only known case of the failure of an ACM Stage 2 turbine during single-pack operation on the Embraer 190/195 fleet."

In addition, the manufacturer said that modifications and maintenance had "significantly improved" the reliability of the Embraer 190/195 air conditioning packs. As a result, the AAIB said no further safety recommendations were needed.

This article is based on AAIB Serious Incident Report EW/C2008/08/01, included in the AAIB Bulletin published in June 2010 and available online at <www.aaib.gov.uk/publications/bulletins/june_2010.cfm>.

Notes

1. Investigators were unable to determine which of several seats was occupied by one passenger, as well as the exit used by that passenger.
2. AAIB. Accident Report EW/C2002/4/1. <www.aaib.gov.uk/cms_resources.cfm?file=/dft_avsafety_pdf_507773.pdf>. Six of the 94 people in the airplane received minor injuries. The report said the manufacturer attributed the problem to a failure of the auxiliary power unit (APU) compressor oil seal, "which had allowed APU oil to leak into the APU bleed air supply and thus to enter the air conditioning system."

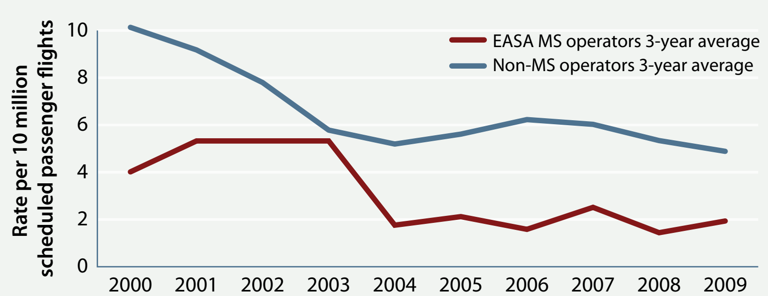
BY RICK DARBY

Accidents Down, Fatalities Up

EASA member states had fewer accidents in 2009 than in previous years, but one airliner loss counted heavily.

The European aviation safety record was marred in 2009 by the loss on June 1 of an Airbus A330 over the Atlantic, resulting in 228 fatalities (*ASW*, 9/10, p. 53). That was the year's only fatal commercial airplane accident for European Aviation Safety Agency (EASA) member states,[1] the agency reported in its most recent annual safety review.[2,3]

Fatal Accident Rates, EASA Member States Vs. Non-Member States, 2000–2009

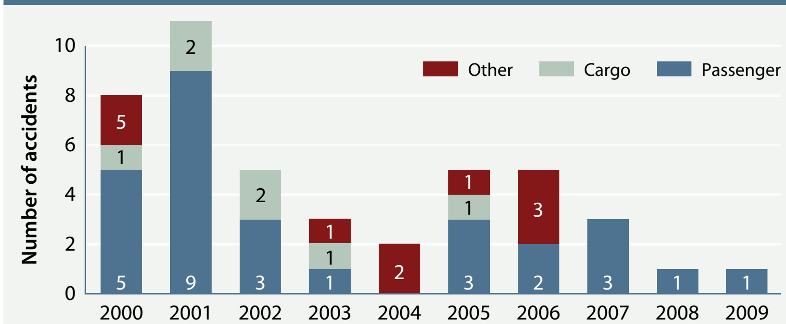


EASA = European Aviation Safety Agency; MS = member state

Source: European Aviation Safety Agency

Figure 1

Fatal Airplane Accidents by Operation Type, EASA Member States, 2000–2009



EASA = European Aviation Safety Agency

Source: European Aviation Safety Agency

Figure 2

The fatal accident rate of scheduled passenger and cargo operations is significantly lower in Europe than in most of the world. According to the review, the EASA member states' fatal accident rate for the 2000–2009 period was 3.3 per 10 million flights, with the North America and East Asia regions lower, at 2.3 and 2.8 per 10 million flights, respectively. Other regional rates ranged from 4.2 in Australia and New Zealand to 49.1 per 10 million flights in Africa. European non-EASA-member states had a rate of 25.0 per 10 million flights.

Member states had 17 airplane accidents in 2009, 45 percent fewer than the 31 in 2008 and 35 percent lower than the 1998–2007 average of 26. As in 2008, there was one fatal airplane accident — the Air France A330 — compared with an average of four in 1998–2007. Because of the A330 accident, the number of on-board fatalities was notably above that of 2008 or the 1998–2007 average.

Over a more recent decade, 2000–2009, both member and non-member state operators showed a declining fatal accident trend in scheduled passenger operations, but the trend line of member state rates was lower throughout the period (Figure 1). "Although the number of fatal accidents for aircraft operated by EASA member state airlines has remained the same in recent years (one accident), the decrease in the number of flights during the years of 2008 and 2009 has led to an increase in the rate of such accidents," the review says. Traffic, and thus rates, for 2009 are estimates, however.

"Worldwide, excluding EASA member states, passenger air transport operations appear to have a declining proportion of the total number of fatal accidents," the review says. "Other commercial air transport operations, such as air taxi or ferry flights [categorized as other] have an increasing proportion of the total."

For member states, the picture looks somewhat different. Throughout most of the decade, the majority of member state fatal accidents have occurred in passenger operations (Figure 2). But the report does not compare accident rates between operational categories, so numbers of accidents do not precisely measure relative risk.

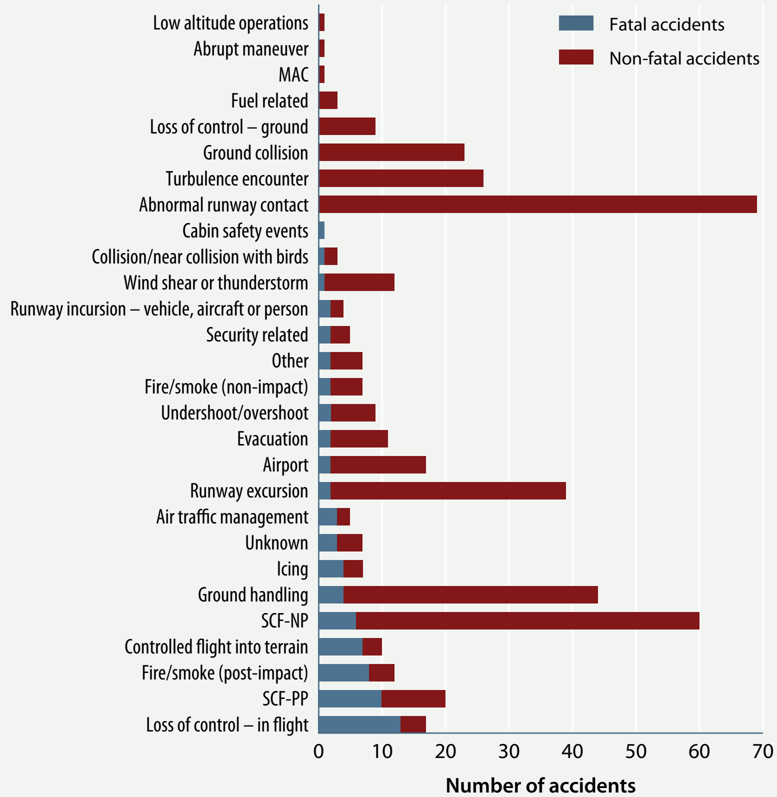
Accidents in member state commercial air transport operations were categorized according to the standardized definitions developed by the Commercial Aviation Safety Team-International Civil Aviation Organization (CAST-ICAO) Common Taxonomy Team.[4] For the 2000–2009 decade, "loss of control in flight" ranked highest among fatal accident categories, followed by "system or component failure — powerplant," and "fire/smoke — post-impact" (Figure 3). Controlled flight into terrain, or CFIT, once the grimmest reaper of all in commercial aviation, has ranked fourth among fatal accident categories during the past 10 years.

The proportions of the top four accident categories, as well as CFIT, have varied over the past 10 years (Figure 4). The review says, "In recent years, the proportion of accidents which included the categorization of ARC (abnormal runway contact) has increased. Such accidents usually involve long, fast or hard landings. …

"Also increasing is the percentile of accidents involving ramp ('ground handling') events. These accidents involve damage to the aircraft by vehicles or ground equipment or the incorrect loading of an airplane."

There were five fatal helicopter accidents in 2009, compared with 10 in 2008 and eight as the 1998–2007 average. The 18 on-board fatalities in 2009, however, exceeded the four of 2008 and the 1998–2007 average of 11. The relatively high on-board fatality number for 2009 was attributable to the 16 occupants killed in a crash during a flight from an oil platform to Aberdeen, Scotland.

Accident Categories, Fatal and Non-Fatal Accidents, EASA Member State Airplanes, 2000–2009

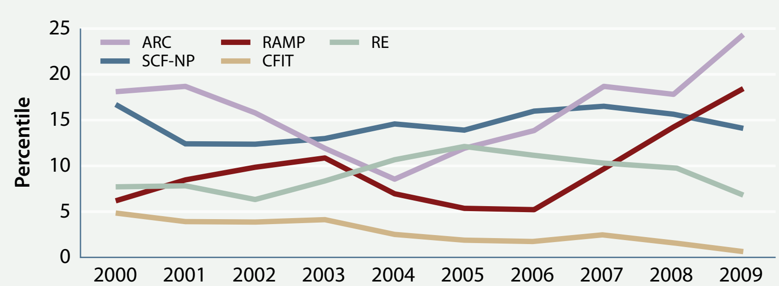


EASA = European Aviation Safety Agency; MAC = airprox/TCAS alert/loss of separation/near midair collision/midair collision; SCF-NP = system/component failure or malfunction (non-powerplant); SCF-PP = system component failure or malfunction (powerplant)

Source: European Aviation Safety Agency

Figure 3

Trends in Top Four Accident Categories and CFIT Category, EASA Member State Airplanes, 2000–2009

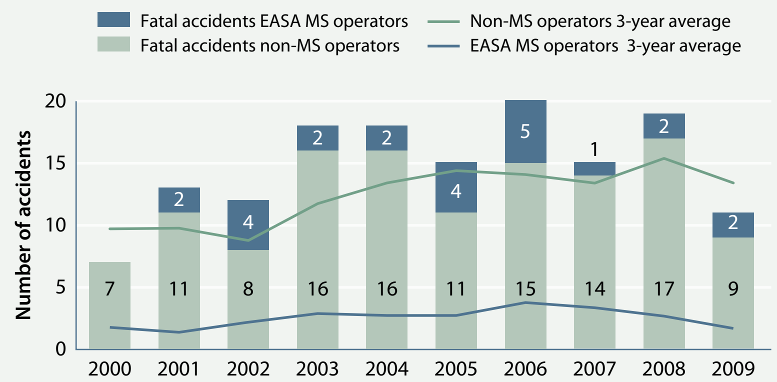


EASA = European Aviation Safety Agency; ARC = abnormal runway contact; RAMP = ground handing; RE = runway excursion; SCF-NP = system/component failure or malfunction (non-powerplant); SCF-PP = system component failure or malfunction (powerplant); CFIT = controlled flight into terrain

Source: European Aviation Safety Agency

Figure 4

Fatal Helicopter Accidents, EASA Member States and Non-Member States, 2000–2009

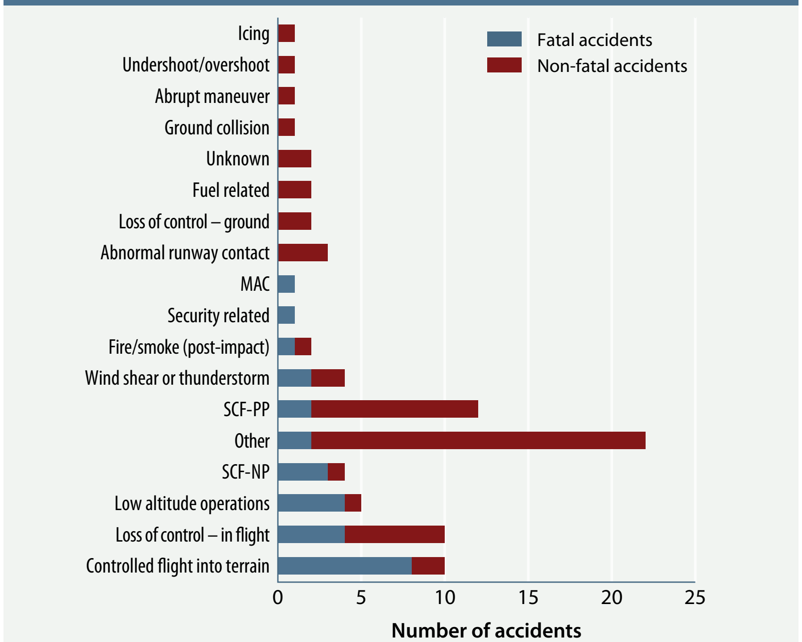


EASA = European Aviation Safety Agency; MS = member state

Source: European Aviation Safety Agency

Figure 5

Fatal and Non-Fatal Helicopter Accidents, EASA Member States, 2000–2009



EASA = European Aviation Safety Agency; MAC = airprox/TCAS 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 6

"When looking at the three-year moving averages, it appears that the number of fatal helicopter accidents worldwide has increased in the last years, while the average for EASA member state operators has remained more or less constant," the review says (Figure 5).

In contrast with airplane operations, CFIT was the most frequent category for member state fatal helicopter accidents from 2000 to 2009 (Figure 6). The review says, "In most cases, adverse weather circumstances were prevalent, such as reduced visibility due to mist or fog. Also, several flights had taken place at night or over mountainous or hilly terrain."

The next highest category in fatal accidents was "loss of control in flight." That was approximately equaled, however, by "low altitude," which scarcely appears in the ranking of categories in fatal airplane accidents. The review says that the category consists of "collisions with terrain and objects that occurred while intentionally flying close to the surface, excluding takeoff and landing phases."

"System component failure — non-powerplant" and "system component failure — powerplant" were significant in member state helicopter fatal accident numbers and non-fatal accident numbers, respectively. "The accidents in both categories mainly involve engine, main rotor system, tail rotor system or flight control failures or malfunctions," the review says.

EASA says that it has attempted to reduce the proportion of accidents classified as "unknown" by obtaining additional accident data. Only two accidents — both non-fatal — had unknown causes in the 2000–2009 data.

Notes

1. EASA member states are the 27 European Union countries plus Iceland, Liechtenstein, Norway and Switzerland.
2. EASA. *Annual Safety Review 2009.* Available via the Internet at <easa.europa.eu/communications/docs/flash/ASR-2009>.
3. The accident data involved at least one aircraft with a maximum takeoff weight greater than 2,250 kg (4,960 lb). Accident and fatal accident definitions followed International Civil Aviation Organization Annex 13, *Aircraft Accident and Incident Investigation.*
4. <www.intlaviationstandards.org/index.html>. An accident may be assigned to more than one category.

Transplant Transport

Doctors want to ensure that parts of you fly safely.

REPORTS

Organ Recital

How Can We Improve Procurement Air Travel Safety?

Renz, John F. *Liver Transplantation*, December 2010. Published online Sept. 21, 2010. <onlinelibrary.wiley.com/doi/10.1002/lt.22191/abstract>, <dmmsclick.wiley.com/click.asp?p=9491760&m=33618&u=729181>.

Physician, Heal Thyself; But Don't Fly Thyself

Merion, Robert M. *Liver Transplantation*, December 2010. Published online Nov. 16, 2010. <onlinelibrary.wiley.com/doi/10.1002/lt.22219/abstract>, <dmmsclick.wiley.com/click.asp?p=9491760&m=33618&u=729182>.

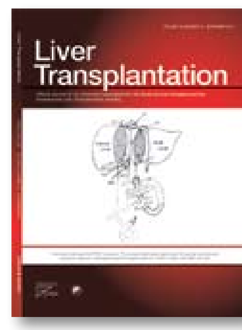
On Nov. 20, 2010, rescuers salvaged a donated liver from the wreckage of a Cessna Citation 501 that crashed on landing at Birmingham (England) Airport. Both pilots were injured but survived, and the undamaged liver was rushed to a hospital where it was implanted in a patient. The patient "would certainly have died" without the liver, the surgeon who performed the operation said.

Even without a crash, body parts can be found in aircraft these days. Thanks to the remarkable transplantation feats of modern surgery, donated organs are in demand, and speed is essential in delivering them to the sites where they will be used. That often means aircraft transportation.

In conventional emergency medical services (EMS) that involve transporting medical personnel and patients, the operational conditions may involve extra risk. EMS operations have had among the highest fatal accident rates in aviation (*ASW*, 3/09, p. 14). Although much less publicized, organ transportation flights, also known as "procurement flights," involve similar considerations. In the December 2010 issue of the medical journal *Liver Transplantation*, two physicians consider the risk factors — while offering conclusions and recommendation that differ somewhat.

The main article, by Dr. John F. Renz, "How Can We Improve Procurement Air Travel Safety?" cites a 2009 study that found that "the procurement air travel fatality rate is 1,000 times higher than scheduled commercial aircraft and speculated [that] surgeons involved in procurement air travel may have 'the riskiest job in medicine.'"

Renz sets himself the goal of evaluating "all fatal and non-fatal procurement air accidents within the United States reported by the National Transportation Safety Board (NTSB) in this context. To date, the NTSB has identified three fatal and four non-fatal U.S. procurement aircraft accidents (fixed-wing and rotary-wing)."



In these accidents, Renz cites evidence — based on NTSB reports — of inadequate equipment, lack of pilot proficiency, or both. In one accident, the captain had previously been imprisoned for a narcotics violation and had failed three periodic pilot proficiency tests. In addition, Renz says, "The NTSB cited numerous references to the pilot's poor safety practices, including anomalies (implied falsification) in reported flight training activities, the absence of routine checklist utilization (the crew did not consult a normal or emergency checklist on the accident flight), and operational decisions not considered within the scope of routine practice."

Renz says, "No accident was associated with the processes of procurement; rather, it was the tolerance of dangerous operational practices, unlike anything routinely employed in scheduled airline service, that contributed to accidents. … These data suggest the transplant community, as a consumer of aviation services, has tolerated practices that are unnecessarily dangerous and unlike any practices routinely employed by airlines. In this context, it is not surprising the safety record is inferior."

Renz believes that a two-pilot crew should be mandatory for procurement flights.

He cites a 2010 paper in the *Proceedings from the Michigan Donor Travel Forum*, which said, "It appears most organ procurement organizations (OPO) and transplant centers procure aircraft charter services for transport with limited knowledge of the qualifications and safety certifications of the charter operators under consideration. Furthermore, few surgeons and OPO directors possess the requisite knowledge needed to properly evaluate the qualifications of these operators and make an informed decision as to an operator's suitability for such flights. In most cases, requisitioning parties appear to select charter operators based upon criteria that are both intuitive and readily accessible to non-aviation personnel, such as price, aircraft availability, and proximity to the departure destination."

When it comes to remedies, Renz says, "Transplant professionals involved in procurement air travel must proactively create a 'culture of safety' through education and understanding of the fundamentals with respect to air safety. This will require acquisition of basic aviation terminology as it applies to safety, recognition of safe operational practices, and appreciation of existing mechanisms to report safety concerns. As educated consumers, we can actively participate in the development and implementation of procurement air travel practices that optimize safety."

Specific recommendations fall under the headings of aircraft, pilots, safety reporting mechanisms and a proposed safety algorithm.

Renz says, "One can improve safety through aircraft selection. The safety record of helicopters is inferior to fixed-wing aircraft and markedly inferior to scheduled airline service. … Utilization of a helicopter or a piston-powered aircraft increases the chance of an accident and disqualifies the operation from comparison to scheduled airline service."

He urges that only turbine-powered aircraft be used in procurement, on the grounds that "it is widely acknowledged that the mechanical failure rate of turbine-powered engines is orders of magnitude lower" than piston engines.

Renz believes that a two-pilot crew should be mandatory for procurement flights, and adds, "A simple strategy widely applied within corporate flight departments is mandating two pilots who are each qualified to captain the aircraft. This replicates an environment of competence and safety one expects with commercial air travel."

Equally important, he says, is ensuring crew qualification: "The [Michigan] Donor Travel Forum emphasized selection of charter operators that have completed a safety certification program such as the Aviation Research Group U.S. platinum certification, the Wyvern Standard, or the International Standard for Business Aircraft Operations of the International Business Aviation Council. The Donor Travel Forum recommended certification by one [of] these groups should be 'strongly considered' during selection of a charter operator by an organization planning procurement travel.

While third party audits and certifications of a charter operator are commendable, it should be noted that the above resources are subscription services that typically involve a substantial annual fee in addition to a per-incident fee. Prerequisite aircraft and pilot specification data may not be readily available or applicable in the time frame of procurement travel. Furthermore, it may be impossible to identify multiple vendors within a geographic region who fulfill such qualifications."

Ignorance of existing safety reporting mechanisms amplifies the risk of organ transportation flights, he says, and pilots and management should be aware of accident databases maintained by the U.S. Federal Aviation Administration and the NTSB, as well as reports from the U.S. Department of Transportation Office of Inspector General. Renz says that familiarity with these sources should increase awareness of hazards caused by poor weather, inhospitable terrain, remote locations and the urgency felt by procurement team members.

Renz advocates a "safety algorithm" for procurement flights: "Turbine-powered, fixed-wing aircraft, operated by reference to instruments under commercial flight regulations [U.S. Federal Aviation Regulations Part 135] to airports with continuous radar surveillance and/or runway guidance systems by two pilots, each qualified to captain the aircraft flown, would ensure a level of competence and safety we expect with scheduled airline service."

In summing up, Renz says, "Procurement professionals must seek a fundamental understanding of the relevant safety issues pertaining to aviation and how to report safety concerns."

Dr. Robert M. Merion, a professor of surgery at the University of Michigan, grieved over the loss of four colleagues and two pilots when an airplane carrying donated lungs crashed in June 2007. "We were determined not to simply get on the next horse that was brought out of the stable," he says. "We sought out nationally renowned experts in aviation safety consultation, in order to ensure that our next horse was a pedigreed thoroughbred with a storied jockey and a world-class trainer."

Merion, who describes himself as "a licensed private pilot, which guarantees that I have just enough knowledge to be dangerous," asked qualified aviation safety consultants to review and improve the system for procurement aviation used at the university hospital.

"With their assistance, we acquired a replacement jet and contracted with a first-rate aviation firm whose focus on safety is paramount and whose culture of safe flying permeates their entire organization," he says. "Their operation is run to airline standards. Although our health system and the aviation firm are bound by a business contract, we are truly partners in a safety-based relationship. I am firmly convinced that this is the best way to minimize the risk of air transportation in the pursuit of organ transplantation."

Merion asked qualified aviation safety consultants to review and improve the system for procurement aviation used at the university hospital.

Merion says that Renz "lays out the problems in an organized and careful way, and it is here that his strongest points are made." But Merion does not believe that excessive risk in organ transportation flight operations is related to acceptance of nonstandard practices. "It's clear that transplant surgeons (especially tired ones) who are also pilots should not fly themselves to donor hospitals," he says. "But other accidents, including the Michigan tragedy, are a result of the actions of pilots who are assumed to be professionals."

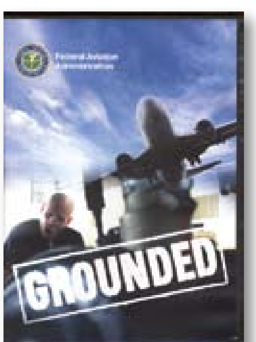
Merion says, "Renz proposes a solution to the complex and multifaceted issues of aviation safety for organ procurement travel. He asks us to believe that it is simple, cheap and easily implemented. The principles underlying the recommended actions are sound, but his characterizations of their ease of application are unrealistic.

"The selection of an aircraft is a good example. I do not know of a simple, cheap and easily implemented method to choose, acquire and operate an airplane. Renz blithely impugns the use of helicopters, without accounting for specific geographical and operational details that may dictate the need for rotary rather than fixed wing operations, although he correctly points out the inferior safety record for helicopter flight in general and the particularly troublesome safety record of medical helicopter operations."

While acknowledging that flights with two captains as pilots would be desirable, Merion sees such a requirement as unrealistic: "Unfortunately, we found that identifying such pilot teams required substantial investment of time and resources. There are few organizations capable of providing this level of service 24 hours a day, 365 days a year."

Merion says, "The Michigan Donor Travel Forum recommendations included safety certification by one of the well-established aviation safety organizations. Renz deems these too expensive and also believes that the required aircraft and pilot specification data may not be available on short notice. At Michigan, we require this certification, pre-approve pilot teams, and have created an additional pre-approval process for back-up vendors needed in the event that our own aircraft is unavailable, precisely to avoid the need to make these assessments in the middle of the night. It's neither simple nor cheap, but it's smart."

— Rick Darby



VIDEO

Lights … Camera … Fatigue Awareness!

Grounded

U.S. Federal Aviation Administration (FAA) Flight Standards, the Civil Aerospace Medical Institute and the Chief Scientist Program. Available online at <hfskyway.faa.gov/HFSkyway/FatigueVideo.aspx>.

Grounded, which can be found on the FAA's fatigue awareness training Web site, is a departure from the traditional training video. Its fictional format uses characters and a story line — "infotainment" instead of the usual documentary-style visuals, written onscreen messages and solemn voice-over.

One character, Gregg, senior manager for maintenance at a major airline, is having a week full of stressors. Deadlines are not being met. Replacement parts go missing. A just-in-time inventory at one base turns out to be a not-in-time inventory. Gregg is tough on maintenance employees, asking them to work extra hours after they finish a graveyard shift to help get caught up with the work.

He doesn't take it easy on himself, either. The hours are long. He gives himself jolts of caffeine to keep up the pace and a few "cold ones" after work to settle down. His wife, a long-haul airline pilot, is often away, so Gregg is on his own a lot of the time with the additional responsibility of their daughter.

Thanks to a plot device at the video's beginning, Gregg makes the acquaintance of a doctor — the script gives her no name — who just happens to work in a sleep research clinic. For the remainder of the video's 20-minute running time, she counsels him about ways to counteract the fatigue that is making him short-tempered and probably affecting his judgment.

"You're going to have to break some bad habits and form new, better ones," the doctor says. "You're going to have to get a lot more rest."

Gregg's "alter ego" — appearing through computer graphics as a double of Gregg in some of the shots — insists he can safely ignore physiological reality and sidestep burnout. A little bit of dramatic conflict builds up, which culminates when Gregg's wife returns from a long flight, also fatigued. Irritation breaks out on both sides. "One happy sleep-deprived family," the doctor comments in an aside to the viewer.

People do not like to be lectured on their lifestyle habits, so *Grounded* takes a new tack to make its points go down smoothly. The actors are talented, and the "doctor" delivers her lines with vivacity and a touch of humor. If infotainment be the food of training, then play on.

— Rick Darby

Down to Battery Power

Several critical systems were not available for the emergency landing.

BY MARK LACAGNINA

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

JETS

Problems Traced to Eroded Contacts

Boeing 757-200. Minor damage. No injuries.

While checking the cockpit during preflight preparations the morning of Sept. 22, 2008, the captain noticed that the standby attitude indicator was not receiving electrical power. He cycled the standby power selector and the battery switch, and power to the instrument was restored. At the same time, however, five fault messages appeared on the engine indicating and crew alerting system (EICAS).

The captain, who later could not recall the specific EICAS messages, summoned assistance from the airline's maintenance department. "A mechanic came into the cockpit, cleared the messages and stated that they were 'good to go,'" said the report released in October 2010 by the U.S. National Transportation Safety Board (NTSB). "No logbook entries were made regarding this event."

The 757 subsequently departed from Seattle with 185 passengers and seven crewmembers for a scheduled flight to New York. Shortly before reaching the assigned cruise altitude, Flight Level (FL) 370, about 30 minutes later, the flight crew saw several cockpit lights flicker and noticed multiple EICAS messages and a warning light indicating that the standby power bus was off line.

The flight crew consulted the "Standby Bus Off" checklist in the quick reference handbook (QRH). The first officer completed the first step on the checklist by switching the standby power selector to the "BAT" (battery) position. "The second step did not apply to their situation, so they stopped the checklist with the standby power selector in the 'BAT' position," the report said. "Although the QRH did not instruct the crew to divert to the nearest suitable airport, it indicated that the battery will supply bus power for approximately 30 minutes."

In this configuration, the main battery powers the battery bus, the standby AC and DC buses, and the hot battery bus. "When the standby power selector is in the 'BAT' position, the main battery is the sole source of power for these buses," the report said. "In addition, the main battery charger is unpowered, and the battery will not be recharged."

The captain radioed the airline's technical center and said that they were "flying on the main battery." He described the EICAS messages and noted that none of the three inertial reference systems was functioning. The captain asked whether a diversion was required, but the technical specialist replied that it was his decision to make. The conversation ended after the captain indicated that they would continue the flight to New York.

Some time later, the captain again radioed the technical center and talked with a different technical specialist. "The captain stated that all systems were working fine but they had lost the main battery charger and might lose their main battery," the report said. "He stated that the standby buses appeared to be powered and that they were going to continue the flight."

The captain asked the specialist to discuss the situation with "their electrical experts" and advise him "if you come up with anything that we're not aware of." The specialist replied, "Yes, I'll talk it over with the other tech guys here, but it sounds like you should be OK to continue on."

Nearly two and a half hours after the battery was selected to provide standby power, the battery charge was depleted and essential electrical systems began to fail. "These systems included the stabilizer trim, the captain's instrumentation, the thrust reversers [and the] anti-skid," the report said. The autopilot and autothrottle also disengaged. The captain transferred control to the first officer, whose instruments were still functioning.

The captain told ATC that there were 'almost no indications in the cockpit.'

The 757 was over western Michigan when the crew told air traffic control (ATC) that they needed to divert the flight to Chicago O'Hare International Airport because of electrical problems. The controller provided a radar vector to O'Hare, cleared the crew to begin a descent and asked if they required assistance. "The captain replied that they were all right," the report said. "He stated that more than one electrical system had failed and it appeared that everything was functioning but their backups were 'going away.'" The captain also told the controller that they would not be able to conduct an instrument landing system (ILS) approach.

Meanwhile, the flight attendants had discovered that the public address system and the interphone were not functioning. The lead flight attendant wrote a note about the problems and slipped the note under the cockpit door. "A short time later, the captain opened the cockpit door and told the flight attendants that they were diverting to [O'Hare]," the report said. "One of the flight attendants then walked through the aisle, informing the passengers of the unscheduled landing."

The airplane was at 10,000 ft at 1332 local time when the captain told ATC that there were "almost no indications in the cockpit" but that they would not require emergency equipment on standby for the landing.

The first officer later told investigators that as he slowed the airplane for the approach, he realized that the main and alternate stabilizer trim systems were inoperative. "He stated he had a 'handful of airplane,'" the report said.

At 1339, the captain reported that the airport was in sight and received clearance to conduct a visual approach to Runway 22R. When the first officer informed the captain about the trim problems about a minute later, he declared an emergency. "The controller cleared the airplane to land and stated that emergency crews were on standby," the report said.

The captain assisted the first officer on the flight controls. Because of their difficulty in maintaining pitch control, the crew decided to limit flap extension to 20 degrees. The 757 touched down hard about 2,500 ft (762 m) from the threshold of the 7,500-ft (2,286-m) runway. "The crew determined that they were going to overrun the end of the runway, so the captain veered the airplane off the left side of the runway into the grass, where the airplane came to rest with seven of the eight main gear tires either blown out or deflated," the report said.

The pilots were not able to shut down the engines using the fuel cutoff valves or the fire handles. "The engines were subsequently shut down by depressing the fire handles and recycling the generator control switch," the report said. "Once the engines were shut down, the passengers were deplaned … using portable stairs."

Examination of the 757, which had accumulated 22,094 hours and 7,474 cycles since it was manufactured in 2001, revealed that the electrical system anomalies were caused by the intermittent failure of an electrical relay — specifically, the K106 relay — because of eroded contacts.

Among the actions prompted by this incident was a service bulletin outlining electrical system modifications that enable the battery charger to remain in operation after the battery is selected to provide standby power.

'NORDO' for 37 Minutes

Airbus A320. No damage. No injuries.

The flight crew established radio communication with a Denver Center controller about three hours after departing from Toronto for a scheduled flight to Los Angeles the night of Nov. 5, 2009. The A320 was at FL 360, with the no. 1 VHF radio set to the ATC frequency and the no. 2 radio set to emergency frequency 121.5 MHz.

The NTSB report said that about 20 minutes after initial contact, the controller instructed the crew to establish communication with Denver Center on a different radio frequency. The crew did not respond. The A320 was classified as "NORDO" — no radio — for 37 minutes while controllers attempted to hail the crew. During this time, the airplane entered Los Angeles Center airspace.

ATC's attempts to re-establish radio contact included a request that the airline transmit a message via the aircraft communications addressing and reporting system (ACARS). The airline transmitted the message via a ground station in New Mexico. However, the ACARS equipment aboard the A320 was set to a frequency that was not available at the ground station. The station's subsequent report of its inability to uplink the message was received by the airline's dispatch system 30 minutes later.

Radio communication with Denver Center finally was re-established via an air-to-air relay by the crew of another airplane that was cruising at FL 490. The A320 was landed in Los Angeles without further incident. The report said that the probable cause of the incident was the flight crew's "failure to monitor and/or switch to the appropriate ATC frequency."

Wheel Falls Off Axle

Boeing 737-300. Minor damage. No injuries.

Shortly after departing from Soekarno-Hatta Airport in Jakarta, Indonesia, the morning of Oct. 30, 2009, the airport traffic controller told the flight crew that one of the wheels on the main landing gear had fallen from the aircraft. The pilot-in-command (PIC), the pilot flying, decided to return to the airport.

The aircraft was flown in a holding pattern for about 90 minutes to reduce the fuel load. "Before landing, the PIC elected to conduct a flight along the runway at 200 ft for an ATC observation of the landing gear," said the report by the Indonesian National Transportation Safety Committee. "The controller confirmed that the no. 2 main wheel [the inboard wheel on the left main landing gear] was not on the aircraft." The 737 subsequently was landed without further incident and was stopped on a taxiway, where the 49 passengers exited via airstairs.

Investigators found that the wheel had been removed eight days before the incident to facilitate replacement of a brake unit. "It was likely that the detachment of the wheel from its axle was due to the catastrophic failure of the wheel bearings," the report said. "The bearing failures [likely] resulted from an under-torque condition during the reinstallation of the wheel following replacement of the brake unit."

The maintenance had been performed in darkness, with the aid of flashlights, on an airport apron. The report said that the wheel probably had not been positioned correctly on the axle when the attachment nut was tightened. "This situation has been known to arise due to a wheel not being rotated continuously during axle nut tightening. Bearing failures resulting from an under-torque condition progress rapidly." The incident occurred on the 48th flight of the aircraft following the maintenance.

The maintenance had been performed in darkness, with the aid of flashlights, on an airport apron.

Close Call at London City

Cessna Citation CJ1, Boeing 777-300ER. No damage. No injuries.

Visual meteorological conditions prevailed at London City Airport the afternoon of July 27, 2009, when the flight crew of the Citation requested clearance to start the engines. The crew likely was surprised when the airport tower controller issued both a start clearance and a departure clearance, said the report by the U.K. Air Accidents Investigation Branch (AAIB).

The controller cleared the crew to conduct the Dover 4T standard instrument departure (SID) from Runway 27 and to maintain 3,000 ft. The crew's readback was: "Four tango departure, climbing four thousand feet."

"Although the tower controller noticed and corrected the omission of the word 'Dover,' he did not notice the incorrect readback of the cleared altitude," the report said.

The SID requires aircraft departing to the west to maintain a minimum climb gradient of nearly 8 percent, to avoid obstacles, while turning right to a northeasterly heading. An initial altitude restriction of 3,000 ft is imposed to avoid conflict with aircraft inbound to London airports from the north.

About the same time that the Citation took off, the crew of the 777, which was northwest of London City Airport, was cleared to turn to a southerly heading, to intercept the ILS approach to Runway 27R at London Heathrow Airport, and to descend to 4,000 ft.

The Citation's traffic-alert and collision avoidance system (TCAS) did not provide a traffic alert, but the commander saw the 777 as he began the right turn toward the north; he turned 30 degrees left to pass behind the other aircraft. The Citation was climbing at 3,300 fpm.

The 777 was descending through 4,900 ft when its TCAS generated a traffic alert about the Citation. The commander, the pilot monitoring, told a Heathrow controller, "We have a traffic alert." The Heathrow controller replied, "Affirm. He's bust his level. Can you climb to maintain five thousand feet?"

During these radio transmissions, the 777's TCAS generated two resolution advisories to increase the descent rate. The 777 commander "noticed from the TCAS display that the traffic was passing the three o'clock position and climbing, and he judged that a descent would only increase the risk of collision," the report said. Neither the commander nor the copilot saw the Citation.

A third resolution advisory, to climb, was generated four seconds later. The commander disengaged the autopilot and initiated a climb; the 777 leveled briefly at 4,000 ft before beginning to climb. The 777 and the Citation were on nearly opposite headings when they passed within 0.5 nm (0.9 km) laterally and 164 ft (50 m) vertically.

The report said that TCAS was not effective in resolving the conflict because the 777 crew did not respond to the initial resolution advisories. In addition, the TCAS equipment aboard the Citation provided traffic advisories but not resolution advisories; thus, coordinated resolution advisories could not be provided to either flight crew.

"During this incident, the crew of [the Citation] saw the [777] in time to take effective avoiding action," the report said. "Had the aircraft been in IMC [instrument meteorological conditions], this would not have been the case and TCAS would have been the only barrier to a potential midair collision."

TURBOPROPS

Touched Down Hot and Long

Antonov 26B. Minor damage. No injuries.

The aircraft was en route from Stuttgart, Germany, to pick up cargo in Kassel, Germany, the afternoon of Oct. 4, 2007. Reported weather conditions at Kassel Airport included surface winds from 310 degrees at 7 kt, 7,000 m (4 mi) visibility, a broken ceiling at 3,900 ft and scattered clouds at 2,000 ft. The flight crew conducted the localizer/DME (distance measuring equipment) approach to Runway 22, which is 1,500 m (4,922 ft) long and is equipped with a precision approach path indicator.

"The cockpit voice recorder (CVR) indicates that, during the entire approach, the pilot flying [the PIC] was given regular verbal updates of the current altitude and speed by another crewmember [the navigator]," said the report issued in September 2010 by the German Federal Bureau of Aircraft Accident Investigation. Also among the crew were a copilot, flight engineer and two loadmasters.

Recorded ATC radar data indicated that the An-26's groundspeed decreased from 140 kt to 130 kt during the initial approach. As the aircraft neared the minimum altitude for the approach, the navigator called out 220 kph (119 kt). The navigator called out 215 kph (116 kt) about one second before the aircraft touched down. The report said that, according to the aircraft flight handbook, the appropriate airspeeds were 192 kph (104 kt) for the approach and 176 kph (95 kt) for touchdown.

The Antonov touched down about 400 m (1,312 ft) from the approach threshold and bounced several times before touching down again about halfway down the runway. "The remaining runway length of 750 m [2,461 ft] was still much longer than the rollout distance of 500 m [1,641 ft] specified in the handbook," the report said.

However, the PIC told investigators that he did not apply reverse thrust until the aircraft was about 250 m (820 ft) from the departure end of the runway. "When he saw that the aircraft would not come to a stop within the available runway length and that there were obstacles ahead, he steered the aircraft to the left and shut down the engines," the report said. "The aircraft sunk up to the wheel rims in soft grass soil."

'Impurity' Causes Engine Failure

Bombardier Q400. Substantial damage. No injuries.

The flight crew was conducting a scheduled 25-minute flight with 38 passengers and two cabin attendants from Tanegashima to Kagoshima, both in southern Japan, the morning of March 25, 2009. The aircraft was climbing through 3,800 ft, to the assigned altitude of 12,000 ft, when the crew heard a loud bang. The master caution light, the oil pressure warning light for the no. 1 engine and the no. 1 engine propeller electronic control warning light illuminated, and the engine's low-pressure compressor and turbine speeds decreased rapidly.

The crew shut down the engine but was unable to feather the propeller. They reported the engine failure to ATC and said that they would stop the climb at 8,000 ft, above the clouds, and conduct an emergency landing at Kagoshima, said the report by the Japan Transport Safety Board. The PIC told investigators that he chose Kagoshima because it had a longer runway and more favorable winds than Tanegashima.

Before beginning the descent, the crew flew a holding pattern for about 10 minutes while communicating by radio with a company maintenance technician and making several attempts to feather the propeller. "All attempts failed, so I finally decided to land at Kagoshima Airport with the propeller as it was," the PIC told investigators. He briefed the cabin attendants and instructed them to have the passengers brace for landing because of the possibility of a runway excursion.

The crew shut down the engine but was unable to feather the propeller.

Surface winds were from 330 degrees at 22 kt with gusts to 31 kt when the crew landed the Q400 without further incident on Runway 34 at Kagoshima Airport.

Investigators found that the helical input gear shaft in the no. 1 engine's reduction gearbox had fractured and that fragments of the broken shaft had caused further damage to turbine blades and vanes, and to the engine case. "It is considered probable that fatigue cracks had started from an impurity inclusion present in the metal stock of the helical gear shaft … and after undergoing repetitive application of stress, the shaft finally fractured," the report said.

The investigation also determined that corrosion had caused permanent magnets inside the feathering pump drive motor to separate and damage the armature, preventing the propeller from feathering automatically when the engine failed. In addition, collateral damage caused by the fractured gear shaft had blocked oil pressure required by the manual and alternate propeller-feathering systems.

No Chocks, No Brakes on Stand

ATR 72-200. Substantial damage. No injuries.

After landing at Manchester (England) Airport the morning of Oct. 21, 2009, the flight crew taxied to the assigned stand, set the parking brake and feathered both propellers. "Ground crew approached the aircraft while the anti-collision lights were flashing and attached the fixed electrical power cable," the AAIB report said. "Although their procedures required them to insert chocks immediately on approaching the aircraft, they did not do so."

The ATR began to move forward slowly, and the ground crew ran away from the aircraft. Both pilots applied wheel braking, and the commander cycled the parking brake. "Recognizing that the aircraft was not under control, the commander gave an 'alert call' to the cabin crew and instructed the copilot to shut the engines down," the report said. The copilot shut down the engines and called for the aircraft rescue and fire fighting service.

"The aircraft rolled forward until the no. 2 engine propeller struck a stand guidance mirror," the report said. "Both the mirror and propeller were damaged, with one propeller blade becoming lodged in the mirror assembly as the aircraft stopped moving."

A trail of hydraulic fluid was found on the stand. The leak was traced to the hydraulic fuse valve casing, which likely had a growing fatigue crack that opened when hydraulic pressure increased from the initial engagement of the parking brake.

PISTON AIRPLANES

Low Flight in Fog

Grumman G-21A. Destroyed. Seven fatalities, one serious injury.

During his preflight briefing, the pilot told the passengers that the flight would be conducted at low altitude and that if anyone was concerned, they could deplane. No one deplaned, and the amphibious aircraft departed from the Vancouver (British Columbia, Canada) Water Aerodrome for a charter flight to Powell River, about 60 nm (111 km) northwest, the morning of Nov. 16, 2008.

Vancouver had 2 mi (3,200 m) visibility in mist and a 500-ft ceiling; the weather conditions at Powell River also were below visual flight rules (VFR) minimums, said the report by the Transportation Safety Board of Canada, noting that "other operators had canceled or delayed their flights due to the low visibility."

About 12 minutes after the aircraft departed from Vancouver under a special VFR clearance, a dispatcher attempted unsuccessfully to radio the pilot that the visibility at Powell River had decreased to 3/8 mi (600 m). Limited ATC radar returns indicated that the Goose was being flown between 100 ft and 200 ft over the Strait of Georgia.

About 19 minutes after taking off from Vancouver, the aircraft crashed in dense fog into a 400-ft peak on South Thormanby Island and burned. One passenger survived with serious injuries.

The pilot had 12,000 flight hours, including 8,000 hours in amphibious aircraft. The report noted that after the air taxi company hired him in February 2008, company managers had met with him three times to discuss concerns they had with his decision making. "The last meeting, about three months before the accident, was held because management was concerned that he was completing trips in what other pilots deemed to be adverse wind and sea conditions. The company believed that this behavior was causing other pilots to feel pressured to fly in those conditions and was also influencing customer expectations."

Frosted Wings Foil Takeoff

Cessna TU206F. Substantial damage. One minor injury.

Shortly after lifting off the runway at Bethel (Alaska, U.S.) Airport the morning of May 6, 2009, the single-engine airplane stalled, rolled left and entered an uncontrolled descent. The left wing, nose landing gear, engine firewall and empennage were damaged when the 206 struck the ground. "During the impact sequence, the unsecured cargo shifted forward and struck the back of the pilot's seat and the right side of the instrument panel," the NTSB report said.

The report said that the probable cause of the accident was the pilot's failure to remove frost from the wings before takeoff. "Photos taken five minutes after the accident show the leading edges and tops of the wings, and the horizontal tail surfaces were covered in rough frost. The photos also show that the frost appears to have been scraped off of most of the windshield."

Main Fuel Tanks Were Dry

Beech E18S. Substantial damage. One serious injury.

Before departing from Fort Myers, Florida, U.S., for the fourth, and final, flight of the day — a positioning flight to Fort Lauderdale the afternoon of Dec. 27, 2008 — the pilot checked the fuel gauge and estimated that the airplane had about 100 gal (379 L) of fuel remaining.

After retracting the landing gear and adjusting the power setting on initial climb, the right engine lost power. The pilot said that he was unable to feather the propeller and that he did not accelerate to the single-engine best rate of climb speed. "Unable to maintain altitude, the airplane impacted trees and came to rest facing the opposite direction of travel," the NTSB report said.

No fuel was found in the right engine's carburetor or in the main tanks, which are required to be used during takeoff and which remained intact during the accident. The report said there was evidence, however, that the auxiliary tanks, which ruptured on impact, contained fuel.

HELICOPTERS

Loose Line Causes Power Loss

Bell 206L-1. Substantial damage. One serious injury, one minor injury.

After landing on a platform in the Gulf of Mexico the morning of Nov. 1, 2009, the LongRanger was refueled and one passenger was boarded for a flight to another platform. Shortly after the helicopter lifted off and passed over the edge of the helideck, the pilot heard a loud pop and saw the engine failure warning light and a "split" between the engine speed and rotor speed indications.

"As the aircraft yawed and lost climb performance, the pilot lowered the collective pitch full down and activated the floats," the NTSB report said. The pilot was seriously injured and the passenger sustained minor injuries when the helicopter struck the water and rolled inverted. They exited the helicopter, inflated their life vests and a life raft, and clung to the raft until they were rescued by personnel aboard a crew boat.

Investigators determined that the power loss was caused by the failure of maintenance personnel to correctly torque (tighten) the B nut on the Pc line, which delivers bleed air from the engine compressor section to the fuel control unit. "A review of the engine maintenance records revealed that 36.7 hours prior to the accident, the turbine module was completely disassembled and overhauled," the report said. "This would have required the removal and reinstallation of the Pc line."

Occupied With Cellphone

Robinson R22. Destroyed. One fatality.

The pilot was repositioning the helicopter from Haast, New Zealand, to Wanaka the evening of Nov. 1, 2008, to prepare for crop frost-protection operations that night. He was known to prefer operating the R22 at maximum speed, said the report by the New Zealand Transport Accident Investigation Commission.

A search was launched when the helicopter did not arrive on schedule. Debris from the R22 was found floating on Lake Wanaka that evening, and some helicopter wreckage and the pilot's body were recovered from the bottom of the lake the next morning.

No one witnessed the accident. Investigators determined that a mast bump — contact between the rotor mast and hub — had occurred. "The low-g condition necessary for a mast bump could have resulted from the helicopter's natural response to a gust or from the pilot abruptly pushing forward on the cyclic stick to counter the effects, or from some other unknown reason," the report said. The pilot had been killed by a rotor blade that struck the cabin before the R22 hit the water at high speed and in a near-vertical, nose-down attitude.

Cellphone records indicate that the pilot was sending and receiving text messages when the loss of control occurred. "Although the initiating event to the mast bump could not be determined, the circumstances strongly suggested that the pilot's cellphone use would have hindered his ability to respond quickly and appropriately to any abnormal condition," the report said.

Preliminary Reports, September 2010

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Sept. 1	Misima, Papua New Guinea	Cessna Citation 550	destroyed	4 fatal, 1 serious
The Citation overran a 1,200-m (3,937-ft) runway while landing in heavy rain and gusts.				
Sept. 2	San Carlos, California, U.S.	Beech Queen Air	destroyed	3 fatal
Several yaw oscillations occurred before the Queen Air stalled on takeoff and descended into a lagoon.				
Sept. 3	Dubai, United Arab Emirates	Boeing 747-400F	destroyed	2 fatal
About 19 minutes after departing in night VMC, the flight crew reported an in-flight fire and that they were returning to the airport. They were vectored for a straight-in approach to Runway 12L but were too high to land. The freighter overflew the airport at 4,000 ft, turned right, descended rapidly and crashed near a residential area.				
Sept. 3	Salinas, California, U.S.	Bell 47G	substantial	1 serious
The helicopter crashed on a highway shortly after taking off for a positioning flight with 2 1/2 mi (4,000 m) visibility and a 100-ft overcast.				
Sept. 4	Fox Glacier, New Zealand	PAC Fletcher FU24-954	destroyed	9 fatal
Apparently loaded aft of CG limits, the single-engine airplane was departing for a skydiving flight when it pitched nose-up and descended rapidly to the ground.				
Sept. 5	Pointe-à-Pitre, Guadeloupe	Cessna 208B	substantial	7 minor
The pilot performed an emergency landing in a sugarcane field after the engine lost power.				
Sept. 7	Uribe, Colombia	Beech King Air 350	destroyed	6 fatal
The air force airplane was on a night reconnaissance flight when it crashed in mountainous terrain.				
Sept. 7	Izhma, Russia	Tupolev 154M	destroyed	81 none
After a total electrical failure and a related fuel problem, the Tu-154 overran a 1,200-m (3,937-ft) runway during a forced landing at an abandoned airfield.				
Sept. 10	Itanhaém, Brazil	Robinson R44	destroyed	2 fatal
The R44 crashed in mountainous terrain during a business flight from Peruibe to São Paulo.				
Sept. 10	Brenham, Texas, U.S.	Embraer Phenom 100	substantial	2 none
The airplane veered off the runway after an apparent braking system failure during landing.				
Sept. 11	near Majuro, Marshall Islands	Hughes 369A	destroyed	1 fatal, 1 minor
The pilot felt a vibration and then lost control of the helicopter during a fish-spotting flight. The observer was killed.				
Sept. 13	Puerto Ordaz, Venezuela	ATR 42-300	destroyed	17 fatal, 34 NA
Day VMC prevailed when the ATR 42 crashed in an industrial yard 8 km (4 nm) from the runway during approach.				
Sept. 14	near Margarita Island, Venezuela	Agusta-Bell 212	destroyed	2 fatal, 1 serious, 4 minor
The navy helicopter and a research vessel were maneuvering during a rescue mission when the 212 struck the bow of the vessel and plunged into the ocean.				
Sept. 16	Lanchang, Malaysia	Agusta A109E	destroyed	1 serious, 3 minor
The rescue helicopter struck trees and crashed during an attempted landing in fog.				
Sept. 18	San Pedro Sula, Honduras	Bell 206B-3	destroyed	1 fatal, 1 serious
A spectator was injured when the JetRanger crashed while making a low pass during an air show.				
Sept. 19	South Bimini, Bahamas	Piper Chieftain	substantial	7 none
The pilot returned to the airport after the cabin door opened on departure for an air taxi flight. The right tire burst on landing, and the Chieftain veered off the runway, into trees.				
Sept. 22	Brooklyn, New York, U.S.	Bell 412EP	substantial	6 minor
The police helicopter was ditched in Jamaica Bay after the rotor drive system failed on approach to a heliport.				
Sept. 24	Palermo, Italy	Airbus A319-100	destroyed	129 NA
Thunderstorms were observed when the A319 touched down short, struck localizer antennas and then veered off the runway. No fatalities were reported.				
Sept. 26	Yakushima Island, Japan	Aerospatiale AS 332-L	destroyed	2 fatal
The Super Puma was transporting building material when it struck a mountain in fog.				

NA = not available

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

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— Will Dirks, Vice President, Flight Operations

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