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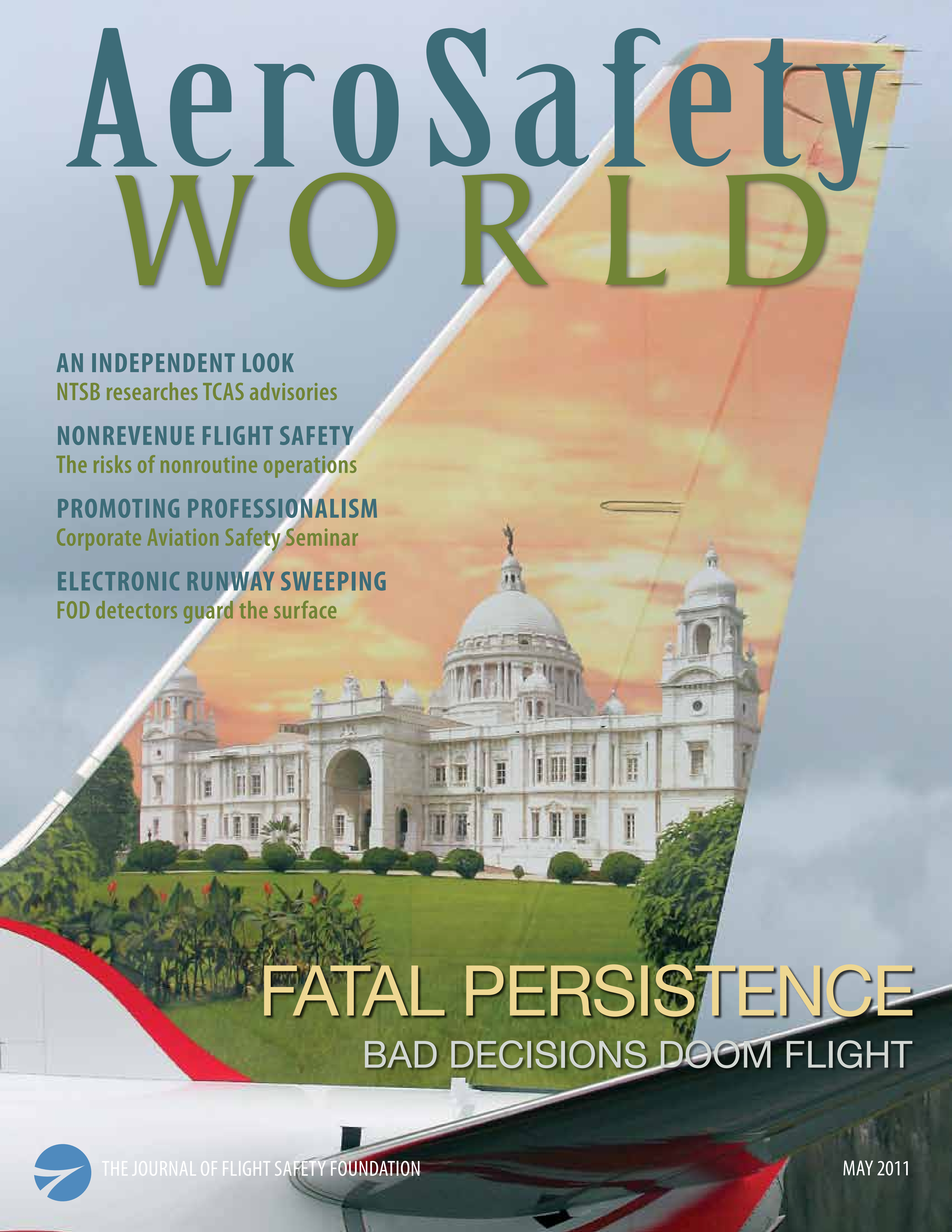

AN INDEPENDENT LOOK
NTSB researches TCAS advisories

NONREVENUE FLIGHT SAFETY
The risks of nonroutine operations

PROMOTING PROFESSIONALISM
Corporate Aviation Safety Seminar

ELECTRONIC RUNWAY SWEEPING
FOD detectors guard the surface

FATAL PERSISTENCE
BAD DECISIONS DOOM FLIGHT

THE JOURNAL OF FLIGHT SAFETY FOUNDATION
MAY 2011

Coaches

Right now, a lot of attention is being focused on issues like intentional noncompliance and the lack of professionalism. Some of the biggest and most powerful regulators are very worried. The problem reaches across professional disciplines and cultures.

About a year ago, I heard Scott Griffith, one of the pioneers of just culture, talk about this problem. He talked about it as at-risk behavior. It is different from recklessness or negligence in that there is not always bad intent. It is more about the natural human tendency to test the limits. Everyone wants to take a shortcut, or work around a silly rule. Let's be honest — it is universal. Who among us has ever gone a day without testing a speed limit?

That being said, in our business, noncompliance with standard operating procedures is not something we can take lightly. The rules are there for a reason, and pushing the limits too far can get people killed. People have to be held accountable, but dealing with this problem with a bunch of isolated disciplinary actions is not going to solve the underlying issue.

Scott suggests that the way to deal with this problem is with coaching, and after thinking about this for a year, I have to say I agree. Whenever there is an incident of noncompliance or lack of professionalism, we must look behind the offending person and examine the people and the system that are supposed to set the boundaries. I think of my experiences as a young man on a shop floor, in an air traffic control room or in a cockpit, and I think about all of the times I felt that familiar tap on my shoulder. I would turn and see somebody I respected who would tell me, "that is not the way we do it here" or "let me show you why that isn't going to work." Those constant little corrections had more to do with defining who I was and how I did my job than any safety management system, training program, incentive program or even threat.

Perhaps what we are seeing now is a breakdown of that system. I have seen the "coaches" of our profession become disenfranchised because of cutbacks and labor disputes. I also have seen airlines built on a base of wet-leases and expat pilots on short-term contracts. I have seen proud airlines lose their best captains to better offers from richer airlines. In all of these cases, the coaches disappear or lose interest. There is no one left who is able or willing to set the limits. The level of compliance degrades, an undisciplined generation of professionals finds the way to the captain's seat, and tragedy follows.

The path to ruin is clear, but what is the path to salvation? I think the solution is to focus on the next generation of coaches as if our profession depends on it. Here is a great example: Danny Ho from EVA Airways takes his best young first officers and uses them as line operations safety audit (LOSA) observers. These first officers are trained to critically observe cockpit procedures and processes and then given a chance to do the job. Imagine the captains they will be five years from now. We need to look for more new ideas like this and act on them. The people who will make or break our system are in our repair shops, control rooms and cockpits today. We need to develop them into the next generation of coaches or live through a long painful decade recovering from our mistake.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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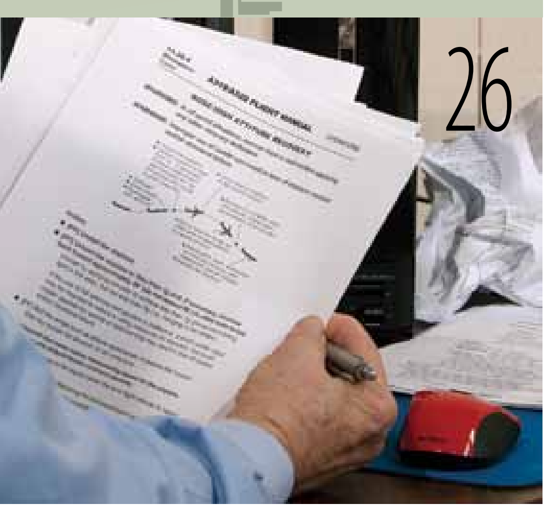

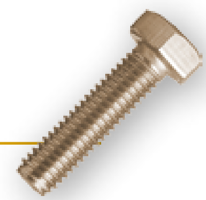

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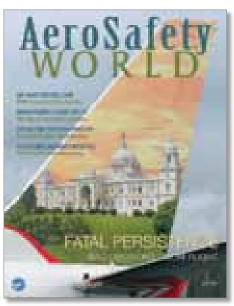

About the Cover
The captain of this Air India Express 737 waited too long to go around.
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If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about aviation safety, we will be glad to consider it. Send it to Director of Publications J.A. Donoghue, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA or donoghue@flightsafety.org.

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FLAWED Training

Explaining how flight crews mishandle aerodynamic stalls is a tough job in no small part because it must be admitted from the outset that the skills needed to survive stalls are rudimentary, taught from the beginning of flight training. With that fact given, how does one explain repeated events, often fatal, in which highly experienced crews fail to perform this most basic maneuver?

Well before the recovery of the flight data recorder (FDR) and cockpit voice recorder (CVR) from Air France Flight 447, the Airbus A330 that two years ago crashed in the South Atlantic, the industry was taking note of numerous accidents and incidents in which an aircraft stalled and its crew mishandled the event. With FDR/CVR data showing that AF447 was a flyable aircraft in a stalled state, nose-high, falling all the way to the ocean from 38,000 ft in just 3 1/2 minutes, the need is even more pronounced for redoubled industry efforts to fix training flaws that have allowed these things to happen.

Those who attended our European Aviation Safety Seminar (EASS) in Istanbul, Turkey, earlier this year, or read my story about it (*ASW*, 4/11, p. 46), know that the basic elements of the discussion were in place even before the AF447 data were recovered. Those data, I suggest, simply reinforce what was already believed about the problem, with perhaps a bit more emphasis on the role automation can play in triggering, confusing and obfuscating a very hazardous situation.

Industry consensus seems to be that traditional training for avoiding stall onset and for recovering from a stall has been, essentially, full power, wings leveled, speed brakes retracted and minimal pitch angle reduction. The goal of this procedure is to minimize altitude loss. In real life, however, this training event had become a stylized kabuki dance, more focused on correctly setting up the approach to stall situation than anything related to actual flying. As Paul J. Kolisch, Mesaba Airlines supervisor, flight operations training, said at the EASS: "Pilots have had more difficulty satisfying evaluators with the setup than with the stall recovery. The training is akin to synchronized swimming: It requires a good deal of skill and preparation but has nothing to do with swimming safely across a river."

Clearly, minimizing altitude loss only becomes important after the airplane resumes flying, so dropping the nose becomes of primary importance in breaking the stall. Then, since aircraft with engines mounted on pylons under the wing can cause a pitch-up during the application of takeoff/go-around thrust, the new advice is "power as appropriate"; in some situations — such as a stall at high-altitude cruise — a reduction in thrust may be more appropriate.

That there was confusion in the AF447 cockpit is implied by the lack of coordinated recovery techniques despite the presence of three qualified pilots, including the high-time captain, and the uninterrupted operation of most of the instruments — which did not prevent the aircraft for much of its fall to the ocean from being in a nose-high attitude in excess of 16 degrees and an angle-of-attack of 35 degrees.

I know this is repeated material for many of you, but I believe the importance of assuring widespread dissemination of this information means I will risk boring some of my audience to get it out there. Airbus and Boeing have already changed their stall training recommendations; clearly, everyone should re-examine their training programs to make certain this flaw is corrected.

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

Serving Aviation Safety Interests for More Than 60 Years

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

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JUNE 5–9 ➤ Human Factors in Flight Safety: Safety Management Systems, Risk Management and Safety Investigation. European Association for Aviation Psychology. Dubai, United Arab Emirates. Brent Hayward, <bhayward@dedale.net>, <www.eaap.net/read/58/human-factors-in-flight-safety-course.html>.

JUNE 6–8 ➤ Aviation Fatigue Research Roadmap: Building a Bridge Between Research and Operational Needs. MITRE Corp. McLean, Virginia, U.S. <www.aviationfatigueregistration.aero>.

JUNE 6–8 ➤ Air Charter Summit. National Air Transportation Association. Chantilly, Virginia, U.S. (near Washington Dulles International Airport). <www.nata.aero/Events/Air-Charter-Summit.aspx>, 800.808.6282, +1 703.845.9000.

JUNE 9–10 ➤ Asia Pacific ANSP Conference. Civil Aviation Navigation Services Organisation. Bangkok, Thailand. Anouk Achterhuis, <Anouk.Achterhuis@canso.org>, <www.canso.org/asiapacificconference>, +31 (0)23 568 5390.

JUNE 13–18 ➤ Human Factors in Flight Safety: Risk Management and Accident Investigation. European Association for Aviation Psychology. Dublin, Ireland. Brent Hayward, <bhayward@dedale.net>, <www.eaap.net/read/57/human-factors-in-flight-safety-course.html>.

JUNE 14–16 ➤ Europe/U.S. International Aviation Safety Conference. European Aviation Safety Agency and U.S. Federal Aviation Administration. Vienna. <vienna2011@easa.europa.eu>, <easa.europa.eu/conf2011/index.html>.

JUNE 14–16 ➤ Emergency Response Bootcamp. Fireside Partners. New Castle, Delaware, U.S. <info@firesideteam.com>, <www.firesideteam.com/index.cfm?ref=60200&ref2=16>, +1 302.747.7127.

JUNE 15–17 ➤ Second Pan-American Aviation Safety Summit. International Civil Aviation Organization and Latin American and Caribbean Air Transport Association. Mexico City. <panamericansafety@alta.aero>, <www.alta.aero/safety/2011/home.php>.

JUNE 17–18 ➤ A Practical Approach to Safety Management Systems. Beyond Risk Management. Dallas–Fort Worth, Texas, U.S. Capt. Elaine Parker, <Elaine@beyondriskmgmt.com>, <www.regonline.ca/builder/site/Default.aspx?EventID=969548>; Brendan Kapuscinski, +1 403.804.9745.

JUNE 20–24 ➤ Human Factors in Aviation Safety. University of Southern California Viterbi School of Engineering. Los Angeles. Thomas Anthony, <aviation@usc.edu>, <viterbi.usc.edu/aviation/courses/hfh.htm>, +1 310.342.1349.

JUNE 20–26 ➤ 49th International Paris Air Show. Salon International de l'Aeronautique et de l'Espace. Le Bourget, France. <www.paris-air-show.com>.

JUNE 27–28 ➤ Aviation Safety Management Systems Overview Workshop and Change Management Workshop. ATC Vantage. Tampa, Florida, U.S. Theresa McCormick, <info@atcvantage.com>, <www.atcvantage.com/sms-workshop.html>, +1 727.410.4759.

JUNE 29 ➤ Transitioning to EASA Requirements for Operators. Baines Simmons. Chobham, Surrey, England. Zoe Martin, <zoe.martin@bainessimmons.com>, <www.bainessimmons.com/directory-course.php?product_id=134>, +44 (0)1276 855412.

JULY 1 ➤ Human Factors Analysis and Classification System Refresher. HFACS Inc. Alexandria, Virginia, U.S. <info@hfacs.com>, <www.hfacs.com/store/hfacshfix-workshop-washington-dc>, 800.320.0833.

JULY 3–8 ➤ Fifth International Summer School on Aviation Psychology. European Association for Aviation Psychology. Graz, Austria. <www.eaap.net/read/56/5th-international-summer-school-on-aviation.html>.

JULY 4 ➤ Introduction to IS-BAO. International Business Aviation Council and Colt International. Calgary, Alberta, Canada. <www.cbaa-acaa.ca/convention/cbaa-2011-1/introduction-to-is-bao-workshop-and-auditor-accreditation-workshop>, +1 866.759.4132.

JULY 5 ➤ Aviation Human Factors Course. Convergent Performance and Global Aerospace Underwriting Managers. Calgary, Alberta, Canada. <www.cbaa-acaa.ca/convention/cbaa-2011-1/aviation-human-factors-course>, +1 866.759.4132.

JULY 11–12 ➤ Quality Assurance for SMS. DTI Training. Winnipeg, Manitoba, Canada. <dtitraining@juno.com>, <staboada@dtiatlanta.com>, <www.dtiatlanta.com>, +1 866.870.5490, +1 770.434.5310.

JULY 13 ➤ Basic Auditing Principles. DTI Training. Winnipeg, Manitoba, Canada. <dtitraining@juno.com>, <staboada@dtiatlanta.com>, <www.dtiatlanta.com>, +1 866.870.5490, +1 770.434.5310.

JULY 14 ➤ Transitioning to EASA Requirements for Operators. Baines Simmons. Chobham, Surrey, England. Zoe Martin, <zoe.martin@bainessimmons.com>, <www.bainessimmons.com/directory-course.php?product_id=134>, +44 (0)1276 855412.

JULY 18–22 ➤ SMS Principles. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Beth Wigger, <mbwigger@mitre.org>, <www.mitremai.org>, +1 703.983.5617.

JULY 18–27 ➤ SMS Theory and Application. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Beth Wigger, <mbwigger@mitre.org>, <www.mitremai.org>, +1 703.983.5617.

JULY 19–21 ➤ Human Factors and Analysis Classification System Workshop. HFACS Inc. Washington, D.C. <info@hfacs.com>, <www.hfacs.com/store/hfacshfix-workshop-washington-dc>, 800.320.0833.

JULY 21–22 ➤ EASA Regulations for Flight Operations Inspectors. Baines Simmons. Zoe Martin, <zoe.martin@bainessimmons.com>, <www.bainessimmons.com/directory-course.php?product_id=133>, +44 (0)1276 855412.

JULY 25–26 ➤ Quality Assurance for SMS. DTI Training. Yellowknife, Northwest Territories, Canada. <dtitraining@juno.com>, <staboada@dtiatlanta.com>, <www.dtiatlanta.com>, +1 866.870.5490, +1 770.434.5310.

JULY 27 ➤ Basic Auditing Principles. DTI Training. Yellowknife, Northwest Territories, Canada. <dtitraining@juno.com>, <staboada@dtiatlanta.com>, <www.dtiatlanta.com>, +1 866.870.5490, +1 770.434.5310.

JULY 29 ➤ SMS Overview/Safety Culture. The Aviation Safety Group. Myrtle Beach, South Carolina, U.S. Robert Baron, Ph.D., <www.tacgworldwide.com/07292011.htm>, 800.294.0872.

Aviation safety event coming up? Tell industry leaders about it.

If you have a safety-related conference, seminar or meeting, we'll list it. Get the information to us early. Send listings to Rick Darby at Flight Safety Foundation, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA, or <darby@flightsafety.org>.

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

Safety News

Training Modifications

The U.S. Federal Aviation Administration (FAA) is proposing a "substantial and wide-ranging overhaul" of training for the crews of U.S. air carriers as part of a plan to emphasize their handling of in-flight emergencies.

The proposal, outlined in a supplemental notice of proposed rulemaking (SNPRM) published in the *Federal Register*, would result in "the most significant changes to air carrier training in 20 years," FAA Administrator Randy Babbitt says. "This is a major effort to strengthen the performance of pilots, flight attendants and dispatchers through better training."

© Carlos Santa Maria/iStockphoto

The SNPRM addressed comments that were submitted in response to the original January 2009 NPRM, as well as requirements developed by Congress in legislation passed in 2010 (*ASW*, 10/10, p. 12).

The SNPRM calls for changes in ground and flight training that would require flight crews to "demonstrate, not just learn, critical skills in 'real-world' training scenarios," the FAA said. "Pilots would be required to train as a complete flight crew, coordinate their actions through crew resource management and fly scenarios based on actual events. Dispatchers would have enhanced training and would be required to apply that knowledge in today's complex operating environment."

The revised proposal specifies that pilots must undergo training in recognizing and recovering from stalls and aircraft upsets, and prescribes remedial training for those who fail proficiency tests or perform unsatisfactorily in flight training. It also revises qualifications, training and evaluation requirements for crewmembers and dispatchers and specifies that flight attendants must participate in "hands-on emergency drills" every 12 months.

Public comments on the SNPRM will be accepted until July 19.

Medical Attention

The airline industry should standardize the care available during in-flight medical emergencies to "improve the chances that passengers who become ill during air travel will do well," according to a commentary published in *JAMA, The Journal of the American Medical Association*.

"Because of improved aviation safety, most individual flight attendants will never experience an emergency landing or evacuation during their careers," said the commentary by Melissa L.P. Mattison and Mark Zeidel, physicians at Beth Israel Deaconess Medical Center in Boston.

"By contrast, in-flight medical emergencies occur frequently. Yet the kinds of approaches that have improved flight safety have not been extended to providing optimal care for passengers who become acutely ill."

Their recommendations included a call for a standardized recording system for in-flight medical emergencies involving airline passengers in the United States, with mandatory reporting to the National Transportation Safety Board.

They also said that the medical experts should recommend the equipment that should be included in the medical kits aboard airplanes, "with a mandate that a standard kit, with identical items in identical locations, be on every flight."

An emergency medical kit currently is required, but different airlines equip their kits differently, and as a result, medical personnel who respond to in-flight emergencies "are likely to lack familiarity with each airline's emergency medical kit, delaying delivery of proper care as they first must identify and locate medications and supplies," they said.

Another recommendation called for "enhanced and standardized" training of flight attendants in how to handle medical emergencies.

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In addition, flight crews' access to ground-to-air medical support should be standardized and "available to all passengers on all flights when on-plane health care professionals are not available," the doctors said.

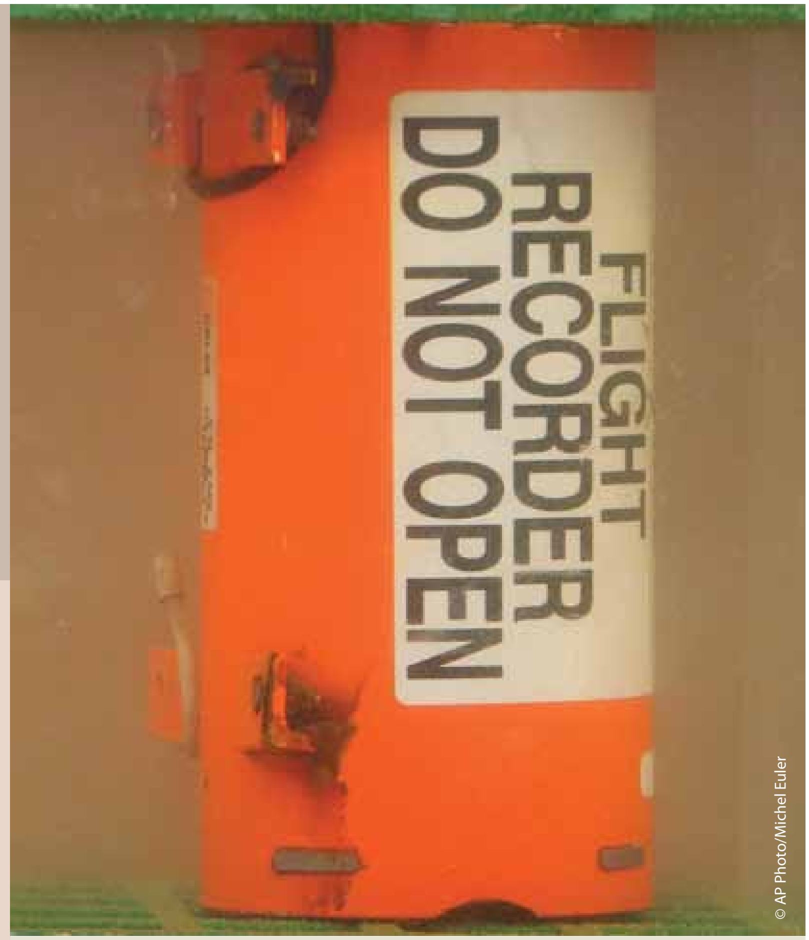
Increased standardization of training, equipment and recording practices offers "the potential to improve outcomes for airline passengers who become ill," they said.

Safety Pact

The European Union and the United States have implemented an agreement, negotiated in 2008, designed to coordinate civil aviation technical and administrative procedures and to enhance aviation safety.

In a printed statement, the European Commission said the agreement will be "the cornerstone of cooperation between the two sides in all matters of aviation safety."

The pact provides a framework for the "continuous, transparent and timely" sharing of information related to aviation safety law and policies and provides "a firm basis for tackling safety problems," the commission said.



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Accident investigators say they have downloaded all data from the flight recorders in the Air France Airbus A330 that plunged into the Atlantic Ocean on June 1, 2009. The recovery of the recorders in May and the successful downloading of information have given investigators "a high degree of certainty that everything will be brought to light," the French Bureau d'Enquêtes et d'Analyses says. The accident killed all 228 people on the Rio de Janeiro-to-Paris flight.

Blacklist Revision

The European Commission, in the 17th revision of its list of airlines banned from operating in the European Union, has extended the ban to all air carriers certified in Mozambique, as well as two Boeing 767s operated by Air Madagascar.

Four Indonesian cargo air carriers and one air carrier based in Ukraine were removed from the list in April "as safety concerns have been satisfactorily addressed," and will be permitted to operate within the EU, the commission said.

The updated list places a full ban on EU operations by all carriers from 21 countries, along with three individual carriers from other countries. In addition, 10 air carriers may operate only under specific conditions.

"The Commission is ready to work together with the authorities of those countries which have safety problems to overcome them as quickly and as efficiently as possible," said Siim Kallas, commission vice president responsible for transport. "In the meantime, safety comes first. We cannot afford any compromise in this area. Where we have evidence inside or outside the European Union that air carriers are not performing safe operations, we must act to exclude any risks to safety."

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Issues and Actions

The Australian Transport Safety Bureau (ATSB) completed 37 investigations of aviation accidents and incidents in the 2009–2010 fiscal year and identified 46 related safety risks — including 12 that it considered significant, the agency says.

The report on the year's safety investigations involving events in all modes of transportation also identified 66 actions undertaken by the ATSB or by the aviation industry to address the safety issues identified during the investigations. Of the 66 actions, 60 were identified as proactive actions taken by the industry, the report said.

"Proactive industry safety actions are encouraged before the release of any formal ATSB safety action, and so generally, the ATSB issues safety recommendations and safety advisory notices as a last resort," the report said.

Rotor-Blade Separation

Citing a 2007 accident that followed the in-flight separation of a section of a Eurocopter EC 130B4 main rotor blade, the U.S. National Transportation Safety Board (NTSB) has recommended daily checks of main rotor blades on specific helicopters for cracks and surface deterioration.

The pilot and seven passengers were not injured in the July 7 accident, but the helicopter was substantially damaged during the emergency descent and autorotation into the Hudson River in New York.

The NTSB said the probable causes of the accident were "the fatigue fracture and in-flight separation of a section of the composite main rotor blade trailing edge aft of the spar, due to inadequate manufacture, and the manufacturer's failure to detect an out-of-specification deviation in the rotor blade's trailing-edge roving." (A "roving" is defined by the NTSB as a "collection of fibers in a parallel bundle with little or no twist.")

The NTSB said that because the fibers were misaligned, loads were transferred to the skin, which is more susceptible than the fibers to cracking.

The safety recommendations to the European Aviation Safety Agency and the U.S. Federal Aviation Administration called on the agencies to require Eurocopter to revise its maintenance manuals for all helicopters with the same rotor blades as the accident helicopter — part no. 355A11-0020 and/or 355A11-0030 — to require daily visual inspections of the trailing edges of the blades' upper and lower skin surfaces.

A second recommendation called on the agencies to require operators of the affected helicopters to revise their maintenance manuals to include the daily blade trailing-edge inspections.

© Mark Seberini/Dreamstime.com

Staffing Cuts

Staff reductions by the Spanish air navigation service provider AENA will place a single air traffic controller in charge of radar service for the Canarias Flight Information Region (FIR) during overnight hours, the International Federation of Air Line Pilots' Associations (IFALPA) says.

The single-controller operation will be in effect between 0100 and 0500, IFALPA said.

IFALPA said that crews flying to Gran Canaria International Airport (GCLP) in the Canary Islands "should be aware that during these hours, no radar vectoring to the GCLP localizer or radar monitoring of the approach will be available." In addition, radar assistance may not be available for standard instrument departures or standard terminal arrivals.

Kalajoki/Wikipedia

In Other News …

Seven countries have signed an agreement to establish the Functional Airspace Block–Central Europe (FAB-CE) — the fourth FAB to be created in the process of implementing the **Single European Sky**. The FABs are intended to end the fragmentation of Europe's airspace, and to increase flight efficiency and safety. … In the aftermath of reports of several **air traffic controllers** sleeping on the job, the U.S. Federal Aviation Administration (FAA) has ordered management changes, accepted the resignation of Hank Krakowski as head of the FAA Air Traffic Organization and increased controller staffing on midnight shifts. … The European Commission (EC) and the **International Civil Aviation Organization** have agreed to a plan calling for enhanced cooperation between the two bodies, including expanded contributions from the EC in preparatory work for ICAO development of policies and standards.

Compiled and edited by Linda Werfelman.

BY MARK LACAGNINA

Fatal

The 737 captain continued an unstabilized approach despite numerous warnings.

The Air India Express aircraft was very high and fast during an approach to Mangalore, India.

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Persistence

Sounds of snoring and deep breathing captured by the cockpit voice recorder (CVR) indicated that the captain of the Air India Express Boeing 737-800 was asleep until the last 25 minutes of the ill-fated flight. And during those last few moments, his judgment might have been impaired by sleep inertia, said an Indian court of inquiry.

With little time for planning and a late descent clearance because the air traffic control (ATC) radar was out of service, the aircraft arrived very high on the approach to Mangalore, India. Despite several warnings by the first officer and by the enhanced ground-proximity warning system (EGPWS), the captain continued the grossly unstabilized approach.

The 737 touched down long and fast. The captain deployed the thrust reversers and briefly applied wheel braking, but then attempted to reject the landing. The aircraft overran the runway, struck the instrument landing system (ILS) localizer antenna mounting structure, traveled through the airport boundary fence and plunged into a gorge. The impact and fire killed 152 passengers and all six crewmembers; seven passengers were seriously injured, and one passenger sustained minor injuries.

In a final report based on public hearings and the findings of an investigation by the Indian Directorate General of Civil Aviation (DGCA), the court of inquiry said that the cause of the May 22, 2010, crash was "the captain's failure to discontinue the unstabilized approach and his persistence in continuing with the landing despite three calls from the first officer to go around and a number of warnings from the EGPWS."

Quick Turnaround

The accident occurred during a daily "quick turnaround" trip conducted by Air India Express from Mangalore to Dubai, United Arab Emirates, and back to Mangalore.

The captain, 55, had 10,216 flight hours as a pilot-in-command (PIC) and 2,845 hours in type. He was hired as a 737 PIC by Air India Express in December 2008. Pilots who had flown with the captain described him as friendly and "ready to help the first officers with professional information," the report said, adding, however, that "some of the first officers mentioned that [the captain] was assertive in his actions and tended to indicate that he was always right."

The first officer, 40, was hired as a 737 copilot in April 2009. He had 3,500 flight hours, including 3,200 hours in type. Noting that the first officer "was due for command training" on the 737, the report said that he "was known to be meticulous in his adherence to procedures [and] to be a man of few words."

Indian Directorate General of Civil Aviation

The 737 was in pieces and engulfed in flame when rescuers arrived. Only eight passengers survived.

The report said that both pilots had been given adequate time to rest before beginning the trip. The captain had received 54 hours of rest after returning to Mangalore on May 19 from a two-week vacation at his hometown in Serbia. The first officer, an Indian national, had received about 82 hours of rest before the trip.

"Due to the non-availability of a medical officer, the crew was not subjected to any preflight medical check prior to departure from Mangalore," the report said. "However, the engineering personnel who interacted with the captain and the first officer … stated that both pilots appeared to be healthy and normal."

The aircraft departed from Mangalore at about 2135 local time and arrived in Dubai at 0114 (2344 Dubai time). The return flight to Mangalore began nine minutes ahead of schedule at 0236. "As indicated by the DFDR [digital flight data recorder], the takeoff, climb and cruise were uneventful," the report said.

No Radar

The first officer established radio communication with Mangalore Area Control at 0532. A notice to airmen published two days earlier advised of an ATC radar outage in the area. The first officer asked the controller if the aircraft was being tracked on ATC radar and was told that the Mangalore area radar was still out of service.

The controller also told the first officer that the airport was reporting calm winds, 6 km (4 mi) visibility, a few clouds at 2,000 ft and a surface temperature of 27 degrees C (80 degrees F).

The aircraft was at Flight Level (FL) 370 (approximately 37,000 ft) and about 130 nm (241 km) from Mangalore when the first officer requested clearance to descend. "This was, however, denied by the ATC controller, who was using standard procedural control to ensure safe separation with other air traffic," the report said.

The first officer later was told to expect the VOR-DME (VHF omnidirectional radio/distance measuring equipment) arc transition to the ILS approach to Runway 24, which is 8,038 ft (2,450 m) long.

The report described the airport as being on a "tabletop" plateau that rises about 300 ft above the surrounding terrain. Airport elevation is 337 ft. The airport is classified as a "critical airfield" by the DGCA, requiring special qualification of flight crews operating there. Air India Express required all takeoffs and landings at the airport to be conducted by the PIC.

The captain, who was based in Mumbai, had conducted 16 flights at the Mangalore airport; the first officer, who was based in Mangalore, had made 66 flights there.

Incomplete Briefing

The captain awakened at 0540, shortly before the descent was begun. The first officer briefed him on the weather conditions and the expected approach procedure at Mangalore. "This was the first time that the CVR recording revealed limited communication between the flight crew," the report said. "However, the captain did not communicate effectively in response to this briefing. The approach briefing was incomplete and not in conformity with … SOP [standard operating procedure]."

The area controller had told the first officer to make a position report at 80 nm (148 km) on the 287-degree radial of the Mangalore VOR/DME. The first officer made that report at 0546 and was cleared to descend from FL 370 to 7,000 ft.

The aircraft was descending through 29,500 ft at 0550 when the captain deployed the speed brakes to increase the rate of descent. The pilots then conducted the "Descent" checklist. The report noted that company SOP requires flight crews to begin this checklist about 150 nm (278 km) from the destination airport and to complete the checklist before beginning the descent from cruise altitude.

The aircraft was 25 nm (46 km) from the airport and descending through 18,400 ft when the crew was cleared to continue the descent to 2,900 ft, the minimum altitude for the published 10-nm (19-km) VOR-DME arc transition. The aircraft entered the arc at about 10,500 ft and 251 kt.

"Throughout the descent profile and DME arc approach for the ILS 24, the aircraft was much higher than the normally expected altitudes," the report said. "During the same time, the only sounds made by the captain were of exhaling, yawning and throat clearing."

'Runway Straight Down'

The CVR also recorded yawns by the first officer, a sign that he, too, was tired, the report said, noting that both pilots were operating in the "window of circadian low," a physiological period characterized by reduced performance and alertness.

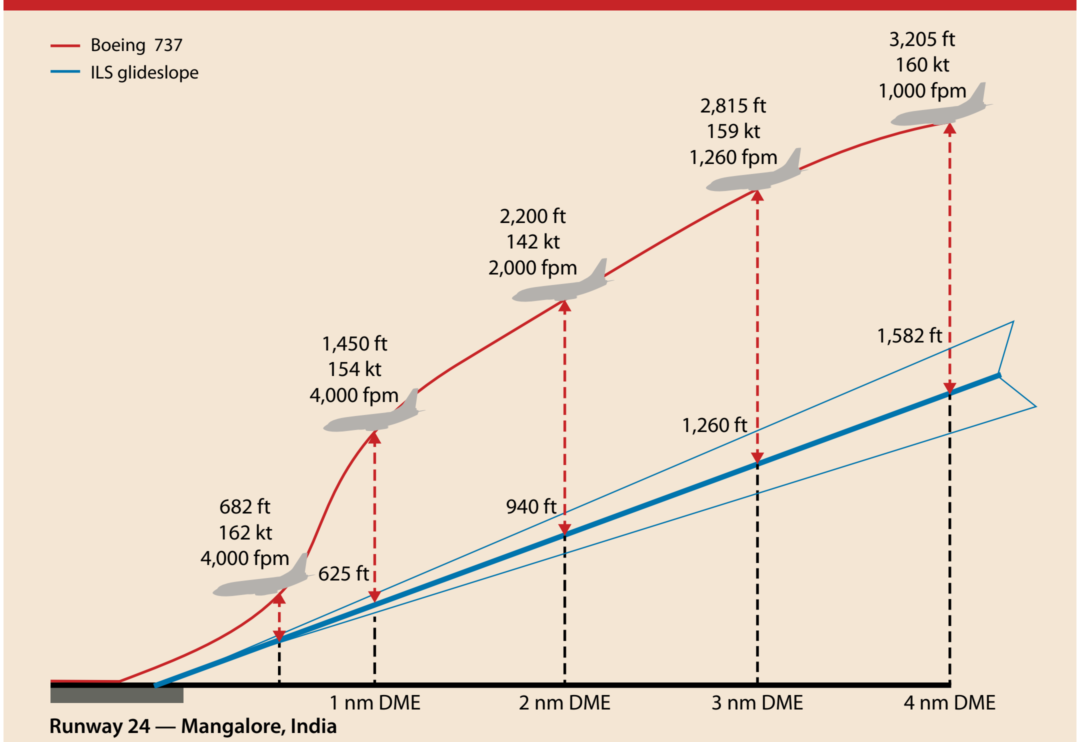
The flight was handed off at 0552 to the airport traffic controller, who asked the first officer to report when the aircraft was established on the DME arc. Shortly after the first officer made that report, "it appears that the captain realized that the aircraft altitude was higher than normal and selected the landing gear down at an altitude of approximately 8,500 ft, with the speed brakes still deployed, so as to increase the rate of descent," the report said.

The 737 was at 7,700 ft when it passed through the localizer course at 217 kt. The first officer had not made the required call of "localizer alive" when the needle began to center. The captain steepened the right turn to correct the overshoot.

After intercepting the localizer course, the aircraft remained about two times higher than the published altitude required to intercept the glideslope from below, per normal procedure.

At 0601 and at a DME distance of 6.7 nm (12.4 km), the aircraft was descending through 4,630 ft with the speed brakes still deployed, when the captain told the first officer to extend the flaps to 15 degrees. The captain called for flaps 25 and then retracted the speed brakes as the aircraft was descending through 3,465 ft at 4.3 nm DME (7.9 km). At 2.5 nm DME (4.6 km), the EGPWS called out a height of 2,500 ft (Figure 1).

Flight Path



DME = distance measuring equipment; ILS = instrument landing system

Source: Adapted from DGCA report by Karen Ehrlich

Figure 1

"It is too high," the first officer said. "Runway straight down."

"Oh, my God," said the captain. He disengaged the autopilot, called for flaps 40, redeployed the speed brakes and moved the control column forward to increase the rate of descent. At 165 kt, the airspeed was above the 162-kt limit for flaps 40, and the flap load-relief system automatically reduced flap extension to 30 degrees.

Fixated on the Runway

"Go around?" the first officer asked.

"Wrong loc … localizer … glide path," the captain said.

"Go around," the first officer stated. "Unstabilized."

'Flight Safety Watchdog' for India?

Prompt adoption of legislation that would establish an independent organization to investigate aviation accidents and serious incidents in India was among numerous recommendations issued by a court of inquiry convened to investigate the fatal Air India Express Boeing 737 accident at Mangalore.

Currently, aviation investigations are conducted mainly by the Directorate General of Civil Aviation (DGCA), which serves primarily as the aviation regulatory authority in India. Shortly after the 737 crashed in Mangalore on May 22, 2010, the DGAC's governing body, the Ministry of Civil Aviation, announced that it was considering originating legislation that would transfer the directorate's accident-investigation responsibilities to an independent body and would give the DGCA total autonomy as the aviation regulator, according to media reports.

The court told the Ministry of Civil Aviation that an Indian Civil Aviation Safety Board should be patterned after the "independent safety organizations [that] have been set up in the United States, United Kingdom, Canada, France and Indonesia, to name a few."

Autonomy is a key to the successful functioning of such a body, the court indicated, citing a previous attempt, in 1987, to establish an independent investigative organization in India similar to the U.S. National Transportation Safety Board. "However, it did not have independence as a statutory body, and, therefore, it did not fructify into a permanent setup," the court said.

The court urged the ministry to proceed with legislation that would create an Indian Civil Aviation Safety Board. Citing the rapid growth of civil aviation in the last decade, the court said, "With further growth projected in this vital means of transportation, there is an urgent need for an independent body which will function as a watchdog in the matters of flight safety [and] help in formulating proactive strategies to reduce accidents and incidents."

The report said that the captain was "fixated on the runway" and did not respond to the first officer's call to go around. Although company SOP empowered the first officer to assume control and discontinue the approach, he did not do so.

The captain had increased the aircraft's descent rate to nearly 4,000 fpm, and the first officer had made no callouts about altitude, airspeed or sink rate. Neither pilot responded to the nearly continuous "SINK RATE" and "PULL UP" warnings generated by the EGPWS.

Working without radar, the airport traffic controller had instructed the crew to report when they were established on the ILS approach. When the report was overdue, the controller asked the first officer if they were on the approach. "To this call, the captain forcefully prompted the first officer to give a call of 'affirmative,'" the report said. "The ATC tower gave landing clearance thereafter and also indicated 'winds calm.'"

The 737 crossed the runway threshold at 200 ft and with an indicated airspeed in excess of 160 kt. The report said that the crossing height should have been 50 ft, and the proper airspeed for the aircraft's weight was 144 kt.

"Despite the EGPWS warnings and calls from the first officer to go around, the captain had persisted with the approach in unstabilized conditions," the report said. "Short of touchdown, there was yet another (third) call from the first officer, this time on the VHF [radio] channel: 'Go around, captain,' followed by, 'We don't have runway left' on the intercom." This call, too, was not heeded by the captain.

When airspeed decreased below 158 kt, the flap load-relief system extended the flaps to the selected 40 degrees. "This extension during the flare, close to the ground, resulted in a prolonged float and a late touchdown," the report said.

The aircraft touched down about 5,200 ft (1,585 m) from the approach threshold of Runway 24, with about 2,800 ft (853 m) of runway remaining.

The captain deployed the thrust reversers. The autobrake, which had been set to

The 737 touched down about two-thirds of the way down the runway and plunged into a gorge during a last-minute attempt to reject the landing at the 'tabletop' airport in Mangalore, India.

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position 2, the second of four settings providing progressively higher wheel braking, activated briefly before the captain applied manual wheel braking.

Six seconds later, the captain "made the grave mistake" of stowing the thrust reversers and applying full thrust to initiate a go-around, the report said. Shortly thereafter, he exclaimed, "Oh, my God. … Aww, big one."

The aircraft overshot the runway and the 300-ft/90-m runway end safety area (RESA). The right wing "sheared into pieces" and the right engine separated when they struck the non-frangible, concrete localizer antenna mounting structure 279 ft (85 m) from the end of the RESA, the report said. "The remaining portion of the aircraft fell into the gorge, broke into three parts and caught fire."

The report said that "a large number of fatalities were due to burns" and that toxicological tests revealed no sign that the captain or the first officer had consumed any drugs, alcohol or medications.

Dozing on Deck

During the hearings conducted by the court of inquiry, several senior pilots said they often wish that they could take a short nap during cruise flight. Most of the pilots admitted to having taken naps on the flight deck or having seen other crewmembers nap during cruise flight.

"There are dangers of such a nap prolonging into a deep sleep, causing effects of sleep inertia," the report said. "There is also a possibility of induced sleep, which affects the other crew-members, who may also doze off."

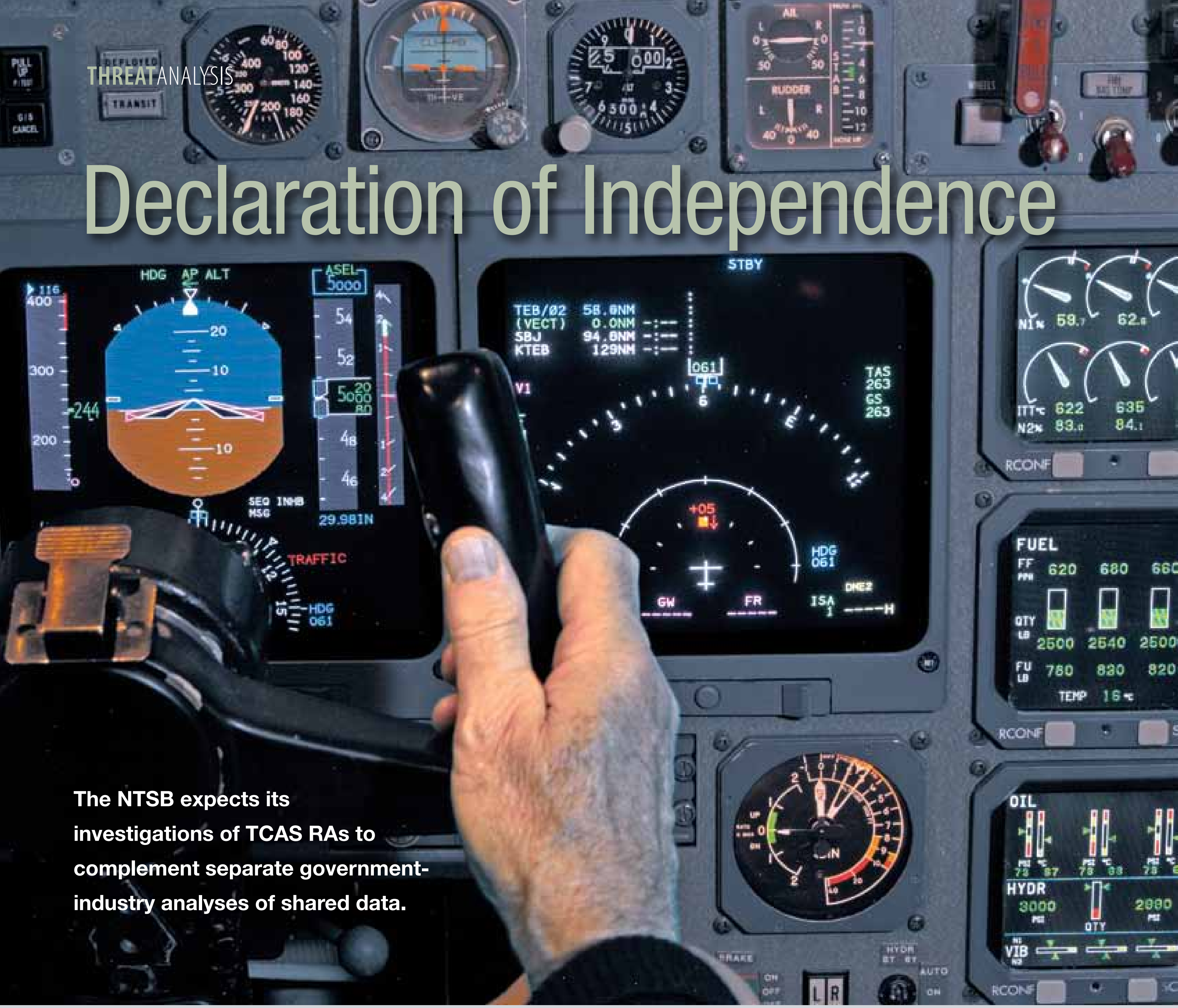
The DGCA had investigated two incidents in which both flight crewmembers were sleeping at the same time. As a result, the directorate in 2009 issued an air safety circular requiring cabin crew "to interact with pilots on intercom every 30 minutes," the report said, adding: "Although such a procedure is useful, it is possible that only one of the pilots, who is awake all the time, would reply and the other crew[member] could go into deep sleep."

Indeed, the CVR in the accident aircraft had recorded the first officer responding to queries by the cabin crew, as well as radio transmissions from ATC, while the captain was asleep.

The report noted, however, that several airlines have established SOPs for controlled rest in the cockpit, recognizing that a 45-minute nap can refresh a pilot prior to descent and landing. Accordingly, the court recommended that the DGCA determine whether Indian airlines should be allowed to adopt such procedures.

This article is based on a report of the DGCA's investigation and the findings of the court of inquiry entitled "Report on Accident to Air India Express Boeing 737-800 Aircraft VT-AXV on 22nd May 2010 at Mangalore." The full report is available on the Aviation Safety Network Web site at <aviation-safety.net/database/record.php?id=20100522-0>.

Declaration of Independence



The NTSB expects its investigations of TCAS RAs to complement separate government-industry analyses of shared data.

BY WAYNE ROSENKRANS

As government-industry exchanges of vast banks of operational data flourish, incident-level investigations by the U.S. National Transportation Safety Board (NTSB) can appear to be out of step with the times. Some aviation safety professionals have seen the board's approach to near-midair collisions (NMACs) as a case in point, specifically the latest requirement for operators to report certain resolution advisories (RAs) issued by traffic-alert and collision avoidance systems (TCAS II).[1]

Yet early indications are that NTSB investigations help to rapidly mitigate underlying risk factors of midair collisions, even if limited sometimes to a local application, while large-scale data analysis may take years to deliver system-level risk mitigations. Finding solutions either way has been extremely difficult, NTSB and U.S. Federal Aviation Administration (FAA) officials admit (*ASW,* 8/09, p. 32).

Before its effective date of March 8, 2010, the requirement to report certain RAs had been widely opposed as an unwarranted duplication of effort, but the first 12 months of RA investigations reveal more about the board's complementary, check-and-balance purposes.

Investigating RAs has been a long-established process falling "well within our mandate," says Tom Haueter,

© Chris Sorensen Photography — TCAS RA on Dassault Falcon 50EX simulator at Teterboro Learning Center, FlightSafety International director, NTSB Office of Aviation Safety. "Our decision to go after formalized reporting was basically because of the problem that we didn't know how many RAs were out there," he said. "We previously got this information second-hand many times, and we needed to have reliable reporting of the TCAS RA events in which aircraft are in the positive control area [i.e., Class A airspace, from 18,000 ft through Flight Level (FL) 600 (approximately 60,000 ft)] or at lower altitudes" under instrument flight rules (IFR) if compliance with the RA is necessary to avert a substantial risk of collision between two or more aircraft.

In December 2004, the NTSB had proposed to add RAs to its list of events required to be reported immediately to the board under Title 49 of the Code of Federal Regulations, Part 830, "Notification and Reporting of Aircraft Accidents or Incidents and Overdue Aircraft, and Preservation of Aircraft Wreckage, Mail, Cargo and Records."

After reviewing public comments in 2005, the board decided to make refinements. The final regulation requires reporting RAs either "when an aircraft is being operated on an [IFR] flight plan and compliance with the advisory is necessary to avert a substantial risk of collision between two or more aircraft, or [when an RA occurs on] an aircraft operating in Class A airspace."

Visitors to the NTSB Web site <www.ntsb.gov> now find on the home page a "TCAS RA" reporting link separate from the link for the nine-page, PDF-format NTSB Form 6120.1, "Pilot/Operator Aircraft Accident/Incident Report." The TCAS RA link simply launches an empty email message from the sender to <tcas@ntsb.gov> but any email program can be used to send a message to this address. "The key for us is getting accurate reports quickly — as fast as we can get them — so we can pull the air traffic control [ATC] radar tapes and interview people if necessary, and make an evaluation," Haueter said. "If we need more data, NTSB staff will contact any person or organization as needed to complete the investigation."

Early Experience

From March 8, 2010, through March 8, 2011, the NTSB received about 950 RA reports. "Of the 950, there were only 260 that we thought merited additional examination to see if something serious was going on," Haueter said. Nine RAs investigated recently include seven that occurred in the 12 months after the effective date of the final rule, one RA from October 2009 and one RA from February 2010.

As to RAs screened so far, "there have been no real surprises … nothing that jumps out in terms of a trend or something unusual," he said. Investigators' reviews of the 260 reports did not support categorization or identification of "pockets" of airspace (hot spots) where more RAs occurred than normal. "The events were about what we have seen before, but we will keep collecting data … and each year we will know better which to investigate, and we will refine the process if necessary," he said. "This is going to take a long time."

Investigation Examples

From Haueter's perspective, the most prominent of the nine RA investigations was an NMAC on Sept. 16, 2010. This collision was averted by an immediate climb maneuver performed by the flight crew of a US Airways Airbus A320 (Figure 1, p. 20). The A320 crew and the pilot of a Beech 99, operated by Bemidji

NTSB TCAS Notification

Date/Time: 9-16-10 1149Z

Flight: 1848

City Pairs: MSP-CLT

Location: MSP Approx.

Altitude: 400 ft AGL RA

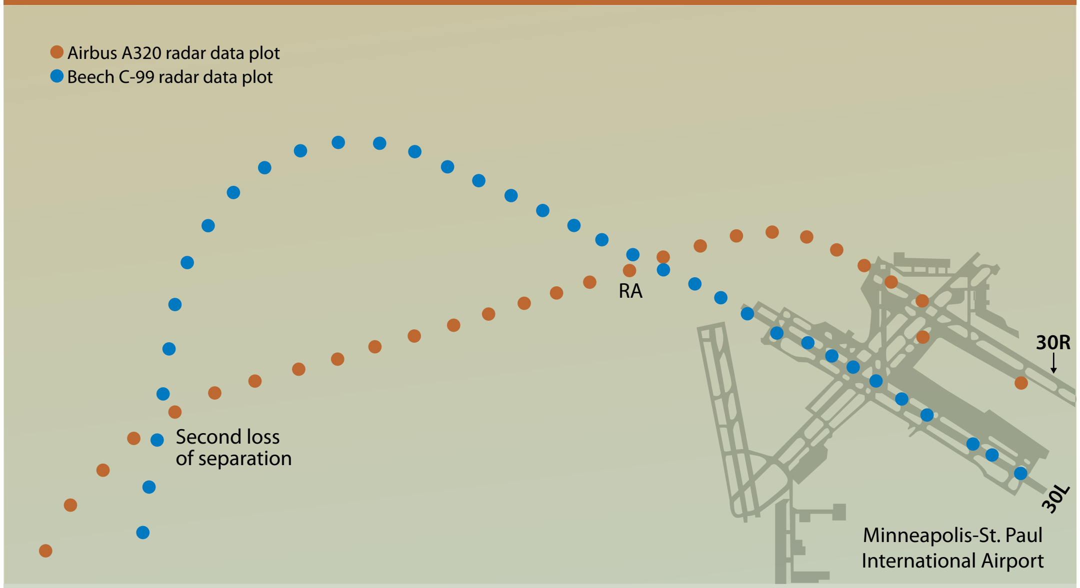
Type: Climb ATC

Facility/Frequency: MSP Tower

Captain Statement:

At 0635 local time we pushed back at KMSP from gate C-11 and taxied to 30R. At 0649 we were cleared for takeoff to fly runway heading (299 deg). At 400 ft AGL the F/O (pilot flying) called for runway heading, at the same time KMSP tower told us to turn left to a heading of 260 and call dept. at 124.7 (from the original of 125.75). We turned to HDG 260 and at that time we received a TCAS RA. We were in a normal takeoff climb rate when the TCAS commanded a much greater climb to clear the conflicting traffic. The F/O responded with a swift pull-up. During this time I observed a red target on the TCAS display to our immediate left, that showed a –100 ft. (We were in the clouds at about 500 ft and could not see the aircraft.) Within just a few seconds I heard the whine of turboprops go under our aircraft from left to right. After this the TCAS gave a "clear of conflict" and we returned to normal flight. After the flight I consulted with KMSP ATC and learned that the tower controller on 30R turned us into the path of a Beechcraft 99 departing from 30L. I have been on the A320 for 8 years and am very grateful of the TCAS and computer systems installed in the Airbus family of aircraft, they worked very well to allow us to survive this event.

NTSB Investigation of TCAS RA and NMAC Incident



NMAC = near-midair collision; TCAS = traffic-alert and collision avoidance system; RA = resolution advisory

Note: The flight crew of the Airbus A320 increased their climb rate in response to the TCAS RA; the Beech C-99 was not TCAS-equipped. The incident occurred Sept. 16, 2010.

Source: U.S. National Transportation Safety Board (NTSB)

Figure 1

Aviation Services, had been cleared to conduct takeoffs and departure turns in instrument meteorological conditions from parallel Runways 30R and 30L, respectively, at Minneapolis-St. Paul (Minnesota) International Airport. Airport weather conditions included a reported ceiling at 900 ft and visibility of 10 mi (16 km).

After takeoff, the A320 crew had received and complied with an ATC instruction to turn left to heading 260. The air traffic controller responsible for the Beech 99 cargo flight's departure instructed the pilot to take off and turn left to heading 180. However, the pilot delayed his compliance with the turn instruction for about 2.0 nm (3.7 km) until reminded, and the controller did not look at the radar display or otherwise realize that this delay was causing the path of the Beech 99 to intersect the path of the A320. The NTSB investigation found that about one minute after the TCAS RA, the same controller issued a vector to the Beech 99 pilot that caused a second, unreported loss of separation — a radar proximity of 500 ft and 1.23 nm (2.28 km).

The Beech 99 conflict with the A320 occurred because of the controller's assumption that the Beech 99 pilot had turned immediately after takeoff, Haueter said. "That kind of assumption in the ATC system is one we have seen before," he said. "By being able to see radar tracks and make safety recommendations, hopefully we can prevent this issue from leading to an accident." The factual report noted that the incident controller was distracted by a taxiing aircraft pilot's questions about an ATC instruction.

Unlike large-scale analyses of operational data, documents in this public docket — accessible via the NTSB Docket Management System <dms.ntsb.gov/pubdms/search> — provide details from radar track replay analysis and the transcribed audio recordings of pilot-controller communication; interviews with pilots, local controllers and ATC supervisors; analysis of applicable ATC rules, procedures, typical route coordination, radar/visual separation practices, radar range setting, automatic acquisition of radar target data tags, position relief briefings, and duty assignments; and analysis of the incident controller's training, fatigue, duties and past performance issues.

The associated reports also describe the FAA's quality assurance investigation, include three local directives to controllers issued before completion of the NTSB investigation, and cite the planned follow-up actions by quality assurance staff from FAA headquarters. The docket also contains an NTSB comparison of similarities between this incident and an ATC operational error that resulted in loss of separation on Nov. 11, 2010, between two airliners departing from these same runways.

First Probable Cause

The probable cause has been determined for a serious incident that occurred March 25, 2010, when the flight paths of a Continental Airlines 737 and a Gulfstream II crossed within 1.04 nm (1.93 km) and 300 ft in Class A airspace over Worton, Maryland. Just before the incident, the GII was at FL 290 and the 737 was at FL 360. An operational error by the controller responsible for the GII occurred during her attempt to simultaneously vector this flight crew to pass clear of Aberdeen Restricted Area and to position the GII more than 5.0 nm (9.3 km) behind the 737, the report said.

The probable cause was, "The [radar controller for sector 10/12 of the Washington Air Route Traffic Control Center] issued an improper vector and descent clearance to the GII that put the airplane on a converging flight path with the B737. Contributing to the incident was the failure of the FAA's training program to correct ongoing controller performance deficiencies before certifying the [manual controller for sector 10/12] to work without immediate supervision." The documents in the public docket are similar in scope to those for the Minneapolis incident.

Strict NTSB Independence

In response to the 2004 and 2008 notices of proposed rulemaking for Part 830, the airline industry and the FAA urged the NTSB to endorse, rely upon or — ideally — participate in the existing voluntary non-punitive FAA-industry processes for reporting and analyzing RAs. Often mentioned was joining in the FAA Aviation Safety Information Analysis and Sharing (ASIAS) program, which currently has 35 participating airlines. The NTSB declines to do so, although some have seen the resulting limited access to data as a disadvantage.

"Certainly the FAA and airlines can take their data and look at it through the ASIAS viewpoint; we can't," Haueter said. "We are not linked into ASIAS."

Some observers may have misconstrued the statutory safety-oversight role of the NTSB, and how this limits relationships with the FAA and the industry. "We have a 'watchdog' function over the FAA, and one of our functions is to oversee ATC safety," Haueter said. "As the regulatory agency running the ATC system, they can make changes. So they do their own investigations of RAs, and we do ours. This works quite well as a system. Certainly, we will share with the FAA any of our information."

Meanwhile, many advantages accrue from the increased RA reports reaching the NTSB. "We now have a better handle on what's going on … numbers to back up what we have been looking at," Haueter explains. "Yet each of these events is unique, so it has been hard to pin down exactly where we definitely see improvement necessary."

The most important driver of these NTSB investigations, Haueter said, is ensuring a detailed awareness of how the few unsafe situations developed and resulted in the RAs. His basic message to pilots and airlines willing to read investigation reports is: "Be vigilant; watch out for situations where you might lead yourself or ATC may inadvertently lead you into another airplane's airspace."

Educating the Industry

Uncertainty persists for now about how many RA reports typically will arrive per year at the NTSB, but outside predictions of many thousands have not materialized, and polite reminders have been effective in enforcing compliance by all operators involved in each reportable event. "One thing we do know from the first year is that there has been a lot of over-reporting," Haueter said. "Some people reported TCAS RAs that they did not have to report, so we are educating the industry, and I imagine in the following years, we will see the number decrease a bit."

Flight crews, pilots and operators can use as a general guideline the FAA definition of an NMAC, given that "the infinite variety of encounter geometries does not lend itself to specific [RA-reporting] guidance that would apply to every possible scenario," the NTSB said. An NMAC is "an incident associated with the operation of an aircraft in which a possibility of collision occurs as a result of proximity of less than 500 ft [152 m] to another aircraft, or a report is received from a pilot or a flight crewmember stating that a collision hazard existed between two or more aircraft."

An explanation in the final rule also clarified, "[RAs] that command maximum vertical speed, 'reversal' advisories that require a change in vertical direction after the initial advisory is issued, or encounters that result in zero vertical separation between the aircraft involved are all examples of the types of advisories that the NTSB believes may be indicative of substantial collision risk. Conversely, [RAs] issued to aircraft operating on closely spaced parallel approaches or in other circumstances where there is no substantial risk of collision need not be reported under this rule."

To read an enhanced version of this story, go to <flightsafety.org/aerosafety-world-magazine/may-2011/ntsb-tcas>.

Note

1. The NTSB uses the international term *airborne collision avoidance system (ACAS).*

Improving Nonrevenue Flight Safety

Guidance material and proposed regulations target the risks in nonroutine operations.

BY MARK LACAGNINA

A spate of recent accidents and serious incidents has raised awareness of the increased risk involved in nonrevenue flight operations and has spurred action to address those risks. Nonrevenue flights, also called nonroutine or nonstandard flights, include functional check flights, ferry and positioning flights, and training flights.

In the past decade, about 25 percent of turbine aircraft accidents occurred during nonrevenue flights, according to the U.S. Federal Aviation Administration (FAA). A similar figure emerged from studies performed by a Flight Safety Foundation task force that examined approach and landing accident data in the late 1990s. The safety specialists found that although non-passenger-carrying flights represented only about 5 percent of the flights conducted by commercial operators, they accounted for 25 percent of the 287 fatal approach and landing accidents that occurred from 1980 to 1996.

In February, a symposium organized by the Foundation to examine functional check flight

The pilots were unable to restart the engines on this regional jet after stalling the airplane at its maximum altitude during a positioning flight in October 2004.

safety drew 275 safety specialists from 41 countries (*ASW*, 3/11, p. 14). The consensus was that safety can be improved if operators adopt best practices in personnel selection and training, and in organizing their check flight efforts; if regulators consider sensible, well-defined regulations developed in conjunction with the industry; and if manufacturers provide more information to operators on training and procedures, said Jim Burin, the Foundation's director of technical programs.

Action is being taken on all fronts. Many operators are gleaning best practices from a variety of guidance material published by civil aviation authorities. The European Aviation Safety Agency (EASA) currently is poring over public comments on proposals to establish minimum qualifications for pilots and flight test engineers, as well as operational requirements, and hopes to complete the rule making next year. Airbus has introduced a Technical Flight Familiarization Course that is offered monthly at its training centers, and Boeing has posted generic flight test profiles for several models on its customer website.

Helpful Handbook

Among the leading sources of operational information on functional check flights is the *CAA Check Flight Handbook*, originally issued by the U.K. Civil Aviation Authority's Aircraft Certification Department in 2008. Issue 2.2 of the 90-page document was current at press time.

U.K. operators must coordinate required check flights with the CAA. Among other things, the CAA determines whether the pilot-in-command (PIC) is eligible to conduct the proposed check flight. This requires a briefing and, possibly, a flight with a CAA test pilot.

Although much of the content of the *CAA Check Flight Handbook* is specific to functional check flights conducted by operators of U.K.-registered aircraft according to "schedules" created or approved by the CAA, any operator likely will find the basic guidance useful.

Preparation is the key to risk management, the handbook says. "The nonroutine nature and requirements of a check flight require careful review and forethought, particularly when the check is to be carried out by pilots more familiar with routine line operations rather than by qualified test pilots. … It is important to decide at the briefing stage who is going to do what."

Only the minimum required flight crew, plus a flight test engineer or observer to record the test results, should be aboard the aircraft, the handbook says. "Should any member of the crew be unhappy with any of the checks being performed or planned, they must say so, and the matter must be resolved before continuing."

While the handbook provides detailed general guidelines for checking and recording handling, performance and systems characteristics — and for recovering from inadvertent stalls and overspeeds — the schedules provide type-specific information and forms for recording test results. For example, the schedule for the Boeing 737-500 includes a table of trim, stick-shaker-activation and stall speeds at various airplane weights and configurations. It stresses that airspeed should not be reduced beyond 4 kt below the expected stick-shaker-activation speed and that recovery should be initiated immediately if the stick shaker activates or pre-stall buffeting is encountered.

The handbook, as well as schedules for most aircraft with maximum takeoff weights above 5,700 kg/12,500 lb, are available on the CAA website <caa.co.uk>. Generic schedules for smaller aircraft also are available.

Maintenance Coordination

A serious incident involving a 737 in 2009 (Table 1, p. 24) prompted the U.K. CAA to follow up with an "airworthiness communication" — AIRCOM 2009-03, "Ensuring Satisfactory Coordination Between Operators and Maintenance Organizations for Maintenance Check Flights."

"Prior to any maintenance check flight, a full pre-brief must be conducted between engineering and operations, during which the flight crew must be made aware of the specific reasons for the check flight," the AIRCOM says. "In particular, specific note must be made of any maintenance tasks that have a direct effect on the control of the aircraft's attitude or the propulsive efficiency of the aircraft."

Red Flags

In the United States, nonrevenue flight risks were highlighted by fatal accidents involving a Douglas DC-8 in 1996 and a Bombardier CRJ200 in 2004 (Table 1). Based on its investigation of the DC-8 accident, the U.S. National Transportation Safety Board (NTSB) called on the FAA to introduce operating limitations and training requirements for nonroutine flights in Federal Aviation Regulations Part 121, which governs air carrier operations.

Because many nonroutine flights are conducted under the general operating and flight rules of Part 91, however, the FAA elected instead to amend the guidance for operations and airworthiness inspectors in FAA Order 8900.1, the *Flight Standards Information Management System* — an action accepted by NTSB. Among the new requirements is that company maintenance manuals must specify maintenance tasks requiring flight checks, as well as procedures for conducting the checks.

The FAA also published an "information for operators" bulletin — InFO 08032, *Non-Routine Flight Operations* — in May 2008. Among other things,

Nonrevenue Flight Accidents and Serious Incidents

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Dec. 22, 1996	Narrows, Virginia, U.S.	Douglas DC-8-63F	destroyed	6 fatal
Following major modifications and an extensive maintenance check, the Airborne Express freighter was undergoing a functional check flight at night with three flight crewmembers and three maintenance technicians aboard. The U.S. National Transportation Safety Board (NTSB) said that airframe icing and/or control misrigging might have triggered a premature stall during a check of the stick shaker at 13,500 ft, just above a cloud deck. The crew applied full power, but the pilot flying held aft control pressure, prolonging the stall as the airplane descended rapidly and struck a mountain. The pilots previously had experienced DC-8 stalls only in a simulator that did not replicate the pronounced stall break characteristic of the airplane. (NTSB report AAR-97/05; *Accident Prevention,* 9/97)				
Oct. 14, 2004	Jefferson City, Missouri, U.S.	Bombardier CRJ200	destroyed	2 fatal
The captain told a controller that they had "decided to have a little fun" and climb to the airplane's maximum altitude, Flight Level (FL) 410, during a night positioning flight for Pinnacle Airlines. The CRJ was in a very low energy state when it reached that altitude, and the first officer kept increasing angle-of-attack in an attempt to keep it there. Both engines flamed out when the airplane finally stalled. The pilots regained control at FL 340 but were unable to relight either engine due to procedural nonadherence and possibly because of engine core lock. The CRJ crashed in a residential area 2.5 mi (4.0 km) from the emergency airport that the crew was trying to reach. NTSB said that the accident was caused in part by the pilots' "unprofessional behavior, deviation from standard operating procedures and poor airmanship." (NTSB report AAR-07/01; *ASW*, 7/06, p. 44)				
Nov. 27, 2008	Perpignan, France	Airbus A320-232	destroyed	7 fatal
The A320, leased by XL Airways, was undergoing functional checks required before its return to Air New Zealand. The French Bureau d'Enquêtes et d'Analyses (BEA) said that the flight crew was unaware that rinse water had accumulated and frozen inside the angle-of-attack sensors. The airplane stalled during low-speed checks conducted at a lower-than-authorized altitude and descended into the Mediterranean Sea. BEA said that among the factors contributing to the accident was the flight crew's lack of training and experience in performing functional check flights. (BEA report D-LA081127; *ASW*, 11/10, p. 22)				
Jan. 12, 2009	Norwich, Norfolk, England	Boeing 737-700	none	4 none
Observers from the aircraft owner and the airline due to take delivery from easyJet of the 737 were aboard for an end-of-lease functional check flight. The U.K. Air Accidents Investigation Branch (AAIB) said that the elevator balance tab had been readjusted improperly, and when the flight crew isolated hydraulic power from the flight controls for a manual reversion check, the aircraft pitched nose-down and descended out of control from 15,000 ft to 5,600 ft, reaching 429 kt and 20,000 fpm. The AAIB found that the crew did not use the aircraft maintenance manual test procedure, which requires that rudder boost be maintained during a manual reversion check. (AAIB Bulletin 9/2010)				
Nov. 11, 2009	Kent, England	Dassault Falcon 2000	substantial	6 none
Although not trained to conduct functional check flights, the flight crew was asked to perform "high-speed taxi tests" following maintenance to correct a tendency of the Falcon to pull left when the wheel brakes were applied. A flight attendant and three maintenance personnel were aboard the NetJets Europe airplane when the crew performed eight accelerate-stop tests within about 15 minutes, causing the brake assemblies to overheat severely and ignite hydraulic fluid released under high pressure from melted seals on the left main landing gear. (AAIB Bulletin 12/2010; *ASW*, 2/11, p. 57)				

Table 1

the five-page bulletin reviews and expands upon regulations related to nonroutine flight operations. Of particular note is its extension of Part 91.3, which covers PIC responsibilities, and Part 91.103, which covers preflight duties, to mean that the PIC of a nonroutine flight must be familiar with anything done to the aircraft that might affect its operation and to cancel or discontinue the flight if he or she determines that safety would be compromised.

The bulletin notes that the preparation for a nonroutine flight operation might be more extensive than the actual flight. It also says that air carrier manuals should include policies and procedures for authorizing and conducting nonroutine flight operations, as well as requirements for flight crew qualification and training.

Noncompliance With SOPs

The "willful misconduct" found by NTSB in its investigation of the CRJ crash was among the factors that led to the publication of a "safety alert for operators" — SAFO 08024, *Review of Flight Data Recorder Data from Non-revenue Flights* — in December 2008.

Noting that noncompliance with standard operating procedures (SOPs) and/or aircraft performance limitations is a common factor in accidents during maintenance ferry flights and repositioning flights, the bulletin encourages air carriers to review flight data recorded during nonrevenue flights.

"If FDR [flight data recorder] analysis indicates a potential trend of SOP noncompliance during such flights, that information should be communicated to appropriate airline management personnel for action to mitigate associated risks," the SAFO says. "If FDR data indicates noncompliance on the part of an individual crew, it is recommended that the information be communicated to the chief pilot and, if applicable, to the professional standards group in the labor association, for the purposes of crew contact discussion, counseling and safety education."

Another useful FAA document is Advisory Circular 25-7A, *Flight Test Guide for Certification of Transport Category Airplanes*. The 459-page circular is intended primarily for personnel at companies seeking certification of transport category airplanes. The most useful information for those conducting nonrevenue flights might be the clarifications and explanations of Part 25 airworthiness standards, and the detailed technical guidance on how to demonstrate compliance with the standards.

'We Need to Do Something'

During the Foundation's symposium in February, Didier Nicolle, chairman of the EASA flight test group, pointed to the fatal A320 accident at Perpignan, France, and the 737 and the Falcon 2000 incidents (Table 1) in saying, "We need to do something."

That *something* is a package of proposed regulations that would affect "flight testing" operations. EASA has grouped these operations in four categories, loosely defined as "experimental flight test," "engineering flight test," "production flight test" and "less-demanding test flights" that do not fit the first three categories.

The notices of proposed amendment — NPA 2008-17 and NPA 2008-20 — would establish minimum qualifications for pilots and flight test engineers based on the types of aircraft involved in the tests, and require operators to have an approved flight test operations manual.

EASA has proposed that the manual include formal hazard assessment methods; crew qualification and training requirements, and their responsibilities during test flights; a policy for carrying personnel beyond the minimum crew requirements; specifications for flight test instruments and safety equipment; and weather minimums.

The agency said that best practices assembled by the EASA Flight Test Safety Committee, available at <flighttestsafety.org>, could be used by operators to develop a flight test operations manual.

Preparation for a nonroutine flight operation might be more extensive than the actual flight.

Ready, Set …Test

BY HEMANT BHANA

Usability testing is a concept from the software industry. It measures how effectively a product enables the end user to accomplish the goal for which the product is designed.

Usability testing has direct applications in aviation safety. Aviation safety professionals who write standard operating procedures (SOPs), special procedures and operations manuals should be as concerned with usability testing as software designers are. If a manual or procedure is unclear, verbose, poorly formatted or does not efficiently transfer information, its value as a safety tool diminishes.

Presenting information accurately the first time is important. This avoids safety managers having to present multiple revisions to clear up ambiguous data. Unfortunately, issuing hastily conceived instructions and procedures is endemic in the industry and can harm an organization's safety culture.

Safety professionals can and should plan and conduct an aviation usability test. The test will ensure that the product is accurate, unambiguous and easy to use. Most important, it will eliminate the need for costly and time-wasting post-release corrections.

The Test

A basic aviation usability test does not require the level of sophistication used by, for example, Microsoft. The premise, however, is the same — find a sample of test participants representative of the end user, identify what the test intends to address and give the participants tasks to perform in various scenarios (Table 1, p. 27). These actions then form the basis for any changes to a procedure or instruction *prior* to its formal release. It tests how well the product accomplishes its goals.

Step 1: Identify the relevant issues

The first step in conducting an aviation usability test is to identify what topics or problems the proposed instructions or manual is supposed to address. This step is the backbone of the actual usability test.

Aviation safety officials can derive this information from sources such as safety, training or survey data, or from a detailed analysis of end user tasks. Identifying the major issues first defines the scope of the test, since the goal is not to resolve every problem but to address the major concerns.

As an example, flight managers learn that there is confusion about autopilot usage during nonprecision approaches. The airline decides to issue guidance to pilots clarifying the procedure. Prior to dissemination, the airline tests the impending instructions for usability.

At this point, the issues are broad and consist of questions such as, "Can pilots use the pending guidance to properly use the autopilot during a nonprecision approach?"

Step 2: Define concrete questions

This step breaks down the large issues into specific questions. A good method is to walk through the users' experience and try to identify what is most important for them to grasp.

Step 3: Define tasks and scenarios

The tasks, based on the concrete questions, are the actions the user must perform to answer the questions.

The scenarios are a real-life approximation of how the user interfaces with the task. The problem with just giving the user a task is that all the issues might not be evident unless the user sees the task in context. For example, task one involves finding out when you cannot use the autopilot — relatively straightforward. However, asking a user to perform a task in its proper context could yield additional information. The user might look in a completely different area of the manual to meet his or her expectations of where the information is found. The goal is to eliminate confusion when the user has to use the product outside the artificial setting of a test.

To get the most accurate results, the scenarios should describe situations that the participants are likely to encounter.

Step 4: Determine what data to collect

Usability testing is not academically rigorous. Interpretation of the data is mostly subjective, since the goal is to uncover major problems with the material, not to conduct statistically significant research.

In our continuing example, tasks one through three involve qualitative

Breaking Down an Issue

Issue	Can pilots find the necessary information in the pending guidance that will enable them to properly use the autopilot during a nonprecision approach?			
Concrete questions	Can pilots find the autopilot limitation information in the guidance?	Is the guidance clear on when autopilot usage is mandatory?	Do pilots understand the SOP in the guidance pertaining to autopilot usage during a nonprecision approach?	Can pilots quickly search key portions of the guidance?
Tasks	Task 1. Use the guidance to find when you cannot use the autopilot.	Task 2. Use the guidance to find under what conditions autopilot usage is mandatory.	Task 3. Use the guidance to explain how to use the autopilot during a nonprecision approach.	Task 4. Use the guidance to quickly learn about using the flight-path-angle mode.
Scenarios	You are briefing the approach, and the person you are flying with wants to use the autopilot to attain a particular altitude. You are unsure whether this is permissible. Using this guidance, inform the other pilot when the autopilot may not be used.	You are close to the airport and receive a weather report that is worse than expected. You mention to the other pilot that you are planning to hand-fly the approach to maintain proficiency. The other pilot asks, "Is that allowed?" Using the guidance, inform the other pilot when hand-flying is permissible.	You are the captain. You are flying with a new-hire first officer who is confused about how to use the autopilot during a nonprecision approach. During the approach briefing, the first officer says, "I have no idea how to do this!" Using this guidance, find the portion that describes the SOP, read and explain it to your new-hire copilot.	You are close to the airport and at the last minute decide to use the flight-path-angle mode of the autopilot. Using this guidance, as fast as you can, find the portion of the manual that describes how to use the flight-path-angle mode.

SOP = standard operating procedure

Source: Hemant Bhana

Table 1

data, while task four involves quantitative data (time). The data collected should not simply record whether the participant successfully completed the task. As part of the pre-test briefing, test moderators should request that the participants "think out loud" or verbalize their thoughts as they proceed with the tasks. Recording and collecting *these* data are critical, as thoughts and opinions will indicate how well the product accomplishes its goals.

A test participant may successfully complete the tasks, but of vital interest is what obstacles the participant encounters en route. That information is far more valuable, since safety managers can use the information to eliminate these obstacles during the rewrite.

The test moderator may also include several questions at the end of each task that focus on the participant's expectations. For example, the moderator may ask about what terminology the participants were looking for or how the test taker is searching for information. The answers to these questions will bring the material more in line with the expectations of the end users.

In our example, task four is slightly more complicated, as it involves recording time. For this task, having participants find the flight-path-angle information is ancillary because the intent of the test is to measure how searchable the document is. Thus for task four, the data metric is both time to completion *and* thoughts and opinions. The time criterion for a successful test is subjective; the stakeholder determines all the benchmarks for product success.

Since the goal of usability testing is to uncover major problems, test moderators only need five to eight participants per group. Research has determined that five test participants can uncover 80 percent of usability problems.[1]

Each testing group represents a specific category of users. In our example, the testing group is a random selection of captains and first officers. Two groups would be needed to see if captains and first officers interpret the instructions differently.

Step 5: Conducting the test

Test facilitators should conduct the test in a comfortable setting that allows for observation and is free from distraction.

The test facilitator should also work from a script to ensure consistency of participant instructions. The script should emphasize that the usability test is not an evaluation of the participants. This will put the participants at ease and increase the quality of the data.

Step 6: Capturing data

If possible, one person should act as the test moderator, another as the note taker. Alternatively, audio and video recording equipment can capture test participant comments for detailed analysis later. However participant data are captured, the goal is to record the participants' thought processes and observations. The note taker should pay special attention to participants' difficulties. Capturing why the participants stumble or what problems the test taker encounters will yield the most valuable data.

Likewise, the data from the post-test questionnaire should emphasize what the test participants were expecting. Test facilitators can also solicit information with off-script questions if information is not forthcoming from the participants.

Step 7: Interpreting and applying the data

First, the information should be organized according to the task performed. Next, the testing team should look for common themes in the data that would indicate systemic problems. For example, multiple people having trouble finding the flight-path-angle information queried in task four could indicate a problem with information organization. The test team's job is to identify what elements of the guidance structure caused the problems.

The test team should then prioritize the problems and start working on potential fixes. Continuing our example, if the data indicate that the flight-path-angle information was not found where the participants expected it, managers can rewrite the guidance to be more in line with expectations.

Not Only Manuals

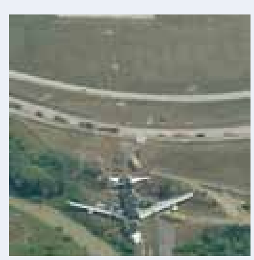
The example in this article centered on a proposed SOP or manual change concerning autopilot usage during non-precision approaches. However, aircraft operators can employ usability testing for a variety of products, including emergency procedures.

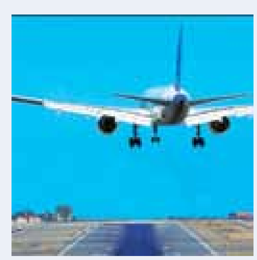
Keep in mind that the usability test is a measure of how well the product *fits the needs of the user*, not a test of the user or the content of the product. The goal is to identify flaws in how well the final product functions as a tool. Getting this information correct prior to dissemination is vital to prevent confusion and noncompliance, and to uphold high standards of safety.

Hemant Bhana is a lead technical pilot with GE Aviation–PBN Solutions, based in Kent, Washington, U.S.

Note

1. Virzi, R. (1992). "Refining the Test Phase of Usability Evaluation: How Many Subjects Is Enough?" *Human Factors*, Volume 34(4), pp. 457–468.





Say Again, Please

More patience and new methods of presenting information could improve ATC communications with non-native English-speaking pilots.

BY LINDA WERFELMAN

Native English-speaking air traffic controllers need to speak more clearly and more slowly and to be patient with pilots who do not immediately understand their instructions, according to U.S. air carrier pilots who offered their observations as part of a U.S. Federal Aviation Administration (FAA) study.[1]

A report on the study — the sixth in a series by the FAA Civil Aerospace Medical Institute — recommended research to determine "the optimal speech rate" for delivering air traffic control (ATC) information, to identify how controllers and pilots communicate in "non-standard situations" involving such factors as thunderstorms and air traffic conflicts, and to determine whether there are alternative ways to provide pilots with information that they otherwise would obtain by hearing and understanding ATC conversations with the pilots of nearby aircraft.

"New phraseology may be needed in lieu of the work-around practices of common English currently in use," the report said. "Pilots unfamiliar with the local jargon and slang are at a disadvantage and may misinterpret these conversations. For example, 'You're following an MD-80, but he's got to slow up … uh … the train's starting to slow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Voice communications between native English-speaking controllers and non-native English-speaking pilots need improvement, according to half of the pilots responding to an FAA survey.

down ahead' may not be meaningful to a pilot unfamiliar with local jargon."

Other recommendations called for making available "graphic and text representations of taxi clearances, route clearances and route modifications" and for using terms and phraseology recommended by the International Civil Aviation Organization (ICAO) in all ATC messages.[2]

The study asked 48 participating pilots — all of whom flew international routes for major U.S. airlines and held airline transport pilot certificates — to complete a survey; a number of pilots then were selected for follow-up interviews. Sixty percent of the participants said that they understood no languages other than English; of the remaining 40 percent, many said that they spoke/understood French or Spanish or both, one spoke/understood Spanish and German, and one spoke/understood French, Spanish and Portuguese.

Forty-six percent of the pilots said that they considered voice communications between non-native English-speaking pilots and native English-speaking controllers "very good in most respects," but 29 percent said that communications "could use some minor changes," and 21 percent said that communications were "not good enough for extreme conditions" (Table 1, p. 32).

Even the pilots who characterized communications between the two groups as very good said that they had observed problems.

"It's been my experience that controllers in New York speak way too fast and often get short [impatient] with (non-native English-speaking pilots)," the report said, quoting observations from the surveyed pilots. "I can tell right away whether the pilot's 'getting it' or not, from the time lag after the controller has given three or four instructions at once and the presence of a big pause before he reads it back.

"I don't think many controllers have a clue about the level of stress they put the non-native English-speaking pilots under. I know because I've been on the other side of the equation (flying into non-native English airspace). We are worn out from flying all night and are feeling the stress of too rapid a communication rate, use of slang, nonstandard ICAO terms (or no ICAO terms to begin with) and having to deal with all that."

Pilots who said they considered the communications that they overheard "not good enough for extreme conditions" said their concerns focused on safety issues.

"I have seen some dangerous things purely because of a lack of communication," one pilot said. "We've had near misses, taxiing situations, airplanes cleared for takeoff (executed by) another airplane."

As an example, one pilot described an event at Hartsfield-Jackson Atlanta International Airport:

> *A non-native English-speaking pilot was given taxi instructions and ended up somewhere where he wasn't supposed to be. There was a miscommunication between him and the ground controller. We became distracted from our own operation because we were trying to figure out where he was (in proximity to us).*

Another pilot observed, "A lot of non-native English-speaking pilots and controllers only learn so many words and phrases and basically work off a script. … I hear long periods of silence after controllers ask [pilots] a non-standard idiomatic question in English. When (non-native English-speaking pilots) get into a non-standard situation [such as the need to deviate around a thunderstorm or a traffic conflict], they cannot adjust."

The pilots said they based their opinions of non-native English-speaking pilots' skills with the language on a number of factors, including their comprehension of clearances and other ATC instructions, fluency, verbal interactions with controllers, pronunciation, sentence structure and vocabulary.

"Are controllers getting their point across the first time, or are they in a debate with the pilot?" one pilot questioned. "Do controllers have to slow their speech and, instead of giving a whole rapid-fire clearance, give it in pieces? …

"I can tell by how pilots react whether they got it or not. Are they slow to respond, or do they come right back? The worst thing I want to hear after ATC's given a clearance is silence. If I hear nothing, a long hesitation, a really slow readback, or an incorrect readback, then I know there's trouble."

On the Same Path

Asked how they have reacted when their aircraft has been on the same flight path as one flown by non-native English-speaking pilots, those participating in the study said that they tried to simplify the language they used in their interactions with ATC so that the non-native English speakers would hear simple phrases and ICAO terminology. They also said that they tried to listen more attentively to both the non-native English-speaking pilots and to the controllers.

"We can pretty much determine where the non-native English-speaking pilot is, from what the controller is telling him to do," one participant said. "We pay close attention to his position and understanding of his clearances. We can determine how that is going to impact our flight or if he is going to have any effect on us."

Another said, "At some of the busier airports, there are separate tower frequencies for each runway, so we don't hear what's going on at the other runways. In my opinion, the threat from a non-native English-speaking pilot with low proficiency skills occurs if we're on parallel approaches — especially if we're joining adjacent localizers. If he doesn't have the right ILS [instrument landing system] frequency tuned in, he's going to stray onto our flight path on down the localizer.

"An even higher threat is on the ground, where he's straying onto our runway as we're taking off or landing. I don't know if he's being cleared to cross the runway in front of me as I'm landing, because he's on a different frequency. I don't know if he's been cleared to take off, or he thinks he's been cleared to take off, because I'm on a different frequency."

In some cases, pilots said, they want to be what the report called "part of the readback-hearback loop," either by asking a controller to clarify instructions to the non-native English-speaking crew or by offering to interpret.

"There are times when I want to get on the radio and say, 'Hey, he said this altitude or this heading' or 'I don't think he understood that,'" one respondent said. "In some situations, the controller might not hear [the pilot's readback] and I know the pilot's going to the wrong altitude and maybe I can help — or certainly keep my aircraft safe."

Some pilots participating in the study said that they had been reluctant to intervene.

"It's probably not the best, but if needed I would interpret for ATC or the other aircraft," one pilot said. "The most I've ever done when things really went south [became problematic] was to say to the controller, 'Hey, slow down. I can't understand you either.'"

Perceptions of Voice Communications*

Voice Communications	Number of Pilots	Issues Discussed
Excellent	1	
Very good in most respects	22	Failure to communicate can lead to frustration
		Proficiency matters
		Slower speech rates and enunciate clearly are key, some problems are universal
		Taxi clearances are a problem
Could use some minor changes	14	Failure to communicate can lead to frustration
		Not getting what you expect to hear
		Some controllers facilitate
		Some problems are universal
		Speak slower and use standard phraseology
Not good enough for extreme conditions	10	Failure to communicate creates safety concerns
		Language barriers affect all pilots and controllers
		Non-native English-speaking pilots and controllers work off scripts
Extremely poor	0	
It varies	1	

* Based on U.S. pilots' comments about radio contacts between non-native English-speaking pilots and native English-speaking controllers

Source: U.S. Federal Aviation Administration

Table 1

In many cases, the participating pilots said that they did not want to be in the position of telling another pilot what to do.

"If there's some sort of conflict, I broadcast what I'm doing and what my intentions are, but I don't tell them what to do," one said. "I tell them exactly what I'm doing and then I monitor them."

In other cases, the pilots said that they rely on "all the available situational awareness clues," including the traffic-alert and collision avoidance system (TCAS), charts and the "back radio air-to-air" — the no. 2 radio set to a non-ATC air-to-air frequency used by pilots in that area.

More Time

Fifty-four percent of those surveyed said that controllers seemed to spend more time on communications with non-native English-speaking pilots than with native English speakers.

"They need to speak more slowly, and things need to be repeated," one pilot said. "Controllers give instructions piecemeal, rather than in one long, clean transmission, because they understand they can't give four or five or even three instructions in one transmission because it will all come apart."

Eighty-one percent said that controllers "have to communicate differently" when dealing with non-native English-speaking pilots.

"Seasoned controllers … slow down and break it down to the most basic fundamentals so they don't eat up the rest of the airtime they need to manage the multiple airplanes that they have in the area," one pilot said. "They understand that if they don't do that, the pilot's going to go back to 'say again.'"

Contingency Planning

When a non-native English-speaking pilot and a native English-speaking controller experience communications problems during the approach phase of flight, the controller sometimes is faced with a choice: alter the arrival plan for either the non-native English-speaking crew or for an English-speaking crew in another airplane.

"Which one does the controller allow to proceed on course and which one is instructed to go around, put into a hold or diverted?" the report questioned. "It is no surprise that during these times, U.S. pilots develop contingency plans — just in case.

"When faced with a possible reduction in situational awareness, brought on by language problems, the U.S. pilots said they may have to revert to the basics of their flight instruction: Aviate first, navigate second and communicate third. They may configure their plane a little early or slow down in anticipation. … To help with communications, they may continue using ICAO standard phraseology as a way to help the less proficient pilot who is operating in an English-speaking environment. They are focused, deliberate in language production and use crew resource management."

The report included researchers' observations that ATC instructions sometimes are "incongruent with pilot expectations," that "lack of familiarity with a country's procedures and phraseology slows down the system" and that "countries that do not adhere to ICAO standard phraseology and terminology contribute to the communication problems that occur between their controllers and foreign pilots."

In addition, a breakdown in communications between a controller and a pilot can distract other pilots in the area and interfere with their performance of certain essential tasks, the report said, adding, "The failure to develop a common ground of understanding is a continuing risk to flight safety."

"The most I've ever done … was to say to the controller, 'Hey, slow down. I can't understand you either.'"

Notes

1. Prinzo, O. Veronika; Campbell, Alan; Hendrix, Alfred M. U.S. Report DOT/FAA/AM–11/4, *Airline Transport Pilot International Flight Language Experiences, Report 6: Native English-Speaking Controllers Communicating With Non-Native English-Speaking Pilots*. March 2011.

2. The pilots were interviewed while the FAA was considering changes in controllers' phraseology to conform to ICAO recommendations. Those changes took effect Sept. 30, 2010.

A Gathering Storm

BY WAYNE ROSENKRANS | FROM ORLANDO

Political pressures, traffic predictions and a stagnant accident rate rock the world of airline pilot preparation.

Government and industry specialists framed pressures to reinvent the training of airline pilots as a seismic shift compared with recent history as they addressed the World Aviation Training Conference and Tradeshow (WATS 2011). Atypical public concerns about the role of human performance in air transport safety mean that substantial changes have to occur almost simultaneously under time constraints, most agreed at the April 19–21 event in Orlando, Florida, U.S. The change process itself also demands concerted risk mitigation.

The effects of predicted airline industry growth on accident frequency and human resources gaps were dominant themes. "Boeing and Airbus agree that in the next two decades, we will probably [deliver] 30,000 more airplanes, virtually doubling [the fleet] we have today," said Len Weber, chief operating officer, Training and Flight Services, Boeing Commercial Aviation Services. "For those new planes, we will need 466,000 new pilots or … about 23,000 new pilots per year for 20 years." Among distinctive characteristics of the multi-generational, multi-lingual, multi-cultural and "digital native" flight crews operating these aircraft will be not only new preferred modes of learning and prior line experience with numerous airlines, but also new attitudes toward communicating safety-related information, he said.

"We could have a safer environment if we learned and shared openly information" [such as flight operational quality assurance (FOQA) data], Weber said. "Tomorrow's pilots call that 'social networking.' … They share everything, and they question why we keep anything a secret." Boeing training

specialists so far have addressed emerging operational and safety issues by creating 17 "bolt-on" specialty courses, on topics such as high-latitude polar operations, and by expanding Internet-based training and distance-learning capabilities. Training increasingly will emphasize ensuring and measuring competence rather than reflecting flight activity, memorization or course completion, he added (Table 1, p. 37).

These courses include scenarios infused with details of real air carrier incidents from the past 10 years, requiring pilots at all levels of experience to respond correctly to challenges such as unreliable airspeed indication, wind shear and upset recovery. Despite using interactive computer-based training, simulation and digital media, the process of training in 2011 largely remains a linear, page-at-a-time method for instructors and students. "Compared to video gaming, we are still pretty far behind," Weber said.

Unless government and industry make significant course corrections, the next 10 years could see safety losing ground despite the development of advanced air traffic management technology and evolutionary improvements in new aircraft, said Jacques Drappier, a captain and senior training adviser, now retired from Airbus.

"I want to express my deep concerns and worries about the state of safety," Drappier said. "We are at a crossroads for the future." Airline pilot training has improved in recent decades, and has influenced safety incrementally in positive ways, he said, yet specialists have difficulty attributing to training any safety paradigm shift like what occurred when ground proximity warning systems were introduced to mitigate controlled flight into terrain.

"Technology is not going to be the solution to reduce further the accident rate," Drappier said. "It is clear that there will be no major step change available in the next decade" from aircraft advances. Current operating procedures and methods of training airline pilots also "clearly do not generate enough improvement" to force downward today's accident rate, he added.

Fundamental concepts of airline pilot training have been "left relatively untouched" against a backdrop of aviation safety advances in other areas, adds John Bent, a captain and principal of Aviation Results. "We really must improve training quality and relevance [to operations as] key to further safety improvements," he said. "A commercial pilot license [(CPL) for first officers and second officers] is still dominant in the world, but the traditional model subjects CPL students to irrelevant instruction at the core stage of learning, the point at which they learn the deep lessons. They may miss the big messages about stall [avoidance and] recovery, upset recovery, and threat and error management. There has been poor emphasis [at this level] on modern commercial multi-crew operations." So "reversion to the first learned [action]" remains a latent threat for them independent of flight hours, and some airlines report they must "un-train" some new pilots today before their initial indoctrination, he said.

Updated ICAO Priorities

Airline pilot training ranks as a global priority in 2011 partly through its inclusion on the list of current safety initiatives driving activities of the International Civil Aviation Organization (ICAO), said Nancy Graham, director, ICAO Air Navigation Bureau.

"ICAO has developed a risk management system to help focus our [state/regional] assistance resources toward reducing exposure to the highest risk of loss of life," Graham said. "With that prioritization, we will be helping states in the developing world that require assistance to develop tailored action plans to address their safety issues." Regarding airline pilots, this includes a special push to explicitly define and measure competencies, standardize their performance and increase professionalism as a risk reduction method.

FAA Fast Tracking

Profound changes in the national airspace system of the United States already had been expected to accelerate in the next 10 years before Public Law 111216, the *Airline Safety and Federal Aviation Administration Extension Act of 2010,* said

Boeing trains pilots in dedicated 787 simulators located in five countries.

© Boeing Training and Flight Services

Robert Tarter, vice president, Office of Technical Training, U.S. Federal Aviation Administration (FAA) Air Traffic Organization (*ASW,* 9/10, p. 12). The law, enacted in August 2010, mandates a series of interlocking revisions of airline pilot qualifications and training in the wake of the 2009 Colgan Air Bombardier Q400 accident.

Federal agencies and the industry are under unusual political pressure to synchronize reforms quickly through joint work groups (typically aviation rule making committees), implementing nine new regulations and sharing training programs. Results are being reported in stages to the U.S. Congress, the FAA and the U.S. National Transportation Safety Board, he said.

Proficiency in real-time data communication (data comm) — replacing most voice communications between air traffic controllers and flight crews with digital data messages — is one example of an objective of near-term airline pilot training motivated by the transition to the Next Generation Air Transportation System (NextGen).

"New skill sets will be required to manage this data, [and] in an era of transition to automation, both legacy and NextGen competencies will have to be maintained," Tarter said. "I sit in on a [daily FAA headquarters] meeting where we go over all of the controller operational errors and pilot deviations from the previous day. Over 50 percent of those errors are hearback/readback errors. … Data comm will fix a lot of the human errors and human factors [issues]."

Neither the temporary operation of legacy airspace management systems nor the final NextGen system is a great concern now to FAA officials. "The transition to the new system is what concerns me the most," he explained. "The mixed equipage on the airplanes, mixed equipage at the FAA as we build more systems, and the training that goes along with those will be the big [safety] issue."

The FAA has numerous deadlines in 2011 and 2012 as a result of the new law, said Dan Jenkins, manager, FAA air carrier and Part 142 training centers, in a joint presentation with Robert Burke, aviation safety inspector. "By Aug. 2, 2013, all Part 121 airline flight crewmembers must have an airline transport pilot [ATP] certificate," they said. "The FAA will issue the notice of proposed rulemaking [(NPRM) in mid-2011], and we anticipate the final rule by Aug. 2, 2012, turning this law into a regulation. Even if the FAA were to do nothing, the public law would take effect."

The FAA final rule requiring safety management systems at Part 121 airlines will be issued by July 30, 2012. Work also is under way toward a final rule in 2012 to address the absence of specific ATP training requirements in current Federal Aviation Regulations.

The new law directed the FAA to introduce standards for stall avoidance and upset recovery training, and airline pilot remedial training, for which a supplemental NPRM was issued in May. The FAA similarly has convened a work group on flight simulator training to help ensure correct responses to stick-pusher, icing-induced and wind shear events. The agency is on target to assess recommendations and deliver a report on these issues to Congress on Nov. 30, 2011, Jenkins and Burke said.

Another work group already has weighed in on best practices for airline pilot training for Part 121 air carrier and Part 135 commuter and on-demand flights, including a recommendation to the FAA on substituting academic training of ATP candidates for required flight time. The FAA will report its decisions to Congress in mid-2011.

Similar work is in progress on a centralized national database for pilot selection purposes; airline management accountability for training quality; improvement of pilot professionalism (i.e., personal responsibility for adequate rest and mitigating risks of long-distance commuting); pilot mentoring; pilot professional development programs; crew communication (updated crew resource management); flight and duty time management with prescriptive rules and fatigue risk management systems; expanding line operations safety audits, FOQA, aviation safety action programs and advanced qualification programs to all U.S. airlines; and new methods of safety information exchange and cooperation among U.S. airlines.

Two Airline Proposals

Against this background, two airlines floated proposals at WATS 2011 as "blue sky thinking" intended to stimulate comments and collaboration. For Cathay Pacific Airways, the more than six years of industry research, development and testing that enabled ICAO to establish a multi-crew pilot license (MPL; *ASW,* 6/08, p. 41) standard did not produce a license that fits into this airline's ultra-long-range (ULR) operations. Nevertheless, elements of MPL could be adapted to existing ab initio training of "second officer cruise pilots" if a variant of MPL were approved.

"Airlines in Asia and Europe have been putting low-hour pilots safely into large airliner cockpits for a considerable period of time using conventional ab initio training schemes," said Alan Wilson, a captain and manager, flying training, for Cathay Pacific. "In Asia and Europe, it is also quite common that the training program is funded [by sponsors so that each pilot] will exit with [minimal or] no financial burden. This makes motivation quite high."

Cathay Pacific has found that concentrated training of ab initio pilots enables the pilots to become qualified ULR second officers in 15 to 20 months compared with several years for collegiate programs, is compatible with airline economic cycles and allows pilots to complete a related college degree while flying for the airline. Each new graduate's restricted type rating is valid only in the cruise phase above 20,000 ft as a member of an augmented crew that also has one captain, one captain-qualified first officer and one other first officer.

The company proposed restructuring this program to incorporate more elements of the MPL, with the idea of seeking regulatory approval of a "cruise copilot MPL" that could meet the current demands for improvements in safety built around core competencies in airline pilot training, and also enable the company to "deploy new training devices appropriate to the phase of training."

"Let us [all] assure that when we bring the new generation of pilots into our operations, we only teach and test relevant knowledge," Wilson said.

A Delta Air Lines official called on the FAA, U.S. airlines and other stakeholders to join in a discussion of the company's preliminary thinking about the country's "gathering storm" of safety and pilot-supply issues. Arnie Kraby, a captain and manager, pilot selection, at the airline, suggested that while the MPL itself typically has not been embraced as a solution by U.S. airlines, its best features are adaptable to the imminent safety-focused reform of training.

"My remarks are just conceptual in nature," Kraby said, introducing Delta's civilian airline pilot training program. "This would be the civilian equivalent of military pilot training … sponsored by all people who have a stake in the air transportation industry." Key elements include outreach to young students, preference for high quality college education as a positive factor in career-long performance of airline pilots, a required period of employment as a flight instructor in a higher education setting, guaranteed interviews with participating regional and major airlines at defined career stages, a three-year delayed start of student loan repayment, and cancellation of up to 50 percent of program-sponsored student loans (5 percent for each year worked at a sponsoring airline) for fulfilling program obligations.

Leveraging Technology to Optimize Safety Benefits of Flight Crew Training

International Focus	Key Ideas	Safety Benefits
Redesigning Pilot Selection Criteria	Heightened industry focus aims for empirically sound aptitude testing and encourages airlines to have adequate candidate-selection skills and resources.	Pilot knowledge, skills and attitudes required for threat and error management in airline operations gain acceptance across cultures.
Multi-Crew Pilot License (MPL)	Since a global standard took effect in November 2006, scenario-based ab initio simulator training to become a first officer in one type of transport airplane influences the concentration on crew learning elsewhere.	Accreditation of MPL instructors encourages a better-defined competency framework worldwide, recognizes inherent threats in managing automation and manual flying, and builds interpersonal skills.
Evidence-Based Training	The core training concept identifies essential skills for global adoption, drops outdated practices and more effectively adjusts training over time in light of risks revealed by shared data.	The concept streamlines content to match current operations and risks, ensuring training elements with strong human factors awareness, practical use and continuous pilot assessment.
Instructor and Evaluator Qualification	Government and industry aim to standardize their qualifications and calibrate how they work for consistent inter-rater reliability.	Ongoing efforts bridge gaps that emerge between training and the risks experienced in line operations.
Standardizing Flight Simulation Training Devices	More frequently updated design and performance data provide a global reference on current requirements and optimal uses.	Standards better reflect pressing challenges of automation systems and flight operation procedures, such as mitigation of loss of control.

Note: Since 2009, ITQI participants have worked to redirect government and industry attention to universally acceptable ways to continuously link competency-based training with measurable risk-reduction outcomes.

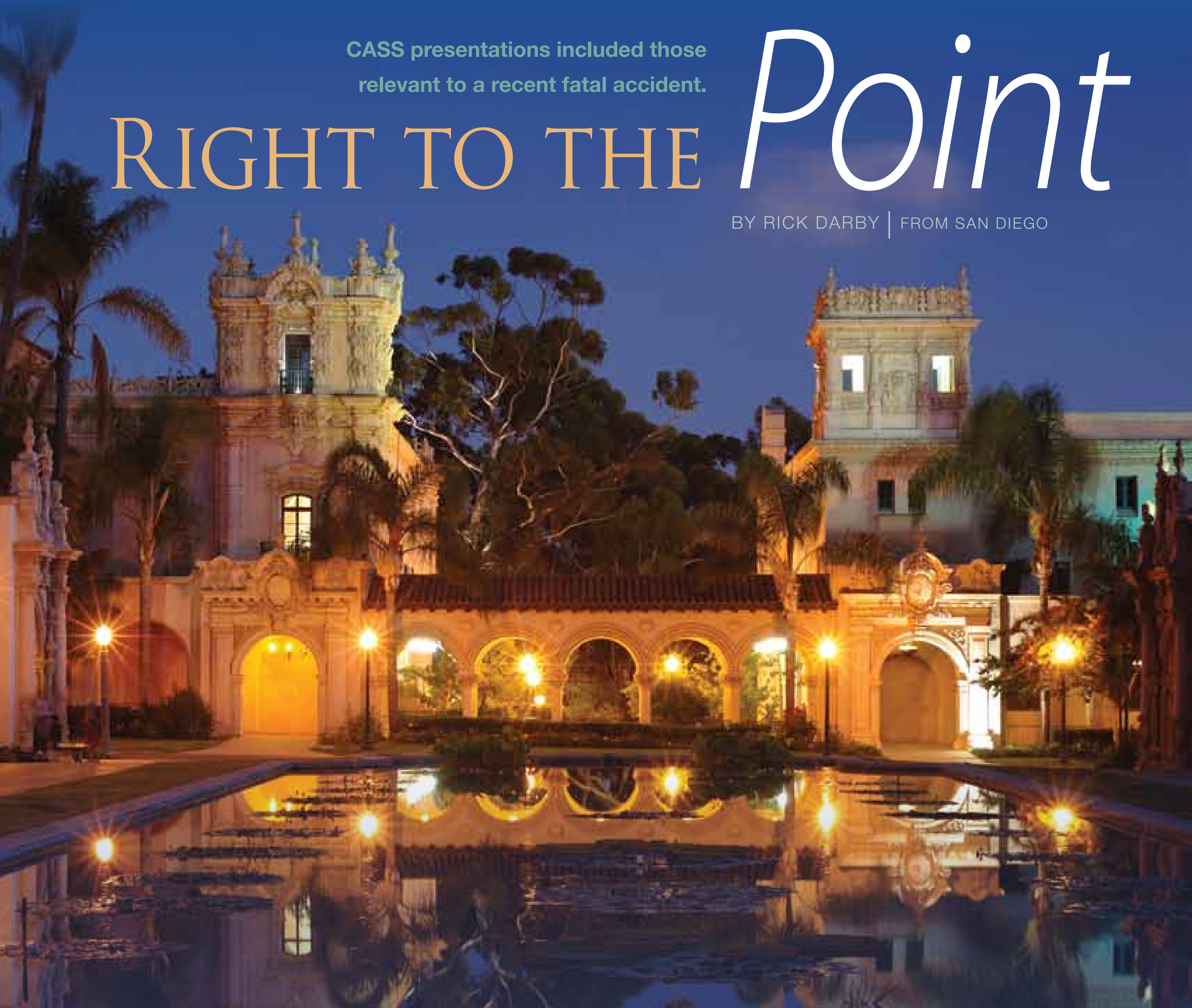
Source: Jacques Drappier (Airbus) and International Air Transport Association Training and Qualification Initiative (ITQI)

Table 1

CASS presentations included those relevant to a recent fatal accident.

RIGHT TO THE *Point*

BY RICK DARBY | FROM SAN DIEGO



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"What do the customers — the people who are paying for aviation services — want?" said Robert Sumwalt, member, U.S. National Transportation Board (NTSB), speaking at the 56th annual Corporate Aviation Safety Seminar (CASS) at San Diego in April. "Do they want substandard performance, just meeting regulations, cutting corners? Or do you think they want best practices, where you're talking and implementing quality?

"The next question is, what are they getting? By definition, if you do not have written standard operating procedures [SOPs] and if you don't insist that people follow them, you are no higher than basic regulatory compliance. To be at best practices, an operator adopts and implements quality, standards, procedures, equipment, and training above and beyond regulatory requirements."

In his presentation, which included reviewing accidents of special interest to corporate operators since the 2010 CASS, Sumwalt emphasized the connection between best practices and strict adherence to SOPs, citing the example of calling out "full flaps" to conform to the flight operations manual, rather than "flaps full."

He asked the audience to think about questions such as, how do you measure adherence to SOPs? Do you reward the right kinds of behavior?

Sumwalt said, "I'm going to talk about an accident that involved fatigue. It involved a lack of professionalism, a customized checklist, a runway excursion. And it also involved a lack of safety leadership."

He was referring to the crash of a Hawker 800A at Owatonna, Minnesota, U.S., in July 2008 that killed all eight occupants (*ASW*, 4/11, p. 16). The factors Sumwalt cited as relevant to the accident also were examined by several other speakers at the CASS, although not specifically in connection with the Hawker.

Fatigue risk management systems have been studied, proposed and implemented in recent years. Generally, they do not monitor the status of individuals as they report for work. Gordon Dupont, CEO, System Safety Services, described a different kind of fatigue risk management system — one that is said to determine "fitness to work" of frontline personnel immediately prior to beginning a shift.

The system, called the Fit for Work Indicator, is a safety tool developed in Australia, originally for mine workers. "It provides a noninvasive tool for a range of personal and other factors that might result in personal impairment and be a workplace risk," Dupont said. "This system has contributed to a significant lowering of the incident and injury rate at many sites, such as lowering injury-related lost time by more than 80 percent on some sites, and has been anecdotally credited with encouraging improved attitudes to alcohol moderation, personal health and fitness for work."

The Fit for Work Indicator measures psychomotor skills involving hand-eye coordination to identify evidence of impairment. "The system does not rely on a predetermined community or industry standard, but requires each person to establish their own profile after completing a number of tests," Dupont said. "It does this by using a computerized terminal to measure a person's reactions in a simple coordination test, maintaining a moving + sign in the middle of a circle for a specified time while the system analyzes their performance."

The individual's previously established mean score is called the personal assessment level (PAL). Each test, which takes less than a minute, provides a comparison with the PAL — it does not measure one employee against others. If the results fall below a threshold, the test generates an alert that tells the individual to report to a supervisor.

It is up to the supervisor and organization to determine why the alert was generated. Dupont recommended that "any person who receives an alert should be required to fill out a questionnaire that asks for possible reasons, such as physical injury, fatigue, stress or alcohol. This should then be used by the supervisor as a basis for discussing the event with the employee and determining possible causes of impairment."

Professionalism, like character, is hard to define because it is a complex mixture of qualities rather than a single one; but like character, most people recognize it when they encounter it. Roger Cox, senior air safety investigator for the NTSB, talked about "Professionalism in Aviation: Approaches to Ensuring Excellence in Pilot and Air Traffic Controller Performance."

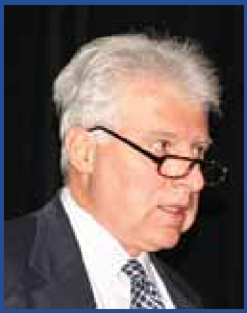
Cox drew on the comments expressed by 45 panelists at the 2010 NTSB Professionalism in Aviation Safety Forum (*ASW*, 6/10, p. 24). Cox referred to professionalism as an "intangible, an internalization of values" beyond being competent or skilled.

"Our panelists told us that the U.S. system of candidates self-selecting and self-financing private flying lessons was not producing the best professional pilots," Cox said. "There was a need for better screening and selection. The panel said that airlines faced with a shrinking pilot pool are faced with a hard decision: Either ground flights for lack of enough professional pilots, or alter their selection system. For most operators, more investment in good recruitment screening and selection would be money well spent."

Cox said that forum participants mentioned selection criteria including technical competence,

Continued on p. 41

From top: Cox, Bjellos and Grace



Photos: Rick Darby

The Flight of the Black Swan


Rick Darby

Gadzinski

AeroSafety World spoke with John Gadzinski, president, Four Winds Consulting, following his presentation on "Runway Excursions and Mitigation Strategies." A former U.S. Navy pilot and flight instructor, he later served as air safety chairman for the Southwest Airlines Pilots Association and then as director of safety for the Coalition of Airline Pilot Associations.

ASW: What is a "black swan" event, and what does it have to do with aviation safety?

JG: A "black swan" event is a highly random or unexpected event that has a great impact on the environment in which it takes place. One of the problems that we have with aviation safety is that the significant events that affect us happen rarely. When we're trying to understand safety in terms of a bell curve [graph of a normal distribution], many of the most significant events occur toward the tail ends of that bell curve. They can't be predicted. A lot of the aviation accidents we see are, by definition, black swans.

ASW: Even if an event is highly unusual and unpredictable, does that mean it is unimaginable?

JG: Imagination is the *key*. Flight involves a very complex system with interactions on many levels — pilot technique, checklist design, air traffic controllers, weather, and much more. Sometimes we have unexpected interactions that we might not have envisioned before.

The most classic, and tragic, example was the Apollo 1 launch pad fire. [Astronaut] Frank Borman testified at a Senate hearing that the cause of the accident was a failure of imagination. It wasn't that they weren't looking for dangers, they just never conceived that those dangers could occur on an unfueled rocket strapped to the earth going zero miles an hour. Yet, in 20/20 hindsight, the conditions for that accident were plain to see: the design of the hatch, the fact that they had pressurized that vessel with pure oxygen, the flammability of the Velcro.

Given that situation, being able to have a door that you could open quickly from the inside was a mitigation for a black swan that could occur in that capsule. Although you can't necessarily prevent them from happening, you can create conditions so those occurrences don't have catastrophic consequences.

ASW: How do you ask a corporate CEO or chief financial officer to spend a lot of money to preclude a one-in-a-million chance of a disaster?

JG: It's a hard sell. They tend to think only in the middle of the bell curve. That's why it's important to convey an understanding of the *inevitability* of uncertainty.

ASW: You can't just think about the odds, you have to come to grips with the potential severity of a seemingly improbable event?

JG: Right. And I think that as the view of safety, human factors and safety analysis progresses, the day might come when using this awareness of the effect of the highly improbable will become more standard, helping to mitigate that risk. For instance, not having an effective runway safety area might in the future be considered a careless act.

ASW: Runway excursions and their mitigation was the main subject of your presentation. How do randomness and improbability tie in with landings?

JG: On an aircraft carrier, where I conducted landings and acted as a landing signals officer, there is — for obvious reasons — an acute awareness of the extreme risk involved in deviations from the approved landing criteria. With so little margin for error, the response is to leave very little to chance in carrier landings. Randomness and improbability are reduced about as far as is humanly possible.

In civilian aviation, practical considerations mean that there is far greater randomness in landing lengths, for instance. That can cause, at the tails of the bell curve, drastic variations in performance. And, on occasion, that may combine with conditions conducive to an overrun, such as a flooded runway with the potential for hydroplaning tires or, like in Little Rock [an MD-82 overrun in 1999 with 11 fatalities], an inadvertent lack of ground spoilers.

ASW: What to do?

JG: One mitigation that civil aviation authorities have allowed is that if you have a runway safety area that's less than standard — say, instead of a 1,000-ft [305-m] safety area, you have a 300-ft [91-m] area — and then you have a road behind it or some obstacle that could severely damage the airplane, you can take the existing runway and decrease its usable length by something known as a declared distance. Maybe you tell the operator, instead of having 6,000 ft [1,829 m] to land on, I'm going to allow you 5,600 ft [1,707 m], and I'll repaint the surface for the new landing area. It isn't actually lengthening the runway, but it's as if there's more paved area to accommodate overruns.

Reducing the usable runway length so there's "extra" pavement won't stop all overruns, of course. Beyond the runway, you need some type of arresting device. It can be as simple as a grass strip. But if there's something especially dangerous beyond the runway end, maybe you ought to consider an EMAS [engineered materials arresting system].

ASW: What else can safety managers do to prepare for unforeseeable events?

JG: The biggest challenge today is to elicit good safety reporting from front-line employees. A lot of the safety reporting systems we have today are geared toward not being punished for noncompliance.

But when I fly, because I'm a "safety guy," I see things every day I could write a report on. Maybe it's something so simple that everybody takes it for granted: You pull into the ramp area and you can't see the painted ingestion zones for your engines. Or you can't see the lead-in lines because the lighting is bad or the paint is worn. These are precursors for a ground mishap, but it's what most pilots think of as just a cost of doing business. You have to get these pilots to understand that if there's something that makes their life a little more difficult, like a procedure that doesn't harmonize with their operational needs, it has to be reported. And the person who reports it should be rewarded with positive feedback.

— RD

leadership, operational awareness, teamwork, attitude and how candidates deal with stress. "Employers can use a variety of tools to select these qualities, including interviewing," he said. "But some of our panelists told us that interviewing is a special skill that has to be trained for, and unfortunately, a lot of people who interview pilot candidates have never learned what to look for and how to find out what you're really trying to find out."

The forum panelists also pointed out that progress is being made to institutionalize professionalism among many operators. "Companies are using a variety of methods, including line checks scheduled at random; CRM [crew resource management] leadership classes; line operations safety audits; and an emphasis on clear communication and feedback," Cox said.

"Captains need to understand policies and procedures, and companies need to invest time and effort to be clear about why policies and procedures exist. They call that 'buy-in,' and it's essential, especially to get younger pilots to buy into the standards we have."

David Bjellos, president, Daedalus Aviation Services, took up the issues around customized checklists.

"Corporate aviation remains an adolescent with regard to regulatory oversight of checklists," he said. "No legal precedent has been set concerning use of a customized checklist. However, some recent accident reports have listed incorrect checklist usage as a contributing factor. The emphasis should be on both content and proper use."

FARs Part 91 allows an operator to use any checklist it believes is appropriate to their flight operation outside the Part 142 training environment, Bjellos said (*ASW*, 4/11, p. 42).

Referring to a letter he had received from the U.S. Federal Aviation Administration (FAA) in response to his query about the acceptability of customized checklists, a letter included in the seminar proceedings, he said, "These recommendations are useful but do not answer the fundamental question of 'what is acceptable?' FAA has no formal opinion as to which checklist they prefer — OEM [original equipment manufacturer] or customized, but has made it clear they have no objection to customized versions."

The burden of getting a customized checklist approved for use at a Part 142 training center is causing many Part 91 operators to use the OEM checklist for training and a customized checklist in operations, Bjellos said. "Sending a single pilot to training (versus a two-person crew) requires a common ground — usually the OEM checklist. Here is the classic conflict: Operators elect *not* to use their own checklists when in training, yet use them in normal operations."

He proposed that operators should try to convince OEMs to develop a "Standard Normal Operations" checklist, including any approved flow patterns, with an option to customize it for retrofitted equipment.

"It is leadership that brings an SMS [safety management system] to life," said Daniel J. Grace, manager, flight operations safety and security, Cessna Aircraft Co. "It is easy to manage an established SMS, but frankly, not everyone has the desire to jump into the safety world and be accountable for the operation and the decisions of others. The person who has the passion for this work and is open to its challenges will be the best candidate. This individual must be able to create strong relationships that form a bond among other team members, someone who can motivate and energize a team while building rapport with others to move in the desired direction."

In addition, Grace said, a safety leader must be comfortable dealing with the organization's top management. "It takes confidence in the work and the ability to discuss and explain a program that may be foreign to some. When discussing the SMS with senior leaders, it is important to explain to them why this is a valuable tool in the organization. It is also important to listen carefully to what they say, because senior leaders may provide additional direction for the program. This leadership discussion gets them involved and encourages them to take ownership of the program."

Clean Sweep

New technologies are supplementing traditional methods of keeping foreign object debris off runways.

BY LINDA WERFELMAN

Airports traditionally have relied on regular visual inspections and sweeping to clear foreign object debris (FOD) from runways. In recent years, however, new systems have incorporated advanced technologies to help attack the problem, estimated to cost the industry $4 billion a year worldwide.[1]

The U.S. Federal Aviation Administration (FAA), while characterizing the people who work at and use airports as the "primary 'sensor' to detect FOD on airport surfaces," says that technological developments have "greatly expanded the capabilities of FOD detection through automation."[2]

In Advisory Circular (AC) 150/5220-24, *Airport Foreign Object Debris (FOD) Detection Equipment*, the FAA outlined minimum performance specifications for four types of detection systems:

- Stationary radar, which can detect a cylindrical metal object 1.2 in (3.0 cm) high and 1.5 in (3.8 cm) in diameter as far away as 0.6 mi (1.0 km). Two or three sensors typically are required per runway, with the sensors located at least 165 ft (50 m) from the runway centerline.
- Stationary electro-optical sensors, which can detect a 0.8-in (2.0-cm) object from distances up to 985 ft (300 m). Five to eight sensors are required per runway, with the sensors at least 490 ft (150 m) from the runway centerline.
- Stationary hybrid sensors, which combine radar and eletro-optical sensors and can detect a 0.8-in object. The sensors typically are located on every runway edge light, or on alternate lights.
- Mobile radar, which is mounted atop a vehicle and scans a surface area about 600 ft by 600 ft (183 m by 183 m) in front of the vehicle as it moves. The system can detect objects 1.2 in high and 1.5 in in diameter. The systems operate at speeds up to 30 mph (48 kph) and often are used to supplement visual inspections.

FAA performance requirements call for FOD detection systems to be able to detect an unpainted metal cylinder 1.2 in high and 1.5 in in diameter, as well as a white, gray or black sphere the size of a golf ball — 1.7 in (4.3 cm) in diameter. In addition, the systems must be able to detect at least nine of the objects in a specified group of 10, including a "chunk" of asphalt or concrete, a part of a runway light fixture, a piece of rubber from an aircraft tire, an adjustable crescent wrench as long as 8 in (20 cm), a metal strip as long as 8 in and a wheel lug nut.

The AC says FOD detection systems must provide location information for any detected object that is accurate "within 16 ft (5 m) of the actual FOD object location," operate continuously and operate when the pavement is wet or snow-covered, as well as when it is dry. Rapid detection is required, and "for continuously operating FOD detection systems that are designed to provide between-movement alerts, the system must provide inspection of runway surfaces between aircraft movements."

False alarms that cause an airport operator to act to remove a FOD object "should be minimized" and not exceed one a day for detection systems with visual detection capability and three a day for systems without visual detection, the AC says.

First Installation

The first system to be installed was a QinetiQ Tarsier radar system, deployed in 2006 at Vancouver (Canada) International Airport. The company says Tarsier uses high-resolution millimeter-wave radar to detect small objects on runways. Among the materials that can be detected are metal, plastic, glass, wood, fiberglass and animal remains, QinetiQ says.

At Vancouver, radar antennas, which measure about 35 cu ft (1 cu m) are housed in radomes atop hexagonal steel towers that are between 11 ft (3 m) and 24 ft (7 m) tall — in each case, the minimum height required to give the antenna a line of sight for the section of runway within its range. When the radar detects an object on a runway, a FOD alarm appears on an electronic airport map display at the airport operations center.[3] The map display is always monitored, and when an alarm is received, airport personnel respond to the scene.

"The system has proven to be so accurate that responding personnel in FOD retrieval vehicles have had to offset their vehicle position from the reported coordinates in order to avoid positioning themselves directly over the FOD during recovery," airport officials said in a presentation to Flight Safety Foundation's International Air Safety Seminar in 2006.

Tarsier has been installed at several other airports, including London Heathrow Airport, Dubai International Airport in the United Arab Emirates and Doha International Airport in Qatar. The system also was installed at the Providence (Rhode Island, U.S.) T.F. Green International Airport, where it was the subject of a performance study conducted for the FAA.[4]

The Tarsier system — like other FOD detection systems — was developed in the aftermath of the July 25, 2000, crash of an Air France Concorde after takeoff from Paris Charles de Gaulle International Airport. Investigators found that one of the Concorde's tires had run over a metal strip that had fallen onto the runway from another airplane; after pieces of the burst tire struck an engine and a fuel tank, the airplane burst into flames. All 109 people in the airplane were killed, along with four on the ground (see "FOD-Related Events").

FOD-Related Events

Foreign object debris (FOD) has been blamed for numerous accidents in addition to the fatal 2000 crash of an Air France Concorde just outside Paris, including:

- A March 26, 2007, accident in which the crew of a Gates Learjet 36A heard a "loud pop" during the takeoff roll at Newport News/Williamsburg International Airport in Newport News, Virginia, U.S., and the airplane pulled to the left. The pilots rejected the takeoff but were unable to stop the airplane on the runway; it swerved off the runway to the right and struck a runway light. Neither of the pilots was injured, but the airplane was substantially damaged. The U.S. National Transportation Safety Board (NTSB) said the probable cause of the accident was the failure of tires because of FOD on the runway. Airport personnel said that, after the accident, they observed rocks and pieces of metal on the runway.[1]
- A Feb. 16, 2007, incident in which the crew of a Frontier Airlines Airbus A319 observed, shortly after takeoff from Denver International Airport, that the windshields were cracking. They returned to the airport for a normal landing, and no one in the airplane was injured. The NTSB investigation revealed that, during that same afternoon, 14 airplanes taking off from Denver experienced cracked windshields. One crew reported having taxied through "dirt and dust being blown around," and investigators determined that all of the windshields had cracked because of impacts with FOD.[2]
- A June 8, 2006, accident in which a piece of aluminum material that had been left on the taxiway during taxiway maintenance "became airborne and struck the tail" of an American Trans Air Boeing 737 taxiing for takeoff from LaGuardia Airport in New York. The aluminum plate measured about 25 in (64 cm) by 60 in (152 cm). None of the 143 people in the airplane was injured.[3]

— LW

Notes

1. NTSB. Accident report no. NYC07LA087. March 26, 2007.
2. NTSB. Accident report no. DEN07IA069. Feb. 16, 2007.
3. NTSB. Accident report no. CHI06LA161. June 8, 2006.

'Intelligent Vision'

Another FOD detection system is Stratech System's iFerret, an electro-optical system that uses a line of self-calibrating cameras to inspect runways, taxiways and apron areas for FOD. The system's "intelligent vision" software helps identify, locate and record any object it discovers. It provides real-time alerts with text and image to allow the system operator to get a close-up look at the object before ground personnel are alerted to remove the FOD.

The company describes iFerret as the only system available that can enable airport personnel to monitor not only runways but also taxiways, aprons and other operations areas. A performance assessment at Chicago O'Hare International Airport marked the first deployment of a FOD detection system on taxiways; the first apron deployment was at Düsseldorf (Germany) International Airport.

iFerret also has completed a trial at Singapore's Changi Airport and been commissioned there.

Stratech Systems' iFerret is an electro-optical system that can be used to monitor taxiways and aprons, as well as runways, for FOD.

Hybrid Sensors

Another FOD detection system is Xsight Systems' FODetect, a hybrid electro-optical and millimeter-wave radar sensing system that can be integrated into elevated runway- or taxiway-edge lights or in separate structures. The location of these surface detection units (SDUs) meets "the demanding requirements of detecting small FOD in challenging weather conditions while utilizing existing power and data infrastructure to minimize installation costs," the company says.

Each SDU scans a portion of the runway and analyzes the data it obtains to detect changes on the runway surface, including the presence of FOD; when an SDU detects debris, the FODetect operator receives an audio alert and a visual alert that includes information on the exact location and size of the detected FOD.

FODetect has been tested at Sde-Dov Airport in Tel Aviv, Israel, and Boston Logan International Airport; in May, the company announced plans for program implementation at Ben Gurion International Airport in Tel Aviv.

Radar on Wheels

The FOD Finder is a mobile system — a millimeter-band radar mounted on a vehicle — that is capable of detecting objects "smaller than gravel," according to the manufacturer, Trex Enterprises. The radar sensor, mounted atop a reciprocating platform, scans an area in front of the vehicle. The FOD Finder also includes a global positioning system, a photographic system, a personal computer and system software that provide the operator with images of the FOD it detects. The system automatically uploads data on the detected debris to an Internet-based data management system, the company says.

The FOD Finder operates as the vehicle moves forward, at speeds up to 30 mph, the company says. When FOD is detected and then retrieved, it is photographed by a camera on the vehicle's roof; the system produces a label for the item that includes information on where it was found and the date and time. The information is then entered into a data table in the on-board computer.

Notes

1. The estimate was developed by U.S. National Aerospace FOD Prevention, an association of people and organizations within the aerospace industry dedicated to preventing foreign object damage.
2. FAA. Advisory Circular 150/5220-24, *Airport Foreign Object Debris (FOD) Detection Equipment*. Sept. 30, 2009.
3. Richmond, Craig; Patterson, Brett. "A New Paragon of Airside Safety: Runway FOD Detection Radar." In *Enhancing Safety Worldwide: Proceedings of the 59th Annual International Air Safety Seminar*. Alexandria, Virginia, U.S.: Flight Safety Foundation, 2006.
4. Herricks, Edwin E.; Woodworth, Elizabeth; Majumdar, Sid; Patterson, James Jr. *Performance Assessment of a Radar-Based Foreign Object Debris Detection System*. DOT/FAA/AR-10/33. February 2011.
5. FAA.

BY LINDA WERFELMAN

ASSERT YOURSELF

The NTSB is pressing for enhanced CRM training, including lessons in how first officers should challenge their captains.

Crew resource management (CRM) training should be expanded to include assertiveness training for first officers, the U.S. National Transportation Safety Board (NTSB) says, citing a 2009 crash in which the first officer did not press the captain on his decision to continue an approach even as they struggled with problems associated with asymmetric flaps.

The NTSB's safety recommendation to the U.S. Federal Aviation Administration (FAA) called on the FAA to "require that role-playing or simulator-based exercises that teach first officers to assertively voice their concerns and that teach captains to develop a leadership style that supports first officer assertiveness be included as part of the already-required crew resource management training" for pilots in U.S. Federal Aviation Regulations (FARs) Part 121, 135 and 91 Subpart K operations.[1]

The accident occurred about 0437 local time on Jan. 27, 2009, when an Empire Airlines Avions de Transport Régional Alenia ATR 42 crashed short of the runway during an instrument approach in icing conditions to Lubbock Preston Smith International Airport in Lubbock, Texas, U.S. The captain was seriously injured, and the first officer received minor injuries in the crash, which substantially damaged the airplane.[2]

The two pilots were the only people in the ATR 42, which was registered to FedEx Corp. and operated by Empire as a Part 121 supplemental cargo flight.

In the safety recommendation letter to FAA Administrator Randy Babbitt, the NTSB noted that the first officer had been flying the approach and that, when she called for the 15-degree approach-flap setting, the right flaps did not extend and the left flaps extended only partially.

The captain recognized that there was a problem with the flaps about 40 seconds later, when the airplane had descended to 1,400 ft above ground level (AGL), just outside the outer marker, which was also the final approach fix.

"Both the captain and the first officer had been trained to perform a go-around maneuver and reference the QRH [quick reference handbook] if a flap problem occurred during an approach," the NTSB said in the letter. "However, neither flight crewmember immediately called for a go-around maneuver or performed the QRH procedure for addressing flap anomalies.

"The captain, without discussing any plan of action with the first officer, instead began a nonstandard response to try to troubleshoot the flap problem; the first officer continued to fly the approach."

Neither pilot adequately monitored the airspeed, however, and the aural stall warning and the stick shaker activated "multiple times," the report said, noting that activation of the stick shaker is "another criterion for performing a go-around maneuver."

The first officer asked the captain if she should perform a go-around, but "he dismissed her request," the report said.

When the airplane reached 700 ft, the captain took the controls and continued the unstabilized approach. The stick shaker continued to activate; at 500 ft AGL, just below the clouds and descending at 2,050 fpm, the terrain awareness and warning system (TAWS) generated a "PULL UP" warning.

"Procedures for responding to either the stick shaker or the TAWS warning require the immediate application of maximum engine power," the report said. If the captain had responded by immediately beginning a go-around, he probably could have averted the stall and subsequent crash, the report added.

The NTSB's final report on the accident said that the first officer had told accident investigators that when the captain told her not to perform a go-around, she "felt that he had a good reason for not wanting to go around and that she trusted that he was making the right decisions."[3]

After the captain took over control of the airplane, she "was still concerned … and felt that she should have called again for a go-around maneuver but … she did not know why she did not say anything," the report said.

The NTSB characterized her failure to speak up as result of the "steep authority gradient in the cockpit" — the captain had 13,935 flight hours, extensive experience in flight in icing conditions and was referred to by his colleagues as a "guru," while the first officer had 2,109 flight hours and very limited experience in icing conditions.

The NTSB noted that a number of studies since the 1970s have shown that too steep an authority gradient can impede flight crew performance, in part because first officers with limited experience are reluctant to question actions by captains who have accumulated many thousands of flight hours.

For example, the accident report cited a 1992 report on a study of 249 airline pilots in the United Kingdom in which nearly 40 percent of first officers said that they had "failed to communicate safety concerns to their captains on more than one occasion for reasons that included a desire to avoid conflict and deference to the captain's experience and authority."[4]

Other captains who had flown with the first officer told accident investigators that "although she did not seem to have a problem standing up for something in the cockpit, she asked a lot of questions when flying that were related to skills that she already knew," the report said.

The first officer indicated that, on the accident flight, asking the captain if she should go around was "her way of saying that she wanted to go around without stepping on toes," the report said.

The NTSB said that the CRM issues that were factors in this accident resembled the poor CRM in the Feb. 19, 1996, crash of a Continental Airlines McDonnell Douglas DC-9 in Houston. In that case, the captain rejected the first officer's go-around request and the first officer failed to challenge the decision.[5]

The investigation of that accident resulted in the NTSB's issuance of two safety recommendations calling on the FAA to require airlines to "make it clear to their pilots that there will be no negative repercussions for appropriate questioning, in accordance with CRM techniques, of another pilot's decision or action and ensure that CRM programs provide pilots with training in recognizing the need for, and practice in, presenting clear, unambiguous communications of flight-related concerns."

In response, the FAA issued Advisory Circular (AC) 120-51C, which emphasized that management must support a safety culture that promotes communications among flight crewmembers and must not allow for "negative repercussions for appropriate questioning of one pilot's decision or action by another."

Nevertheless, because the FAA did not issue a flight standards information bulletin on the subject, the NTSB classified the recommendations as closed, with unacceptable action from the FAA.

"Thirteen years after the FAA issued AC 120-51C, the NTSB continues to investigate accidents in which one pilot does not question the actions or decisions of another pilot," the accident report said.

As for the 2009 accident, the NTSB said that the first officer's CRM training had not included role-playing activities to help pilots gain assertiveness skills.

"Practice allows pilots to bridge the gap between their knowledge of assertiveness and the actions needed in the cockpit to effectively be assertive," the report said. "Role-playing exercises are essential for effective assertiveness training because such exercises provide flight crews with opportunities for targeted practice of specific behaviors and feedback that a lecture-based presentation format lacks."

The NTSB recommendation, therefore, called on the FAA to require CRM training to be expanded to include role-playing or simulator exercises to teach first officers to "assertively voice their concerns and … teach captains to develop a leadership style that supports first officer assertiveness."

Notes

1. FARs Part 121 governs air carrier operations, Part 135 governs commuter and on-demand operations, and Part 91 Subpart K governs fractional ownership operations.

2. The NTSB said the probable cause of the accident was the crew's "failure to monitor and maintain a minimum safe airspeed while executing an instrument approach in icing conditions, which resulted in an aerodynamic stall at low altitude." Poor CRM was among four factors cited as contributing to the accident.

3. NTSB. Accident Report NTSB/AAR-11/02, *Crash During Approach to Landing, Empire Airlines Flight 8284, Avions de Transport Régional, Aerospatiale Alenia ATR 42-320, N902FX, Lubbock, Texas, January 27, 2009*. April 26, 2011.

4. The NTSB report cited the following: Wheale, J. "Crew Coordination on the Flight Deck of Commercial Transport Aircraft." In *Proceedings of the Flight Operations Symposium, October 1983*. Dublin, Ireland: Irish Air Line Pilots Association/Aer Lingus.

5. Twelve of the 87 people in the airplane received minor injuries. The NTSB said the probable cause of the accident was the captain's decision to continue the approach, despite the airline's standard operating procedures that required a go-around.

BY RICK DARBY

Nothing Doing

U.S. scheduled airline and commuter operations had no fatalities in 2010.

For U.S. Federal Aviation Regulations (FARs) Part 135 on-demand operations, the striking improvement in the fatal accident rate and numbers noted in 2009 (*ASW*, 4/10, p. 48) reversed course in 2010, although both rate and numbers remained well below 2001–2008 averages.

Accident rates for commuter flights in 2010 conducted under Part 135 were up from those of 2009, but for the fourth year in a row, there were no fatal accidents. In FARs Part 121 scheduled service — airlines — the accident rate was the highest since 2005, but in that category, too, there were no fatal accidents. Data for U.S. operations were released in April by the U.S. National Transportation Safety Board (NTSB).[1]

Scheduled Part 121 operations had 0.276 accidents per 100,000 departures in 2010 (Table 1). The corresponding number for Part 135 commuter operations was 1.026, or 3.7 times higher.

Accidents, Fatalities and Rates, U.S. Civil Aviation, 2010

	Accidents		Fatalities		Accidents per 100,000 Flight Hours		Accidents per 100,000 Departures	
	All	Fatal	Total	Aboard	All	Fatal	All	Fatal
U.S. air carriers operating under FARs Part 121								
Scheduled	26	0	0	0	0.152	—	0.276	—
Nonscheduled	3	1	2	2	0.613	0.204	2.001	0.667
U.S. air carriers operating under FARs Part 135								
Commuter	6	0	0	0	1.899	—	1.026	—
On-demand	31	6	17	17	1.05	0.20	—	—
U.S. general aviation	1,435	267	450	447	6.86	1.27	—	—
U.S. civil aviation	1,501	274	469	466	—	—	—	—
Non-U.S.-registered aircraft	9	1	1	1	—	—	—	—

FARs = U.S. Federal Aviation Regulations

Notes: All data are preliminary.

Flight hours and departures are compiled and estimated by the U.S. Federal Aviation Administration (FAA). On-demand U.S. Federal Aviation Regulations (FARs) Part 135 flight hours are estimated by the FAA. Departure information for on-demand Part 135 operations is not available. On-demand Part 135 operations comprise charters, air taxis, air tours or medical services when a patient is aboard.

Accidents and fatalities in the categories do not necessarily sum to the figures in U.S. civil aviation because of collisions involving aircraft in different categories.

Source: U.S. National Transportation Safety Board

Table 1

Accidents and Accident Rates, FARs Part 121, by NTSB Classification, 2001–2010

	Accidents				Accidents per Million Hours Flown			
Year	Major	Serious	Injury	Damage	Major	Serious	Injury	Damage
2001	5	1	19	21	0.281	0.056	1.067	1.179
2002	1	1	14	25	0.058	0.058	0.810	1.446
2003	2	3	24	25	0.114	0.172	1.374	1.431
2004	4	0	15	11	0.212	0.000	0.794	0.583
2005	2	3	11	24	0.103	0.155	0.567	1.238
2006	2	2	7	22	0.104	0.104	0.363	1.142
2007	0	2	14	12	0.000	0.102	0.713	0.611
2008	3	1	8	16	0.157	0.052	0.419	0.838
2009	2	3	15	10	0.114	0.170	0.852	0.568
2010	1	0	13	14	0.057	0.000	0.740	0.797

FARs = U.S. Federal Aviation Regulations; NTSB = U.S. National Transportation Safety Board

Notes: The NTSB classifications are as follows:

Major — an accident in which any of three conditions is met: A Part 121 aircraft was destroyed, or there were multiple fatalities, or there was one fatality and a Part 121 aircraft was substantially damaged.

Serious — an accident in which at least one of two conditions is met: There was one fatality without substantial damage to a Part 121 aircraft, or there was at least one serious injury and a Part 121 aircraft was substantially damaged.

Injury — a nonfatal accident with at least one serious injury and without substantial damage to a Part 121 aircraft.

Damage — an accident in which no person was killed or seriously injured, but in which any aircraft was substantially damaged.

Source: U.S. National Transportation Safety Board

Table 2

The accident rate per 100,000 departures for on-demand (air taxi) Part 135 accidents could not be calculated because of the unavailability of departure data, but there were six fatal accidents in that category.

For all Part 121 operations, there was one accident in 2010 classified as "major" by the NTSB, the lowest number since 2007 (Table 2).[2] That compared with an average of 2.3 in the previous nine years.[3] There were 13 "injury" accidents, close to the average of 14.1 in the previous nine years.

With no fatal accidents in scheduled Part 121 operations in 2010, the year looked good compared with 2009, which included the Colgan Air Bombardier Q400 accident. Nevertheless, the overall accident rate — 0.276 per 100,000 departures — was higher than any year since 2005, and an 8.2 percent increase over 2009 (Table 3). The average for the nine-year period before 2010 was 0.293. The number of accidents was 26, the same as in 2006, 2007 and 2009; the average for 2001–2009 was 31.2, or 20 percent higher.

This fatal accident rate for Part 121 nonscheduled operations remained about the same in 2010 as in 2009, but the rate for all accidents — as well as the number of accidents — decreased for the second year in a row (Table 4).

As in 2007–2009, commuter operations recorded a fatality-free year in 2010 (Table 5, p. 52). The accident rate almost tripled between 2009 and 2010, from 0.353 accidents per 100,000 departures to 1.026 per 100,000 departures. The average for the previous nine years was 0.827, or 19 percent lower than the 2010 rate. The six accidents in the Part 135 commuter category in 2010 compared with an average of 4.6 in the previous nine years.

The 2010 rate for all accidents in Part 135 on-demand operations was lower than that for the previous year (Table 6, p. 52). The 31 total accidents in 2010 represented a further improvement on the 2009 total of 47, as well as the 2001–2009 average of 61.7.

Although not shown in the table, the latest year's rate and number of accidents were the lowest of all years beginning in 1991.

The 2010 fatal accident rate, 0.20 per 100,000 flight hours, was an increase of 186 percent over the 0.07 per 100,000 flight hours of 2009. However, flight hours are considered a less significant measure than departures, which were unavailable in this category for analysis.

Continued on p. 52

Accident Rates, FARs Part 121 Scheduled Operations, 2001–2010

	Accidents		Fatalities		Accidents per 100,000 Flight Hours		Accidents per 1,000,000 Miles Flown		Accidents per 100,000 Departures	
Year	All	Fatal	Total	Aboard	All	Fatal	All	Fatal	All	Fatal
2001	41	6	531	525	0.216	0.012	0.0053	0.0003	0.348	0.019
2002	34	0	0	0	0.203	—	0.0049	—	0.331	—
2003	51	2	22	21	0.302	0.012	0.0073	0.0003	0.499	0.020
2004	23	1	13	13	0.126	0.005	0.0030	0.0001	0.213	0.009
2005	34	3	22	20	0.182	0.016	0.0043	0.0004	0.312	0.027
2006	26	2	50	49	0.139	0.011	0.0033	0.0003	0.245	0.019
2007	26	0	0	0	0.137	—	0.0032	—	0.242	—
2008	20	0	0	0	0.108	—	0.0026	—	0.195	—
2009	26	1	50	49	0.149	0.006	0.0036	0.0001	0.255	0.010
2010	26	0	0	0	0.152	—	0.0036	—	0.276	—

FARs = U.S. Federal Aviation Administration

Notes: 2010 data are preliminary.

Flight hours, miles and departures are compiled by the U.S. Federal Aviation Administration.

For 2001, the Sept. 11 terrorist attack is included in the totals for accidents and fatalities but excluded for accident rate comparison. Other than the persons aboard aircraft who were killed, fatalities resulting from the act are excluded.

Source: U.S. National Transportation Safety Board

Table 3

Accidents, Fatalities and Rates, FARs Part 121, Nonscheduled Operations, 2001–2010

	Accidents		Fatalities		Accidents per 100,000 Flight Hours		Accidents per 1,000,000 Miles Flown		Accidents per 100,000 Departures	
Year	All	Fatal	Total	Aboard	All	Fatal	All	Fatal	All	Fatal
2001	5	0	0	0	0.762	—	0.0167	—	1.553	—
2002	7	0	0	0	1.225	—	0.0265	—	3.012	—
2003	3	0	0	0	0.517	—	0.0113	—	1.462	—
2004	7	1	1	1	1.002	0.143	0.0215	0.0031	2.915	0.416
2005	6	0	0	0	0.885	—	0.0186	—	2.728	—
2006	7	0	0	0	1.138	—	0.0243	—	3.619	—
2007	2	1	1	1	0.321	0.161	0.0069	0.0034	1.030	0.515
2008	8	2	3	1	1.464	0.366	0.0325	0.0081	4.832	1.208
2009	4	1	2	2	0.753	0.188	0.0166	0.0041	2.663	0.666
2010	3	1	2	2	0.613	0.204	0.0131	0.0044	2.001	0.667

FARs = U.S. Federal Aviation Regulations

Notes: 2010 data are preliminary.

Flight hours, miles and departures are compiled by the U.S. Federal Aviation Administration.

Source: U.S. National Transportation Safety Board

Table 4

Accidents, Fatalities and Rates, FARs Part 135, Commuter Operations, 2001–2010

Year	Accidents		Fatalities		Accidents per 100,000 Flight Hours		Accidents per 1,000,000 Miles Flown		Accidents per 100,000 Departures	
	All	Fatal	Total	Aboard	All	Fatal	All	Fatal	All	Fatal
2001	7	2	13	13	2.330	0.666	0.1624	0.0464	1.254	0.358
2002	7	0	0	0	2.559	—	0.1681	—	1.363	—
2003	2	1	2	2	0.627	0.313	0.0422	0.0211	0.349	0.175
2004	4	0	0	0	1.324	—	0.0855	—	0.743	—
2005	6	0	0	0	2.002	—	0.1312	—	1.138	—
2006	3	1	2	2	0.995	0.332	0.0645	0.0215	0.528	0.176
2007	3	0	0	0	1.028	—	0.0651	—	0.506	—
2008	7	0	0	0	2.385	—	0.1508	—	1.215	—
2009	2	0	0	0	0.685	—	0.0432	—	0.353	—
2010	6	0	0	0	1.899	—	0.1239	—	1.026	—

FARs = U.S. Federal Aviation Regulations; NTSB = U.S. National Transportation Safety Board

Notes: 2010 data are preliminary. Flight hours, miles and departures are compiled by the U.S. Federal Aviation Administration (FAA).

Based on a February 2002 FAA legal interpretation provided to the NTSB, any Part 135 operation conducted with no revenue passengers aboard is to be considered an on-demand flight. This interpretation is applied to accidents beginning with 2002 but not retroactively for 2001.

Source: U.S. National Transportation Safety Board

Table 5

Accidents, Fatalities and Rates, FARs Part 135, On-Demand Operations, 2001–2010

Year	Accidents		Fatalities		Accidents per 100,000 Flight Hours	
	All	Fatal	Total	Aboard	All	Fatal
2001	72	18	60	59	2.40	0.60
2002	60	18	35	35	2.06	0.62
2003	73	18	42	40	2.49	0.61
2004	66	23	64	63	2.04	0.71
2005	65	11	18	16	1.70	0.29
2006	52	10	16	16	1.39	0.27
2007	62	14	43	43	1.54	0.35
2008	58	20	69	69	1.81	0.62
2009	47	2	17	14	1.63	0.07
2010	31	6	17	17	1.05	0.20

FARs = U.S. Federal Aviation Regulations

Notes: 2010 data are preliminary.

Flight hours are estimated by the U.S. Federal Aviation Administration (FAA).

In 2002, the FAA changed its estimate of on-demand activity. The revision was retroactively applied to the years 1992 to 2002. In 2003, the FAA again revised flight activity estimates for 1999 to 2002.

On-demand Part 135 operations comprise charters, air taxis, air tours or medical services when a patient is aboard.

Source: U.S. National Transportation Safety Board

Table 6

The 2010 fatal accident rate was far from a reversion to the mean. The 2001–2009 average was 0.40, double the 2010 rate, and the six fatal accidents in the category were below the previous nine-year average of 14.9.

Notes

1. Available via the Internet at <www.ntsb.gov/aviation/Stats.htm>.
2. The NTSB classifications are as follows:

   Major — an accident in which any of three conditions is met: A Part 121 aircraft was destroyed, or there were multiple fatalities, or there was one fatality and a Part 121 aircraft was substantially damaged.

   Serious — an accident in which at least one of two conditions is met: There was one fatality without substantial damage to a Part 121 aircraft, or there was at least one serious injury and a Part 121 aircraft was substantially damaged.

   Injury — a nonfatal accident with at least one serious injury and without substantial damage to a Part 121 aircraft.

   Damage — an accident in which no person was killed or seriously injured, but in which any aircraft was substantially damaged.
3. All averages in this article are means.

The Limits of Realism

High fidelity may not be the best measure of effective simulation training.

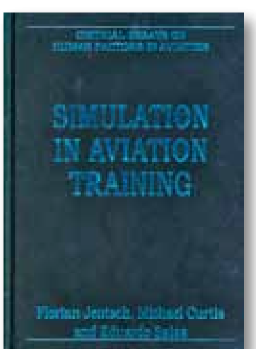
BY RICK DARBY

BOOKS

A Simulating Discussion

Simulation in Aviation Training

Jentsch, Florian; Curtis, Michael; Salas, Eduardo (eds.). Farnham, Surrey, England, and Burlington, Vermont, U.S.: Ashgate, 2011. 540 pp. Figures, tables, references, index.



"The objective of simulation is to provide an alternative exposure to real world tasks that are either difficult to access, too dangerous or too costly to conduct in the real world," the editors say.

Simulation in aviation training appears to be growing in importance. "While the most intensive instruction occurs in initial flight training, pilots are required to continue training to learn new technologies, fly different aircraft, upgrade to captain or just stay current with the aircraft they fly," the editors say.

"Simulations are used for a wide range of skill development in aviation. In the past, the simulator was largely dedicated to the development of technical skills, such as stick and rudder control. In the last two decades, however, simulator training programs … have widened the scope of training to include not only technical skills, but also team communication and coordination skills such as crew resource management. Consequently, a large portion of the current commercial aviation training curriculum relies on hours in full-motion simulators."

Yes, but the devil is in the details, the papers collected in the book suggest.

It is organized in six sections, five of which are directly concerned with aviation training; the last is about other simulation applications.

The first section is an overview of "Using Simulation for Training." The articles "address the importance of learning objectives when using simulations for training," the editors say. "There are still many instances where simulation is used ineffectively. The chapters in this section discuss common issues associated with the implementation of simulation training and how consideration of educational and general training theory are critical first steps to building an effective simulation training program."

"Simulation Fidelity," the next section, surveys the progress of realistic flight simulation and considers how much realism contributes to effectiveness. "The simulation industry has largely been driven by improved realism," the editors say. "Despite being able to achieve high levels of fidelity, researchers and practitioners alike have questioned the level of fidelity that is necessary to produce targeted training outcomes." One study in the section suggests that "specific flight skills can be trained using lower-fidelity training devices," including personal computers.

Simulator training is not an end in itself and can be no more effective than the program of which it is a part.

Another study suggests that "photorealistic" simulation is useful in training for defined — even though unexpected — flight events involving rehearsed roles, duties and procedures, but state-of-the-art realism offers no particular advantage in preparing pilots for ambiguous, time-pressured situations.

"Both the studies of aviation accidents and the use of lower-fidelity simulation reveal a disconnect between the fidelity (or photorealistic faithfulness) of a simulation and its validity (how the skills it develops map onto situations in the target environment)," the study authors say. "Lower-fidelity simulation allows the development of generic problem-solving skills, such as sharing knowledge, making and following up on plans, dividing work, stepping back for broader evaluation, borrowing time from the future by current task investments and maximally exploiting a group's available expertise."

They conclude that lower-fidelity simulations "could contribute significantly to the development of resilient crews in ways that reliance on considerably more costly and more high-fidelity training cannot."

Next is a section with the theme "Physiological Responses and Simulation Sickness." Including in a simulation the warnings, alerts and motion that may occur in flight can be good preparation for a fast, correct response to a real event. But there is a downside. Several essays discuss the phenomenon of "simulation sickness," an advanced case of the motion sickness people sometimes experience in moving automobiles. Besides the standard motion sickness symptoms of nausea, perspiration and disorientation, simulation sickness tends to include more visually based symptoms such as eyestrain and dizziness.

"Due to the diversity of symptoms that can characterize the different forms of motion sickness and even different simulators, … simulation sickness is polysymptomatic," says one paper. "A disadvantage of being polysymptomatic is that scientists and engineers are not able to sample just one output from the human and arrive at meaningful conclusions." The authors' recommendation is that "low-cost survey data be utilized to isolate potential drivers that may matter and to identify those that must be controlled. From this information, a series of field experiments could proceed in which critical manipulations and constraints are imposed and that can be conducted at low cost and with a suitable number of subjects."

The fourth section, "Simulation as Training and Method," samples the range of simulation training methodologies. This is the most theoretical section, comprising studies on the nature of learning and instruction techniques. Some of it may seem to have little direct bearing on simulator use, but the editors point out in the introduction that without intelligent instruction design, the many advantages of the simulator will not be used to the fullest.

That theme recurs often in the book — simulator training is not an end in itself and can be no more effective than the program of which it is a part.

In a section on "Training Evaluation Using Simulation," one paper says, "Before an instructor, program director or researcher can evaluate a training program, much less compare that program to a set of standards or to another program, the training effectiveness of the program must first be measured. That measurement must be relevant, accurate and valid, or the entire evaluation procedure is a waste of time and money. There are three general issues in the basic methods of evaluation. The first issue concerns *when* the training effectiveness is measured. The second concerns *how* the training effectiveness is measured. The third issue concerns the validity of the measures that are used."

Another simulation issue, commonly encountered when technology meets human factors, is integrating the disciplines of engineering, computer science, psychology and training.

"The capabilities now offered by simulation have created unlimited opportunities for aviation training," says an article in the first section. "In fact, aviation training is now more realistic, safe, cost-effective and flexible than ever before. However, we believe that a number of misconceptions — or invalid assumptions — exist in the simulation community that prevent us from fully exploiting and utilizing recent scientific advances in a number of related fields in order to further enhance aviation training. These assumptions relate to the over-reliance on high-fidelity simulation and to the misuse of simulation to enhance learning of complex skills."

Among the "invalid" assumptions cited are these:

Simulation is all you need. "The very large majority of training funding is allocated to the development of simulation devices and not to further our understanding of the learning process. Although there has been considerable progress in this regard, it is clear that the 'human' side of training research has simply not kept pace with the 'machine' side. …

"It appears to have been a common practice to neglect performing appropriate training needs analyses prior to the development or procurement of simulators. This practice occurs because there is a reluctance to pay for the analysis, which can be costly, and to wait for its completion, which just delays the introduction of the device. Therefore, plans proceed for developing a device using the most logical design criterion, which is a realistic mimicking of the real-world environment. This situation seems to have led us to the point where, in the quest for a more realistic simulation, we may have lost sight of the true goal — a more effective training device in terms of both training outcomes and cost."

More is better. "That the training is conducted in a high-fidelity simulator does not ensure training success. … The level of fidelity built into the simulator should be determined by the level needed to support learning on the tasks that will be trained using the device. … High-fidelity simulations have a time and a place in training. They should be used as determined by training and task requirements, costs and learning objectives."

If the pilots like it, it is good. "[Evaluation] techniques include the use of the trainees' opinions of whether they liked the simulator and the training program. … Training research clearly now indicates that there is not a significant relation between trainee reactions and learning and subsequent performance.

"Ideally, the determination that the training is effective should come from the trainee's performance rather than the [realism] of the simulation. However, many of the simulation evaluation techniques that are currently in use evaluate the 'machine,' that is, the system's characteristics and parameters, and not the 'person's' or the trainee's performance. As a result, because the simulation is judged favorably, the training it provides is judged to be good as well."

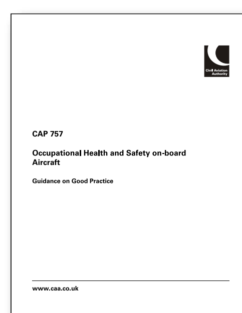
In general, the authors say, "The field must shift its emphasis to a more trainee-centered design. This does not mean we rely on trainees' opinions about the training. Rather, it calls for a paradigm shift that moves from a focus on the simulation to a more holistic consideration of the entire training system including content, measures and instructional strategies."

REPORTS

Handle With Care

Occupational Health and Safety On-Board Aircraft: Guidance on Good Practice

U.K. Civil Aviation Authority. CAP 757. Issue 4, May 2011. 40 pp. Appendixes. Available via the Internet at <www.caa.co.uk/docs/33/cap757.pdf>.



The latest amendments to this comprehensive guide to cabin safety are in Chapter 2, "Manual Handling Guidance."

"Manual handling incidents represent a substantial risk to employees working on-board an aircraft," the report says. "A survey, involving 10 U.K. airlines, found manual handling to be the cause of 16 percent of all reported incidents during 2007, with some of these resulting in significant injuries to crewmembers."

Manual handling includes tasks such as maneuvering food and drink carts, stowing baggage in overhead compartments, opening and closing aircraft doors, moving incapacitated passengers and working in confined spaces that require awkward posture. In the case of pushing and pulling carts, the report says that "typical loads can be in the range of 90–110 kg [198–243 lb]" with the risk of carts toppling over and the stress of maneuvering them into awkward locations.

Injuries from manual handling include the development of musculoskeletal disorders — conditions that affect the skeleton, muscles, tendons, ligaments, nerves and other soft tissues and joints — resulting in upper limb disorders and back pain. Acute injuries caused by sudden overloading of the body's muscles are a threat.

Additions to the latest version of the report include the following:

- "Aircraft operators should make a suitable and sufficient assessment of the risks posed to both cabin and flight crewmembers by manual handling operations while in the aircraft. Good practice is to include those who carry out the tasks as part of the assessment team to ensure the true nature of the activity is captured."
- "Risk assessments should take account of the tasks, the individuals involved (including any pre-existing conditions from which they may suffer), the loads and the specific environment. It should be remembered that crew must be fit for duty, including being capable of undertaking emergency actions."
- "Additional risk assessment may be required where a crewmember is returning to work following an injury and information suggests there could be a residual impact on their manual handling capabilities. This shall ensure they can safely undertake any emergency actions. Any assessment should also ensure that other manual handling activities are managed so as not to exacerbate any injury."
- "Aircraft operators should ensure that flight deck stowage locations for manuals and items which need to be accessed during flight be located in accordance with good ergonomic principles, where possible. This should reduce the risk of manual handling injuries to flight crew."
- "Crew should be taught to identify their personal limitations and address the importance of the correct manual handling techniques. This should include the importance of the use of dynamic assessment throughout the working day to ensure they remain within their own safe handling limits."

Discussing the techniques for minimizing risk from baggage handling, the report includes a new note that "these considerations should be equally applied to crew baggage. Incident data suggest high-weight crew bags have been a factor in several manual handling incidents resulting in serious injury."

Turbulence Triggers Roll Upset, Stall

The 737 encountered a mountain wave on approach.

BY MARK LACAGNINA

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

JETS

Thrust Increase Caused Pitch-Up

Boeing 737-300. No damage. No injuries.

A rapid and slightly asymmetric increase in thrust during an encounter with turbulence while the 737 was in a low-speed turn led to a roll upset and a stall on approach to Antalya, Turkey, the morning of May 2, 2009, according to the French Bureau d'Enquêtes et d'Analyses (BEA).

The incident occurred during a flight with 110 passengers and five crewmembers from Marseille, France. The copilot was the pilot flying.

After nearly three hours en route, the flight crew began the descent from cruise altitude at 0655 coordinated universal time (0955 Antalya time). The 737 was over a "broken layer of cumulus with variable development," the BEA report said. "The cabin manager confirmed to the captain that the cabin was ready for the landing and [that] the cabin crew [had their] seat belts fastened."

The airplane encountered turbulence while descending through Flight Level 130 (approximately 13,000 ft) with a selected airspeed of 240 kt. During the turbulence encounter, the indicated airspeed "varied between 225 kt and 252 kt, while the vertical accelerations varied between +0.54 g [i.e., 0.54 times standard gravitational acceleration] and +1.62 g," the report said.

Shortly after the 737 encountered the turbulence, which the crew apparently did not report to air traffic control (ATC), the approach controller told the crew to reduce airspeed to the minimum for approach. "They selected 210 kt — that's to say, 10 kt more than the clean-configuration maneuvering speed at the estimated weight," the report said.

After descending to their assigned altitude, 11,000 ft, the crew observed through the windshield and on their weather radar display "a relatively compact cumulus about 2.5 nm [5 km] in diameter … about 25 nm [46 km] from the runway threshold" and requested a deviation to the left to avoid it, the report said. "While they asked for a left-side avoidance maneuver where the sky was less cloudy, the controller cleared them for a right-side avoidance maneuver."

The 737 was about 30 nm (56 km) from the airport at 0713, when the crew began the right turn. They were flying the airplane with the autopilot engaged in the heading- and altitude-hold modes, and with the autothrottle engaged in the speed-hold mode. Seconds after beginning the turn, with a bank angle of 25 degrees selected on the mode control panel, the airplane again encountered turbulence, which caused vertical accelerations between +0.5 g and +1.36 g. The autothrottle reduced thrust in reaction to the disturbance, and indicated airspeed decreased to 199 kt.

Shortly thereafter, while still in the right turn and experiencing a peak vertical acceleration of

+1.45 g, the crew overrode the autothrottle by moving the thrust levers forward. "The speed continued to decay while the engines responded to the throttle advance," the report said.

The thrust levers apparently were not moved symmetrically, or the engines did not accelerate evenly. Low-pressure rotor speed (N_1) in the left engine reached about 98 percent, while N_1 in the right engine reached about 87 percent. The asymmetric thrust contributed to the initiation of a very high roll rate, with the right bank angle increasing through 57 degrees. The increased thrust produced by the underwing-mounted engines also caused the airplane to pitch 9.5 degrees nose-up.

The enhanced ground-proximity warning system (EGPWS) generated a "BANK ANGLE" warning, and the stick shaker activated. The crew reduced thrust and applied full left aileron and rudder. "The bank reached its maximum of 102 degrees to the right, and the minimum speed of 181 kt was reached," the report said.

The airplane stalled and descended rapidly. Nose-up elevator control was being held as the right bank angle decreased through 90 degrees and the pitch attitude reached about 25 degrees nose-down. The airplane rolled through wings-level and into a 35-degree left bank. The crew applied nose-down elevator control and full thrust.

The upset lasted about 18 seconds, during which the 737 descended at up to 12,000 fpm in instrument meteorological conditions. After recovering control at 7,576 ft, the crew climbed back to 11,000 ft.

The 737 descended at up to 12,000 fpm in instrument meteorological conditions.

"At the request of ATC, the crew described the violent phenomenon they had encountered," the report said. "After the landing, at 0727, takeoffs were suspended and airplanes on arrival put in holding for about 30 minutes."

The report said that the airplane had encountered turbulence in the lower layer of a mountain wave. The 737's optimum speed for penetrating turbulence below 15,000 ft is 250 kt.

According to the manufacturer, the first step in recovering from a stall is to reduce angle-of-attack, the report said. "Nose-down pitch control must be applied and maintained until the wings are unstalled. Under certain conditions, on an airplane with underwing-mounted engines, it may be necessary to reduce thrust in order to prevent the angle-of-attack from continuing to increase. Once the wing is unstalled, upset recovery actions may be taken and thrust reapplied as needed."

After the incident, the airplane operator instituted additional pilot training and a "pilot awareness campaign on the suddenness and violence of some environmental phenomena that may exceed the possible responses of the automatic systems and require the flight crew to intervene manually using the flight and thrust controls," the report said.

Controller Loses Track

British Aerospace Hawker 800A. No damage. No injuries.

A reduced visibility operations plan was in effect at Calgary (Alberta, Canada) International Airport the morning of March 2, 2010. Only Runway 16 was in use, and runway visual range was 2,000 ft (600 m) in light snow and freezing fog, said the report by the Transportation Safety Board of Canada (TSB).

Fifteen aircraft were holding for departure. The Hawker was the first in a line of 12 aircraft holding on a taxiway near the approach threshold of Runway 16; two aircraft were holding on a taxiway farther down the runway; and one, a de Havilland Dash 8, was holding on Taxiway U at midfield.

A shift change had occurred in the airport control tower. After receiving a hand-off briefing, the airport traffic controller advised the flight crews of five aircraft of their sequence for departure. At the time, the Hawker was third in sequence, and the Dash 8 was fourth.

The controller cleared the Hawker crew for takeoff at 0942 local time. Six seconds later, the controller told the Dash 8 crew to line up and wait at the threshold of Runway 16, and to turn right to a heading of 193 degrees after takeoff. The Dash 8 crew "acknowledged the heading change and began to taxi slowly toward the hold line," the report said. "The crew did not hear the controller's reference to lining up at the threshold and did not indicate that they were at Taxiway U."

The report said that the controller had "lost track of the location of [the Dash 8]" and did not check his electronic flight data display, which showed that the aircraft would begin its takeoff from the Taxiway U intersection.

The first officer of the Dash 8 was completing the "Before Takeoff" checklist when the captain "asked about the clearance and expressed concern about the recent takeoff clearance given to an aircraft at the threshold," the report said. "By this time, [the Hawker] was accelerating through 85 kt."

At 0944, the first officer "queried the airport controller to confirm that the tower hadn't authorized anyone's departure," the report said. "The airport controller restated the instruction to line up, adding that they should be ready for an immediate departure."

The Hawker had lifted off the runway about 2,900 ft (884 m) from Taxiway U and passed 400 ft above the intersection of Taxiway U as the Dash 8 crew began to taxi the aircraft onto the runway.

"Visibility was low enough to preclude the airport controller from visually seeing either aircraft or the runway," the report said. The controller had been monitoring the runway threshold area shown on his airport surface detection equipment (ASDE) primary radar display for movement of the Dash 8. When he noticed a target moving near Taxiway U, he realized that it was the Dash 8 and that the Hawker was passing overhead.

Noting that the controller had complied with ATC requirements by instructing the Hawker crew to line up and wait at the threshold of Runway 16, the report said, "The flight crew was not obligated by regulation to read back the instruction, but to acknowledge it, which they did."

However, the report also noted that the Transport Canada *Aeronautical Information Manual* "advises that, while acknowledging ATC instructions without a full readback is compliant with [Canadian Aviation Regulations], it is good operating practice to read back instructions to enter, cross, backtrack or line up on any runway."

The ASDE's runway incursion monitoring and collision avoidance system (RIMCAS) was not in use when the incursion occurred. The report said that because of the complexity of the airport and its high level of traffic, "multiple RIMCAS alarms per hour" occur during normal operations, and the system is considered more of a nuisance than a safety feature.

The airport's reduced visibility operations plan did not require RIMCAS to be active, an oversight that the report characterized as "a missed opportunity … to provide another layer of defense against collisions in low-visibility conditions."

Gust Factors in Tail Strike

Boeing 747-400. Minor damage. No injuries.

Shortly after departing from Sydney, Australia, with 229 passengers and 17 crewmembers for a flight to San Francisco the afternoon of May 7, 2010, the flight crew was advised by ATC that the aircraft's tail had struck the runway on takeoff.

"After completing the appropriate checks and dumping fuel, the crew returned the aircraft to Sydney and landed," said the report by the Australian Transport Safety Bureau (ATSB). "A subsequent inspection revealed scrape damage to the aircraft's lower rear fuselage consistent with contact with the runway surface."

The automatic terminal information service had reported the surface winds as from 300 degrees at 10 kt when the flight crew performed the reduced-thrust takeoff from Runway 34L. The pilot-in-command (PIC) told investigators that during rotation, the aircraft's response to his elevator control input was "slightly more aggressive than he would have liked and was expecting."

"None of the crewmembers recalled feeling or hearing anything unusual during this phase, and there were no aircraft system alerts or other indications," the report said.

Recorded flight data indicated that the 747 had encountered a gust that caused its airspeed to stagnate briefly during rotation. The aircraft lifted off the runway 6 kt below the target rotation speed of 173 kt. The initial rotation rate was about 2.2 degrees per second — or slightly below the nominal rotation rate of 2.5 degrees per second — but had increased to 4 degrees per second at liftoff.

The data also indicated that the PIC's use of left aileron to counter a left crosswind had

'None of the crewmembers recalled feeling or hearing anything unusual.'

caused the flight spoilers to deploy, resulting in a slight loss of lift.

The report said that the airspeed loss due to the gust, the increased rotation rate and the lift reduction due to spoiler deployment were primary factors that contributed to the reduction of tail clearance leading to the tail strike.

"Another contributing factor was the reduced-thrust takeoff, which increased the aircraft's exposure to wind variations during rotation," the report said.

Damper Leaks Fluid Into APU

Airbus A320-211. No damage. Four minor injuries.

While preparing for a flight from Montreal to Toronto the morning of March 23, 2010, the flight crew noticed no anomalies during their inspection of the aircraft but saw a logbook entry that 6 L (6 qt) of fluid had been added to the "green" hydraulic system. "The entry included an instruction to monitor the quantity levels," the TSB report said.

The crew detected an odor after starting the auxiliary power unit (APU). "Such odors are not uncommon and are often caused by engine washes or residue in the air conditioning system from the previous flight," the report said. The odor dissipated after the crew increased the airflow and decreased the temperature in the cabin.

The odor returned shortly after takeoff but dissipated after cabin airflow and temperature again were readjusted.

The A320 was nearing cruise altitude when the crew received an indication of a low fluid level in the reservoir of the green hydraulic system, one of three hydraulic systems aboard the aircraft. They completed the applicable procedures, including disengaging the hydraulic power transfer unit and the engine-driven pump, which isolated the green hydraulic system.

The isolation of the green hydraulic system rendered several systems inoperative, including nosewheel steering, normal wheel brakes, normal landing gear extension and the left engine thrust reverser.

The crew decided to continue the flight to Toronto, which had better weather conditions than Montreal. "Following an emergency extension of the landing gear, the aircraft made an uneventful landing on Runway 05 and came to a complete stop," the report said.

Because of the inoperative systems, the aircraft had to be towed to the gate. While waiting for a tow vehicle to arrive, the crew started the APU and shut down the engines. Company procedure called for all doors to be closed during towing. After conferring with maintenance personnel, the crew re-engaged the green hydraulic system to close the landing gear doors.

"Almost immediately, smoke began to enter the cabin and cockpit," the report said. The captain ordered an evacuation. The flight attendants told the passengers to leave everything behind, but several passengers took baggage and personal items with them.

Evacuation of the 98 passengers was completed in about two minutes. However, the slides had become damp in the light rain, and two passengers who exited with their baggage received minor injuries, including scraped knuckles and sore backs. Two crewmembers, who were the last to evacuate and were required to bring emergency equipment with them, sustained similar injuries.

Examination of the A320 revealed that fluid from the green hydraulic system had leaked through worn piston rod seals in a yaw damper actuator. The fluid had flowed down the aft fuselage and into the APU intake. "The APU had compressed and heated the fluid, which was then sent through the bleed air system to the air conditioning pack, through the filters and eventually into the cabin," the report said.

TURBOPROPS

CFIT in a Mountain Gap

de Havilland DHC-6. Destroyed. 13 fatalities.

The Twin Otter was on a scheduled flight from Port Moresby to Kokoda, both in Papua New Guinea, the morning of Aug. 11, 2009, when it crashed in a mountain gap about 11 km (6 nm) southeast of Kokoda Airstrip. All 11 passengers and the two pilots were killed.

The accident site was in jungle on the eastern slope of the Kokoda Gap, at an elevation of 5,780 ft, said the report by the Accident Investigation Commission of Papua New Guinea (AIC).

The flight crew made no radio transmissions indicating that they were experiencing any difficulties. The aircraft was not equipped with, and was not required to be equipped with, a cockpit voice recorder (CVR).

The crew was operating on an instrument flight rules (IFR) flight plan but likely were attempting to descend visually through the mountain gap, the report said. "There were no navigation aids at Kokoda to assist crews during their arrival or departure from the airstrip."

"At about the time of the accident, there was a solid bank of cloud situated at the junction of the Kokoda Gap and Kokoda valley," the report said. "Witnesses at [a local village] stated that they observed an aircraft fly low over the village and that cloud obscured the eastern ridge of the gap at that time." Witnesses at another local village said that they heard an aircraft flying low overhead but could not see it through the clouds.

The Twin Otter was banked 25 degrees right on impact. The accident likely occurred as the crew was maneuvering in an attempt to maintain or reacquire visual contact with the terrain, the report said. "The investigation concluded that the accident was probably the result of controlled flight into terrain [CFIT] — that is, an otherwise airworthy aircraft was unintentionally flown into terrain, with little or no awareness by the crew of the impending collision."

In a response to an AIC recommendation generated by the findings of the accident investigation, the Civil Aviation Safety Authority of Papua New Guinea intends to require the installation of CVRs in turbine-powered aircraft with more than nine passenger seats.

Starved on Crossfeed

Beech King Air C90A. Substantial damage. No injuries.

Four days before the King Air departed from Key Largo, Florida, U.S., for a charter flight to Orlando on May 25, 2009, the pilot reported that the left fuel boost pump was operating intermittently. "Maintenance [personnel] checked the pump but could not duplicate the intermittent discrepancy, and the airplane was approved for return to service," said the report by the U.S. National Transportation Safety Board (NTSB).

Shortly after the airplane departed from Key Largo, the left boost pump failed, and the crossfeed valve automatically opened to enable the right boost pump to feed the left engine, as well as the right engine, with fuel from the right wing and nacelle tanks.

The PIC told investigators that he "looked at the emergency procedures checklist for boost pump failure but did not comply with the checklist and did not change the fuel control configuration," the report said. "The PIC reported he did not see any urgency and elected to continue the flight [with the crossfeed system engaged], though he did not monitor the fuel quantity gauges."

'The PIC did not comply with the checklist [and] did not monitor the fuel quantity gauges.'

The report said that, in accordance with the checklist, the pilots could have disengaged the crossfeed system, so that the left engine-driven pump could suction-feed fuel from the left tanks, which contained a sufficient quantity of fuel.

During the descent to Orlando, both fuel pressure warning lights illuminated. Shortly thereafter, both engines lost power due to fuel starvation when the fuel from the right tanks was exhausted. The pilot turned toward a nearby airport but, realizing that the airport was out of glide range, extended the landing gear and landed the King Air in an open field near Yeehaw Junction, Florida. The airplane touched down hard and skidded, and the right main landing gear wheel assembly separated and struck the right horizontal stabilizer. The two passengers, the pilot and the copilot escaped injury.

"Postaccident inspection of the airplane revealed internal components of the left boost pump were worn … and that the right no-fuel-transfer time delay relay was inoperative due to a broken terminal on the relay," the report said.

The failure of the relay precluded illumination of a warning light indicating that fuel no longer was being transferred from the right wing tanks to the 60-gal (227-L) right nacelle tank. Had the warning light illuminated, "it is likely that the flight crew would have diverted earlier for an uneventful landing at a suitable airport," the report said.

Fuel Leak Traced to O-Rings

Cessna 208 Caravan. No damage. No injuries.

Shortly after taking off from Runway 02 at Nelson (New Zealand) Aerodrome for a scheduled flight with four passengers to Wellington the morning of Feb. 20, 2010, the flight crew noticed an uncommanded reduction in torque and moved the power lever forward. Then, they detected a strong odor of fuel and saw a higher-than-normal fuel flow indication.

The PIC reduced power and told the airport traffic controller that he was returning to land on Runway 20. "He did this without declaring an urgency or distress situation," said the report by the New Zealand Transport Accident Investigation Commission.

Another aircraft had been cleared to line up for takeoff on Runway 20, so the pilot landed the Caravan on an adjacent grass runway and taxied it to the apron.

Investigators found that the loss of torque had been caused by fuel leaking past O-ring seals that had been damaged by movement of the fuel-transfer tubes. The tubes "had been reduced in size [by 0.2 to 0.5 mm, or 0.008 to 0.020 in] at some time during maintenance by a chemical milling process that had removed the anodic protective coating," the report said. The chemical milling, which had been done to clean the tubes, is not an approved cleaning method and is "contrary to good engineering practice," the report said.

The report also said that the pilots should have declared an urgency or distress situation so that they would receive priority handling by ATC and ensure that emergency services would be readily available on arrival. "A fuel leak, especially near a hot engine, could have been serious," the report said. "Fire could have broken out at any time."

PISTON AIRPLANES

Loss of Control in Fog

Britten-Norman Islander. Destroyed. One fatality.

Visual meteorological conditions prevailed at Forteau, Newfoundland and Labrador, Canada, the morning of June 7, 2009, when the pilot departed on an emergency medical services (EMS) flight to pick up a patient at Port Hope Simpson Airport for delivery to St. Anthony. The airport did not have an approved weather-reporting system, but a local contact had told the pilot that fog was "down over the trees," the TSB report said.

"It is common on the east coast of Labrador to have localized fog patches that clear up quickly after the sun heats the surface," the report said.

The pilot had told the St. Anthony hospital dispatcher that he would turn back to Forteau if he could not maintain visual flight rules conditions. The Islander did not have an autopilot; thus, single-pilot operation in IFR conditions was prohibited. Moreover, the only instrument approaches available at the destination were global positioning system (GPS) approaches; although the aircraft had GPS equipment, the company was not authorized to conduct GPS approaches.

Nearing the destination, the pilot radioed an airport attendant who estimated that visibility was between 1/4 and 1/2 mi (400 and 800 m), and the ceiling was at about 200 ft. Shortly thereafter, witnesses heard the sounds of a sudden increase in power and an impact. The wreckage was found on a hill about 4 nm (7 km) from the airport.

The investigation concluded that the Islander had "departed from controlled flight, likely in an aerodynamic stall." The report noted that the fog cleared about 30 minutes after the crash.

Takeoff on Fumes

Aero Commander 500S. Substantial damage. One fatality, one serious injury.

Shortly after taking off from Runway 07R at Daytona Beach (Florida, U.S.) International Airport the morning of May 25, 2009, the pilot reported "an engine failure" and that he was returning to land on Runway 25R. The pilot was seriously injured and his passenger was killed when the airplane struck terrain short of the runway.

The pilot told investigators that he had conducted a "full" preflight and that the fuel quantity indicator showed 110 gal (416 L). However, maintenance records showed that the gauge had been replaced about a month earlier in an unsuccessful attempt to solve a fuel quantity indication problem known to the pilot. The maintenance technician had determined that the fuel system would have to be drained to enable further troubleshooting of the problem, and the pilot had decided to continue flying the airplane to reduce the fuel load before this was done.

The pilot said that both engines began "surging from full throttle to idle" on takeoff from Daytona Beach, and, after turning back to the airport, he "dropped the gear and gave it full flaps when I felt I had the runway made." He said that he had "no recollection of the airplane stalling or the impact."

The report said that only trace amounts of fuel were found in the two tanks, and 1.0 qt (0.9 L) of fuel was drained from the sump.

The Aero Commander was built in 1973 and was modified in 1978 with twin-turbocharged, eight-cylinder Lycoming IO-720 engines replacing the original six-cylinder IO-540s. Each of the 720s consumed about 40 gal (151 L) per hour at rated power. The airplane's fuel capacity was 226 gal (855 L).

HELICOPTERS

Fan Fracture Affects Control

Bell 47G-2A-1. Substantial damage. One minor injury.

The helicopter had climbed about 200 ft on departure from Rolleston, Queensland, Australia, the morning of May 3, 2009, when the pilot heard a very loud bang and felt a jolt. "The helicopter immediately started descending, and the pilot noted that the forward/aft cyclic control was unresponsive," said the ATSB report.

The pilot was able to use lateral cyclic control to turn away from trees as the 47 continued to descend with violent pitch changes. Nearing the ground, he raised the collective control to cushion the touchdown. However, the helicopter landed hard, causing the tail rotor to sever the tail boom. The pilot sustained a minor back injury.

Examination of the helicopter showed that three of the 16 engine cooling fan blades had fractured due to fatigue cracking and had struck the fan cowling. The cowling then separated and jammed the flight control linkages.

Investigators found that the cooling fan had not been reassembled correctly after maintenance. An imbalance resulting from the incorrect installation likely affected the fan's vibration and resonance characteristics, and increased its susceptibility to fatigue failure, the report said.

Manual Dropped on Jettison Lever

Eurocopter AS 365-N3. Minor damage. No injuries.

The EMS helicopter was en route to the site of an automobile accident near Huber Heights, Ohio, U.S., at about 0300 local time on July 4, 2010, when the pilot accidentally dropped a flight manual onto the right-front passenger door jettison handle.

The NTSB report said that maintenance personnel had neglected to reinstall a plastic guard over the handle after a required inspection of the door. The dropped manual caused the handle to rotate, break its safety wiring and disengage the door's upper hinge pin. The door's middle and lower hinge pins did not disengage.

The passenger door remained in place, but its window bent outward, separated from its frame and struck the horizontal stabilizer.

When the pilot heard the loud bang, he was told by the flight nurse that the window had blown out. The pilot diverted to Moraine, Ohio, and landed the helicopter without further incident.

Preliminary Reports, March 2011

Date	Location	Aircraft Type	Loss Type	Injuries
March 1	Hanoi, Vietnam	Airbus A320	major	NA
The right horizontal stabilizer and elevator struck a light pole as the A320 was being towed in darkness from a stand to a hangar.				
March 2	Forli, Italy	Cessna Citation S/II	major	3 minor/none
Visibility was reduced by snow and darkness when directional control was lost at about 100 kt during the takeoff roll. The emergency medical services (EMS) airplane veered off the left side of the runway, and the landing gear collapsed.				
March 2	Oslo, Norway	Fairchild Metro	major	11 minor/none
The Metro veered off the right side of the runway while landing in freezing fog at Oslo Gardermoen Airport. The nose landing gear collapsed.				
March 2	Birmingham, Alabama, U.S.	Bell 206	major	1 minor/none
During a functional check flight following replacement of the engine governor, the pilot performed an autorotative landing in an empty parking lot after hearing a loud bang and feeling the helicopter lurch.				
March 4	Nuuk, Greenland	Bombardier Dash 8	total	34 minor/none
Surface winds were from 160 degrees at 28 kt, gusting to 40 kt, when the Dash 8 veered off the right side of Runway 23 while landing at Godthåb Airport.				
March 4	Houston, Texas, U.S.	Learjet 25	minor	6 minor/none
Visibility was less than 1 mi (1,600 m) in fog when the EMS airplane touched down long and fast, overran the 7,600-ft (2,316-m) runway and struck the localizer antenna.				
March 5	Belgorod, Russia	Antonov An-148	total	6 fatal
The regional jet crashed during a functional check flight for customer familiarization. The right horizontal stabilizer was found 3 km (2 mi) from the main wreckage.				
March 8	Pellatt Lake, Northwest Territories, Canada	Eurocopter AS 350	total	3 minor/none
The survey helicopter was destroyed by fire after it struck a snow-covered lake in white-out conditions.				
March 10	Bakersfield, California, U.S.	Cessna 208 Caravan	major	1 minor/none
Day visual meteorological conditions (VMC) prevailed when the Caravan struck three parked vehicles while being taxied to the cargo ramp.				
March 12	Mulia, West Papua, Indonesia	Cessna 208 Caravan	major	10 minor/none
The Caravan veered off the right side of the runway and struck a ditch after the right main landing gear tire apparently deflated on landing.				
March 13	El Segundo, California, U.S.	Sikorsky S-58	total	1 serious
The helicopter was lifting an air-conditioning unit from the roof of an office building when it lost power and descended into trees.				
March 16	Long Beach, California, U.S.	Beech King Air 200	total	5 fatal, 1 serious
A witness said that the King Air climbed 200 ft after takeoff, "wobbled from side to side," rolled left and descended to the ground.				
March 18	Rurrenabaque, Bolivia	Xian MA-60	major	33 minor/none
The flight crew was unable to extend the nose landing gear on approach and landed the twin-turboprop with the nose gear retracted. The main landing gear collapsed during the ground roll.				
March 19	Toledo, Spain	Bell 407	total	6 fatal, 1 serious
Day VMC prevailed when the helicopter crashed en route to fight a fire.				
March 21	Pointe-Noire, Congo	Antonov An-12	total	4 fatal
The cargo airplane rolled inverted on approach and crashed in a residential area in day VMC. About 19 people on the ground are believed to have been killed, and 14 injured.				
March 24	San Clemente, Chile	Bell UH-1	total	1 fatal, 1 serious
Tail rotor failure is suspected in the crash of the helicopter during a fire fighting operation.				
March 29	Xinjiang, China	Cessna Citation II	total	3 fatal
The Citation is missing and believed to have crashed during a local flight.				
March 30	Pertisau, Austria	Eurocopter EC 135	total	4 fatal
A witness saw the border patrol helicopter flying low over the Archensee before it struck the surface of the lake.				

NA = not available

This information is subject to change as the investigations of the accidents and incidents are completed.

Source: Ascend