# AeroSafety WORLD

IASS 2014
November 11–13, 2014 — Preliminary Agenda p. 32

**ALTITUDE DEVIATIONS**
SMS Analyzes Noncompliance

**AFRICA ADVANCES**
But Some Initiatives Lag

**COGNITIVE LOSS**
Risks Identified


# UNSTABLE
## MISMANAGED DESCENT CITED


THE JOURNAL OF FLIGHT SAFETY FOUNDATION

OCTOBER 2014

# COOPERATION And Data

It is widely recognized among safety experts that the collection, analysis and sharing of data is key to improving the industry's already stellar safety record. Despite this recognition, however, numerous obstacles and issues exist that prevent industry stakeholders from realizing the full potential of what the International Civil Aviation Organization (ICAO) refers to as Safety Data Collection and Processing Systems (SDCPS).

I am delighted to announce that the Flight Safety Foundation, through a cooperative agreement with the U.S. Federal Aviation Administration (FAA), will lead an international initiative to identify and address current issues surrounding the collection, analysis, protection and use of information derived from data collected through SDCPSs. This initiative, which builds on an important base of existing work many years in the making, initially will focus on the Latin America and Asia Pacific regions.

The first step of this project is to identify and catalog existing efforts to collaboratively gather data across the industry in the selected regions. We'll be working closely with stakeholders in those regions to develop this understanding and then move forward to other steps with their input and help.

As the Foundation envisioned for many years, the next frontier of risk mitigation has arrived in aviation safety — the gathering and analysis of data from normal operations, which enable safety experts to identify and mitigate precursors before they result in serious incidents or tragic accidents.

Developing a robust system of data collection and analysis requires trusted partners to protect the safety information. It has taken the United States many years to develop systems that are trusted and effective. The FAA and the industry worked together, for example, to develop the Aviation Safety Information Analysis and Sharing (ASIAS) program, and it has proved that data can be de-identified and shared to advance aviation safety. This is a model that can work in other regions of the world.

The Foundation is the perfect vehicle to lead this effort. We have existing relationships with the Commercial Aviation Safety Team, the FAA, ICAO, the International Air Transport Association and The MITRE Corporation — all major players in data gathering and analysis. Our only interest is aviation safety.

I'm excited for this project and what it means for aviation safety worldwide. This cooperative agreement will help us start this effort. Stay tuned for more information on this project as it takes shape.

*Jon L. Beatty*
*President and CEO*
*Flight Safety Foundation*

AeroSafety WORLD

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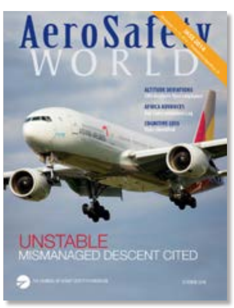


**About the Cover**
This Boeing 777-200 was operated as Asiana Airlines Flight 214 on July 6, 2013.

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# AeroSafety WORLD

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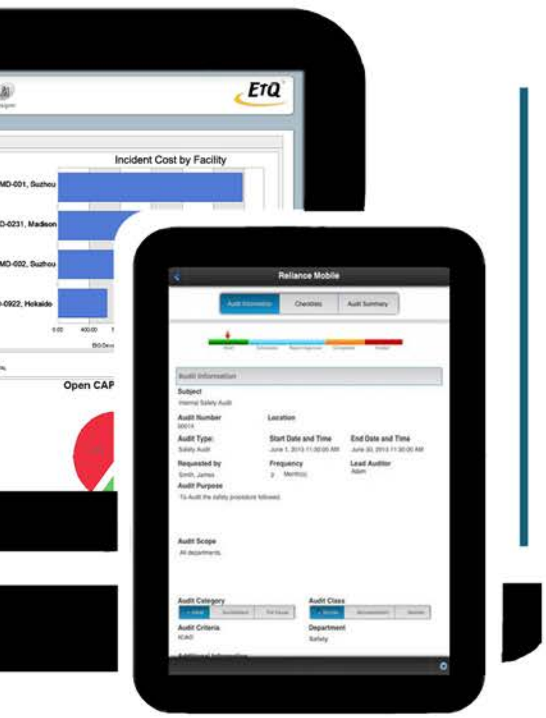


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# Leadership

I am often asked, particularly by friends and acquaintances outside of aviation, about the industry's stellar safety record. Most people want to know if the industry is as safe as is commonly believed. When I say "yes," they then want to know how it got to be so safe. As many of you probably do, I have a canned response that mentions learning from past accidents, technological advancements and the dedication of career aviation people, among other points. If my wife happens to be within earshot, I usually don't get to too many of the other points because she will swoop in and change the subject, fearing that I'm about to bore some poor, unsuspecting civilian into a coma.

The truly curious, however, eventually will circle back to ask another, more difficult-to-answer question: How is the commercial aviation industry going to maintain its safety record? Of course, the industry spends a lot of time contemplating this same question. Data sharing, analysis and protection is at or near the top of the list of acceptable answers, as are improving technology, training and the widespread implementation of internationally agreed standards and practices.

"Leadership" also is an acceptable answer, but I find it often is difficult to define and explain the concept. Sometimes it is easier to use an example, which brings me to the International Civil Aviation Organization's Regional Aviation Safety Group–Pan America (RASG-PA). Susan Lausch, senior director of membership and business development, and I represented Flight Safety Foundation at the 7th RASG-PA Annual Meeting, which was held in conjunction with ALTA's (Latin American and Caribbean Air Transport Association's) 5th Pan American Aviation Safety Summit in Curaçao in early September.

During both events, and at the RASG-PA Executive Steering Committee meeting that began the week, I was impressed with not only the quality of the content but also the pragmatic and systematic approach to dealing with issues. Data, and not just any data, but scrubbed and vetted data, determine where RASG-PA focuses its attention and resources. Projects are not launched on the basis of opinions, and results are measured to determine success.

A number of successes were noted. For instance, since RASG-PA's inception in 2008, the risk of fatal accidents in Latin America has been reduced by nearly 24 percent. The goal is a 50 percent reduction by 2020. And areas in need of improvement — such as those in the implementation of safety management systems — were noted as well.

Perhaps most impressive is that RASG-PA is a legitimate government- and industry-led organization. Beyond the fact that there is an industry co-chair and a government co-chair, there is a sense of all the parties involved working together effectively to identify and mitigate risk.

*Frank Jackman*
*Editor-in-Chief*
AeroSafety World

# Serving Aviation Safety Interests for More Than 65 Years

Since 1947, Flight Safety Foundation has helped save lives around the world. The Foundation is an international non-profit organization whose sole purpose is to provide impartial, independent, expert safety guidance and resources for the aviation and aerospace industry. The Foundation is in a unique position to identify global safety issues, set priorities and serve as a catalyst to address the issues through data collection and information sharing, education, advocacy and communications. The Foundation's effectiveness in bridging cultural and political differences in the common cause of safety has earned worldwide respect. Today, membership includes more than 1,000 organizations and individuals in 150 countries.

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**OCT. 6–9 ➤ 2014 Public Safety and Security Fall Conference.** Airports Council International–North America. Arlington, Virginia, U.S. <aci-na.org>.

**OCT. 9–10 ➤ CANSO Africa Runway Safety Seminar.** Civil Air Navigation Services Organisation (CANSO) and National Airports Corp. Livingstone, Zambia. Anouk Achterhuis, <events@canso.org>, +31 (0) 23 568 5390.

**OCT. 13–17 ➤ ISASI 2014 Seminar.** International Society of Air Safety Investigators. Adelaide, Australia. <www.isasi.org>.

**OCT. 15–16 ➤ 2014 EASA Annual Safety Conference.** European Aviation Safety Agency (EASA). Rome. <asc@easa.europa.eu>.

**OCT. 20–24 ➤ OSHA (U.S. Occupational Safety and Health Administration)/Aviation Ground Safety.** Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. <embryriddle.edu>.

**OCT. 21–23 ➤ NBAA2014 Business Aviation Convention and Exhibition.** U.S. National Business Aviation Association. Orlando, Florida, U.S. <info@nbaa.org>.

**OCT. 21–23 ➤ SMS II.** MITRE Aviation Training Program. McLean, Virginia, U.S. <maimail@mitre.org>, <mitremai.org/sms_course>, +1 703.983.5617.

**OCT. 24 ➤ SMS Audit. MITRE Aviation Training Program.** McLean, Virginia, U.S. <maimail@mitre.org>, <mitremai.org/sms_course>, +1 703.983.5617.

**OCT. 26–30 ➤ CANSO Global ATM Safety Conference.** Civil Air Navigation Services Organisation (CANSO). Amman, Jordan. Anouk Achterhuis, <events@canso.org>, +31 (0) 23 568 5390.

**OCT. 28–29 ➤ European Airline Training Symposium (EATS 2014).** Halldale. Berlin. <halldale.com/eats>.

**OCT. 28–30 ➤ Accident Site Photography.** U.S. National Transportation Safety Board (NTSB). Ashburn, Virginia, U.S. <ntsb.gov/tc>, <studentservices@ntsb.gov>, +1 571.223.3900.

**OCT. 30–31 ➤ Safety in North America. Flightglobal Conferences.** Washington <events.registration@rbi.co.uk>.

**NOV. 2–3 ➤ Offshore/Onshore Aviation Conference and Exhibition.** Middle East and North Africa (MENA) Helicopter Safety Team. Abu Dhabi, United Arab Emirates. Alison Weller, <alison@accessgroup.aero>, +971 5 6116 2453.

**NOV. 3–5 ➤ 52nd annual SAFE Symposium.** SAFE Association, Orlando, Florida, U.S. <safe@peak.org>, <www.safeassociation.com/index.cfm/page/symposium–overview>, +1 541.895.3012.

**NOV. 8–9 ➤ Aviation Training Congress China 2014.** Pyxis Consult, China Decision Makers Consultancy. Zhuhai, China. Sharon Liu, <Sharon@pyxisconsult.com>, +86 21 5646 1705.

**NOV. 9–10 ➤ International Flight Operations Congress China 2014.** Pyxis Consult, China Decision Makers Consultancy. Zhuhai, China. Sharon Liu, <Sharon@pyxisconsult.com>, +86 21 5646 1705.

**NOV. 11–13 ➤ 67th annual International Air Safety Summit.** Flight Safety Foundation. Abu Dhabi, United Arab Emirates. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

**NOV. 17–21 ➤ Safety Management Systems for Remotely Piloted Aircraft.** University of Southern California, Viterbi School of Engineering. Los Angeles. <aviation@usc.edu>.

**NOV. 20–21 ➤ AVM Summit USA.** Aviation Maintenance Magazine. Orlando, Florida, U.S. Adrian Broadbent, <abroadbent@aerospace-media.com>, <avm-summit.com>.

**NOV. 24–27 ➤ ICAO Regional Aviation Safety Group Asia and Pacific Regions (RASG-APAC) Meeting.** International Civil Aviation Organization. Hong Kong. <icao.int>.

**DEC. 7–9 ➤ AAAE Runway Safety Summit.** American Association of Airport Executives (AAAE). Salt Lake City, Utah, U.S. <aaaemeetings.aaae.org>.

**DEC. 8–12 ➤ SMS Principles.** MITRE Aviation Training Program. McLean, Virginia, U.S. <maimail@mitre.org>, <mitremai.org/sms_course>, +1 703.983.5617.

**DEC. 9–11 ➤ Unmanned Aircraft Systems (UAS) Fundamentals Course.** Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. <daytonabeach.erau/uas>.

**DEC. 11–12 ➤ Safety in Air Traffic Control. Flightglobal Conferences.** London. <flightglobalevents.com/safetyATC2014>, <events.registration@rbi.co.uk>.

**DEC. 15–17 ➤ SMS Theory and Application.** MITRE Aviation Training Program. McLean, Virginia, U.S. <maimail@mitre.org>, <mitremai.org/sms_course>, +1 703.983.5617.

**JAN. 13–14 ➤ MRO Latin America. Aviation Week.** Buenos Aires, Argentina. <events.aviationweek.com>.

**FEB. 10–11 ➤ Approach and Landing Accident Reduction (ALAR) Info Exchange.** Flight Safety Foundation. Singapore. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

**FEB. 12–13 ➤ Maintenance and Engineering Safety Forum.** Flight Safety Foundation. Singapore. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

**FEB. 17–18 ➤ 1st International Human Factors Conference.** Lufthansa Flight Training. Frankfurt/Main, Germany. <human-factors-conference@lft.dlh.de>, <human-factors-conference.com>, +49 69 696 53061.

**MARCH 2–5 ➤ HAI Heli-Expo 2015.** Helicopter Association International. Orlando, Florida, U.S. <rotor.org>.

**MARCH 10–11 ➤ Air Charter Safety Symposium.** Air Charter Safety Foundation. Dulles, Virginia, U.S. <acsf.aero>.

**MARCH 10–12 ➤ World ATM Congress 2015.** Civil Air Navigation Services Organisation (CANSO). Madrid, Spain. Anouk Achterhuis, <events@canso.org>, +31 (0) 23 568 5390.

**APRIL 21–23 ➤ 2015 International Rotorcraft Safety Conference.** Rotorcraft Directorate, U.S. Federal Aviation Administration. Hurst, Texas, U.S. <faahelisafety.org>.

**MAY 13–14 ➤ Business Aviation Safety Summit 2015 (BASS 2015).** Flight Safety Foundation. Weston, Florida, U.S. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

**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 Frank Jackman at Flight Safety Foundation, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA, or <jackman@flightsafety.org>.

Be sure to include a phone number, website, and/or an email address for readers to contact you about the event.

## Solving Bad Setups

While reading [William G.] Bozin's April 2014 *AeroSafety World* editorial ("Stable Approach Criteria and Go-Arounds"), a question came to mind: Of all the very significant effort that has been put into examining unstable approaches, and developing stable-approach criteria, I can't recall seeing an analysis of what factors outside the cockpit may set up an unstable approach.

As a [U.S. Federal Aviation Regulations] Part 121 captain, I quite frequently shake my head in frustration when air traffic control (ATC) is the sole factor in finding myself in a bind when it comes to establishing a stable approach by my airline's criteria.

The number of ATC units in the United States and internationally that require the airplane to maintain altitudes and/or airspeeds that work against executing a well-planned, safe, stable approach is increasing.

I don't doubt the cause of much of this is political (noise complaints), but some is not. A great example is Indianapolis Approach Control. Some years ago, they put out a request for feedback on the quality of their work. I commented that their procedure of keeping airplanes at 7,000 to 10,000 ft above mean sea level (MSL; airport elevation is 797 ft MSL) until abeam the airport on downwind leg, when Runways 23L and23R are in use, was a constant factor in a rushed approach.

An ATC supervisor contacted me by phone and, to my wonder, expressed surprise at my comment. It was their opinion that pilots actually liked this "slam-dunk" kind of set up, and they couldn't recall ever hearing a negative comment.

I know I'm not the only pilot to complain about this particular procedure, but can understand that no one called in about it (including me). Pilots generally understand that noise abatement takes precedence over safety (that is, good setups) at many, many airports and that complaining will do you absolutely no good. So why bother?

Another great example is Honolulu International Airport's Runway 08L. After a recent discussion with them, it was very apparent that they mostly deal with smaller transport aircraft, and just apply the same flight-handling characteristics to larger aircraft. The result is a very bad setup for everyone (10,000 ft on downwind abeam the airport), with both close-in altitude restrictions and and speed restrictions. The smaller aircraft flight crews are capable of handling it. The larger aircraft flight crews either struggle and are not very stable, or go around and try again.

To end a long screed, has anyone taken on the task of trying to get ATC involved in solving bad setups, one of the biggest problems in establishing a stable approach? It would be nice to have them be a help instead of, in too many cases, being part of the problem.

I would be happy to work on a task like that.

Alan Gurevich


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

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

# Safety News

## Risks of Methane Venting


The U.S. National Transportation Safety Board (NTSB), citing two cases of engine power loss on turbine helicopters operating to and from oil platforms in the Gulf of Mexico, is calling for action to mitigate the risks of the nearby discharge of methane and other raw gases.

The NTSB said that, in both accidents, the loss of engine power probably resulted from "inadvertent ingestion of methane gas that was being vented in the vicinity."

The first accident, on March 24, 2011, involved a Bell 206-L3 that experienced a partial power loss after takeoff from an oil production platform. As the helicopter passed above an "exhaust pipe" on the platform, the pilot and passengers heard a loud bang, and the helicopter subsequently struck the water and rolled. The three people in the helicopter received minor injuries, and the helicopter was substantially damaged.

Investigators said there was no visual indication to inform pilots when the pipe was in use, and the accident pilot said that, although he had seen the pipe, he did not know what it vented and could not tell it was in use. The NTSB said the probable cause of the accident was the "loss of engine power due to an engine compressor stall as a result of ingesting methane gas during takeoff."

The second accident, on Aug. 13, 2013, involved a Bell 207 that lost all engine power after takeoff from a different oil production platform. The pilot heard a loud bang and the helicopter struck the water. The pilot and both passengers received minor injuries; the helicopter was substantially damaged.

The NTSB investigation was continuing, but preliminary information indicated that the platform had no system to indicate to pilots when venting was in progress.

As a result of its investigations, the NTSB recommended that the U.S. Interior Department and the U.S. Coast Guard develop systems and procedures to mitigate the risk that methane and other discharged raw gases will be ingested by helicopters operating near the platforms, and that the systems and procedures be implemented. A recommendation to the American Petroleum Institute calls for revision of institute guidelines for offshore platform design and construction to address the venting of raw gases.

## Performance-Based Environment

The European Aviation Safety Agency (EASA) is pressing for development of a European approach to a performance-based environment (PBE) to improve the management of aviation safety.

EASA defines PBE as "an environment based on safety performance indicators on which safety assurance and promotion, as well as performance-based regulation [PBR] and performance-based oversight, can be built."

A PBE that emphasizes risk management is needed because of the increasing complexity of the aviation system, EASA said in a report issued in late August. The document noted that a PBE provides the framework for establishing clear goals and establishes safety performance indicators (SPIs) to measure trends, obtain feedback and determine methods of meeting goals.

"SPIs can be qualitative, quantitative, absolute or relative, and they must be supported by the systematic collection and analysis of data," the report said. "In relation to safety, this data can be obtained from sources such as questionnaires/surveys, occurrence reports, technical reports (reliability, observation and data-capturing systems such as flight data monitoring), operational performance monitoring systems, oversight and inspection activities and, more generally, data on areas such as economics, social and organisational information."

The report said that, although prescriptive rules and associated oversight have succeeded in reducing the rate of passenger fatalities, PBR offers new advantages such as an improved focus on performance improvements and improved understanding of risk mitigation.

"A PBE improves the overall quality of rules and safety oversight," the report said. "Instead of establishing prescriptive regulations telling individuals and businesses what they can and cannot do, PBR sets goals for the desired outcomes (safety objectives) and measures performance against them."

## Searching for Flight 370

The search for the missing Malaysia Airlines Boeing 777-ER has shifted to what the Australian Transport Safety Bureau (ATSB) describes as a "long but narrow arc" in the southern Indian Ocean, where investigators are focusing on mapping the ocean floor.

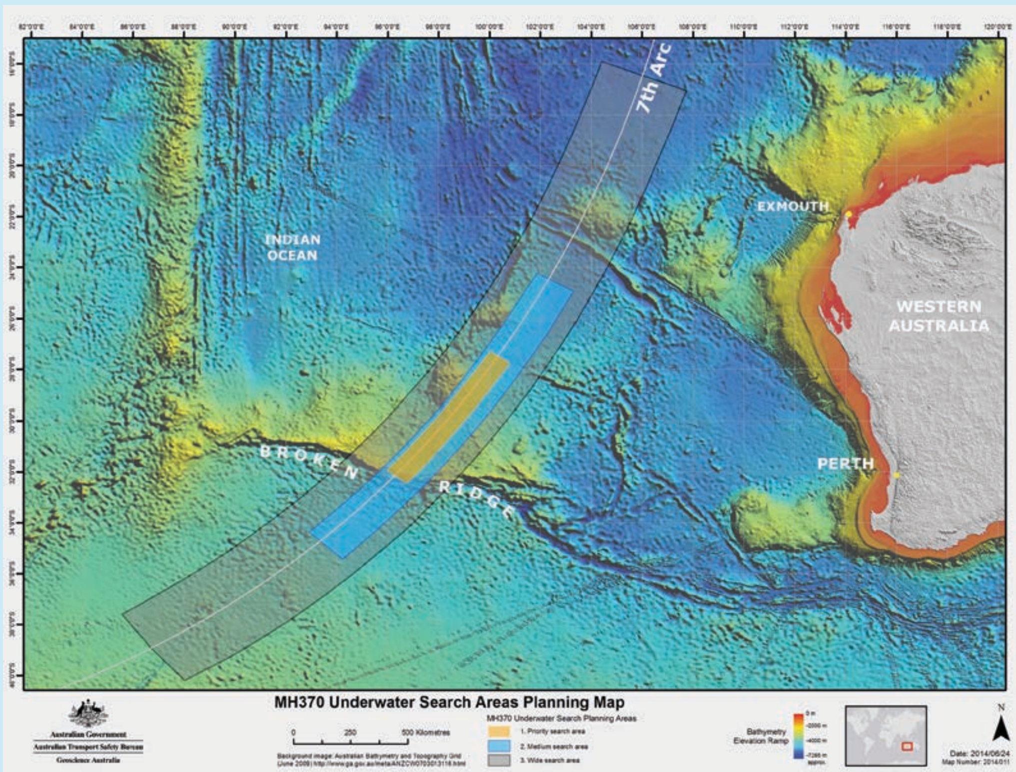
"The complexities of the search cannot be understated," said the ATSB, which is leading the search at the request of the Malaysian government. "Our work will continue to be thorough and methodical, so sometimes weekly progress may seem slow."

The agency said the first step in the current effort is a bathymetric survey, which involves measuring the ocean's depth in order to develop a map that can depict the "contours, depths and hardness of the ocean floor."

The mapping process includes the use of multibeam sonar, which calculates depth by measuring the time sound waves take to travel from the ship to the ocean floor. Unlike single-beam sonar, which maps one point beneath the ship, multibeam sonar uses multiple beams and measures a wider area. The speed at which sound travels depends in part on the salinity, temperature and depth of the water, the ATSB said, "and noting that these change throughout a water column, signals are corrected."

When the mapping is complete, map information will be used to aid a search of the ocean floor, to be conducted with scanning equipment or submersible vehicles, the ATSB said.

Flight 370, with 227 passengers and 12 crewmembers, disappeared on March 8 during a scheduled flight from Kuala Lumpur, Malaysia, to Beijing. The flight crew's last contact with air traffic control came less than an hour after takeoff. Accident investigators believe that the airplane flew for several more hours, eventually entering the water in the southern Indian Ocean.




## Conflict Zones

The International Civil Aviation Organization (ICAO) says a task force is investigating how the notices to airmen (NOTAM) system could be used to disseminate urgent information about flights above areas of armed conflict.

The Task Force on Risks to Civil Aviation Arising From Conflict Zones (TF RCZ) said after a late August meeting that it also would consider a new centralized system for sharing the information.

"These recommendations will help to ensure the safety of civilian passengers and crew, no matter what airline they are flying on or where they are flying," said TF RCZ Chairman David McMillan, who also is the chairman of Flight Safety Foundation's Board of Governors.

The task force was convened in the aftermath of the July 17 downing of a Malaysia Airlines Boeing 777 over eastern Ukraine. All 298 people in the airplane were killed, and the airplane was destroyed in the crash. Investigators say the 777 was struck by a missile as it flew over an area where pro-Russian separatists had been fighting Ukrainian government forces.

The task force's preliminary findings will be delivered in October to the 203rd session of the ICAO Council, and the task force has scheduled further discussions in December.

## Unstable-Approach Mitigation Plan

The Transportation Safety Board of Canada (TSB) says it will take time to assess the effectiveness of Transport Canada's (TC's) response to a TSB safety recommendation intended to reduce the number of unstable approaches that are continued to a landing.

The TSB issued its recommendation as a result of its investigation of the Aug. 20, 2011, controlled-flight-into-terrain crash of a Boeing 737 in Resolute Bay, Nunavut. Eight passengers and all four crewmembers were killed in the crash, and three passengers were seriously injured; the airplane was destroyed.

"In this accident, the aircraft arrived high and fast on final approach, was not configured for landing on a timely basis, had not intercepted the localizer and was diverging to the right," the TSB said. "This approach was not considered stabilized … and the situation required a go-around. Instead, the approach was continued."

The flight crew began a go-around only after it was too late to avoid the crash, the TSB said.

In its safety recommendation, the TSB said that TC should require the operators of large commercial aircraft (those operated under Canadian Aviation Regulations Subpart 705) to "monitor and reduce the incidence of unstable approaches that continue to a landing."

TC's response took the form of a civil aviation safety alert calling on Subpart 705 operators to use their safety management systems (SMS) to identify situations in which unstable approaches occur and to develop plans for mitigation. The plan calls for a follow-up program beginning in June 2015 to determine what actions have been taken.

"Although TC's safety alert is a positive step, it will be some time before the effectiveness of this voluntary approach can be validated," said TSB Chair Kathy Fox. The TSB added that Subpart 705 operators have had SMS for several years, but the systems have not effectively addressed the problem of unstable approaches.

Transportation Safety Board of Canada

## Proposed Penalties

British Airways faces a possible $195,000 civil penalty proposed by the U.S. Federal Aviation Administration (FAA) for an alleged violation of hazardous materials regulations.

The FAA says that in August 2012, the airline gave American Airlines "a cardboard box containing a chemical oxygen generator for shipment aboard a passenger aircraft" from London to Dallas. "Oxygen generators are extremely flammable and are forbidden as cargo aboard passenger aircraft," the FAA said, adding that the generator — a part of the passenger oxygen system — was being sent to Texas for repairs.

British Airways did not declare the hazardous material and did not provide required packaging, labeling or emergency response information, the FAA said.

The FAA proposed smaller civil penalties against three other firms — FedEx, Linvin and Allied Technology Group — that it also accused of violating hazardous materials regulations. All four companies have either requested or scheduled meetings with the FAA to discuss the matter.

## In Other News …

The U.S. Federal Aviation Administration (FAA) is seeking **public comments** on draft Advisory Circular (AC) 120-66C, *Aviation Safety Action Program (ASAP)*, which clarifies FAA policies on ASAP, designed for voluntary reporting of safety concerns by air carrier and repair station employees. Comments will be accepted through Nov. 4. More information is available at <www.faa.gov/aircraft/draft_docs/afs_ac>. … The U.K. Civil Aviation Authority (CAA) says that it may ask pilots who infringe on controlled or restricted airspace to take an online test to evaluate their airmanship. Under the policy, which took effect in September, the test is part of an effort to reduce **airspace infringement**, the CAA said.

**Macarthur Job** … Australian pilot, aviation safety consultant and author Macarthur Job, the first full-time editor of *Aviation Safety Digest*, the safety publication of the Australian Department of Civil Aviation's Air Safety Investigation Branch, died Aug. 6 at age 88. Job "established a lasting legacy in promoting aviation safety in Australia," the Australian Transport Safety Bureau said.

*Compiled and edited by Linda Werfelman.*



# MANAGING Risks in the WFP

Basic aviation risk management can be performed even in the most challenging conditions, as shown by United Nations World Food Programme (WFP) aviation operations in the Democratic Republic of the Congo (DRC), Flight Safety Foundation Board of Governors member Cameron Ross reported back to the Foundation after reviewing the operations.

Ross, who was named in August as the Foundation's representative to the WFP Aviation Safety Board, is also the manager of aviation safety for BHP Billiton.

He said that his three-week review, which ended in June, examined risk-based aviation safety assurance programs used by the WFP; he also conducted aviation risk-management workshops for WFP aviation personnel.

The WFP's programs are "very robust and focused on a series of risk evaluations by the WFP aviation safety unit of the aircraft operator and aircraft," Ross said.

The risk evaluations also include regulatory oversight by the state, the aircraft operator's safety management system, aircraft operational service inspections and aviation field operations risk evaluations, he said.

He added that he witnessed some of the daily challenges faced by WFP flight crews in the form of poor regulatory oversight, significant infrastructure challenges, lack of radar surveillance of air traffic and weather conditions that include poor visibility during the dry season and "significant weather systems" during the rainy season.

"The WFP Aviation Services require weather radar, traffic [alert and] collision avoidance systems, terrain [awareness and] warning systems and dual GPS [global positioning system receivers] for their contracted aircraft, and in environments like the DRC, it is easy to understand why," Ross said.

Ross's observation flights were conducted by flight crews with extensive operating experience in the DRC, he said, adding, "The importance placed by the WFP on crews having operating environment experience, alongside total operating experience and experience on aircraft type, meant that numerous daily threats to the operation were well understood, recognized in advance and ultimately managed to ensure that the risk remained acceptable."

As an example, he cited the crews' frequent briefings on coping with runway incursions by local residents and livestock.

The Foundation's Business Advisory Committee (BAC) is involved in another ongoing initiative to aid WFP aviation operations — an effort directed by the University of Southern California (USC) Aviation Safety and Security Program and the program's director, Thomas Anthony, to develop an automated security checklist and risk assessment tool. Anthony is a BAC member.

Most existing aviation security programs are intended for use by large international air carriers operating from large international airports, said Anthony and BAC Chairman Peter Stein, director of flight operations for Johnson Controls.

A "significant need … exists for a security tool that is effective and useful in the WFP operating environment," they said, adding that WFP operations frequently take place "in areas that present security challenges far greater than routine scheduled operations."

Over the past two years, Stein, Anthony and USC instructor Sue Warner Bean have conducted training sessions in Nepal, emphasizing subjects that included threat and error management; emergency response planning and family assistance; and pilot professionalism, decision making, risk-management strategies and safety culture.

**Inadequate monitoring of the flight instruments and misuse of the 777's autoflight system led to a collision with a seawall at San Francisco.**

# Mismanaged Descent

BY MARK LACAGNINA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The indicated airspeed was on target, and the approach path lights showed that the airplane was just slightly high as it descended below 500 ft, the point at which the stability of a visual approach typically is judged. These indications were deceptive, however, and the flight crew did not recognize that the airspeed was decreasing rapidly and that the airplane would soon descend below the 3-degree glidepath.

There were other signs that the approach was not stabilized: The thrust levers were at idle (the engines were not spooled up properly), and the descent rate was higher than it should have been.

By the time the crew realized that a missed approach was in order, it was too late. "The airplane did not have the performance capability to accomplish a go-around," the U.S. National Transportation Safety Board (NTSB) said in its report on the subsequent accident.

The Asiana Airlines Boeing 777-200ER clipped a seawall bordering Runway 28L at San Francisco International Airport, slid down the runway as it shed parts and became airborne again momentarily before coming to a stop in flames off the side of the runway.

Three of the 291 passengers were killed, and 40 passengers, eight of the 12 flight attendants and one of the four flight crewmembers were seriously injured in the accident, which occurred the morning of July 6, 2013.

The NTSB concluded that the probable cause of the accident was "the flight crew's mismanagement of the airplane's descent during the visual approach, the PF's [pilot flying's] unintended deactivation of automatic airspeed control, the flight crew's inadequate monitoring of airspeed, and the flight crew's delayed execution of a go-around after they became aware that the airplane was below acceptable glidepath and airspeed tolerances."

The report said that factors contributing to the accident were: "(1) the complexities of the autothrottle and autopilot/flight director systems that were inadequately described in Boeing documentation and Asiana's pilot training, which increased the likelihood of mode error; (2) the flight crew's nonstandard communication and coordination regarding the use of the autothrottle and autopilot/flight director systems; (3) the PF's inadequate training on the planning and execution of visual approaches; (4) the PM [pilot monitoring]/instructor pilot's inadequate supervision of the PF; and (5) flight crew fatigue, which likely degraded their performance."

## New Roles

The 777 was being operated as Asiana Airlines Flight 214, a scheduled passenger flight from Seoul, South Korea, with an estimated time en route to San Francisco of 10 hours and 24 minutes.

An instructor pilot and a trainee captain comprised the primary flight crew, backed up by a relief captain and first officer. The instructor pilot was the pilot-in-command (PIC) of the flight. He occupied the right seat and served as the PM during the takeoff from Seoul and the approach to San Francisco; the trainee captain was in the left seat and was the PF. Both pilots were relatively inexperienced in their flight roles.

The trainee captain, 45, had 9,684 flight hours, including 3,729 hours as PIC. He had no previous flight experience when he was hired by Asiana as a cadet pilot in 1994. He served as a first officer in 737s and 747s before upgrading as a 737 captain in 2005. He transitioned as an Airbus A320 captain in 2007 and began transition training to become a 777 captain in March 2013. By the end of May, he had completed ground training, flight simulator training and line-oriented flight training in the 777.

"He began flying the 777 with an IP [instructor pilot] as part of his required initial OE [operating experience] on June 16, 2013," the report said. He had logged eight flight legs and 33.5 flight hours with IPs. "All of the approaches the PF had previously flown during OE were ILS [instrument landing system] approaches, and there was no requirement to perform visual approaches during OE," the report said.

Investigators received mixed feedback when they interviewed three IPs who had flown with the trainee captain. One said his overall performance was above average. Another said that "nothing stood out" about his performance. The third IP said that the trainee captain had not performed well. "He said the PF was not well organized or prepared, conducted inadequate briefings, poorly monitored the operation and deviated from multiple standard operating procedures," the report said.

The IP told investigators that he provided "extensive counseling" but "worried that the PF was not taking his feedback seriously." However, the IP said that he was not overly concerned because he knew that the trainee captain had to complete more OE flights. (Korean aviation regulations required 20 flight legs and 60 flight hours of OE.)

The IP who served as the PIC and PM on Flight 214 was 49 and had 12,307 flight hours, including 9,045 hours as PIC and 3,208 hours in 777s. He served as a Korean air force pilot before joining Asiana in 1996. He flew as a 767 first officer and captain before transitioning as a 777 captain in 2008.

"He underwent 777 IP training in May and June 2013 and became qualified as an IP on June 12, 2013," the report said. The captain who conducted the IP's final check flight said that he was "very calm, followed the procedures correctly, had professional knowledge of the flight and had good capability and skill as an instructor." Flight 214 was the PIC's first as an acting IP.

## Visual Approach

The relief pilots took over about four hours into the flight, allowing the primary crew to rest for about five hours. When the trainee captain and IP resumed their posts, the airplane was less than two hours from San Francisco.

Visual meteorological conditions prevailed at the destination, and visual approaches to Runway 28L and 28R were in progress. The automatic terminal information service noted that the glideslopes for the ILS approaches to these runways were out of service.

The relief captain already had programmed the ILS approach to Runway 28L in the flight management system. Expecting vectors for a visual approach to 28L, the trainee captain (the PF) planned to use the ILS localizer to maintain the lateral path to the runway and the automatic flight control system (the autopilot/flight director and autothrottle systems) to manage the vertical profile. The calculated reference landing speed ($V_{REF}$) was 132 kt.

The airplane was nearing the airport at 1112 San Francisco time when the relief first officer returned to the flight deck and occupied the center jump seat. He served as an observer during the approach and landing.

As expected, Northern California Approach Control provided the crew with radar vectors for a straight-in approach to Runway 28L. At 1121, the approach controller asked the crew if they had the airport in sight. The PM (the instructor pilot) replied that the runway was in sight, and the controller issued clearance for a visual approach.

At the time, the airplane was descending through 6,300 ft at 210 kt. The autothrottle system was in the "HOLD" mode, and the autopilot was in the "FLCH SPD" (flight level change speed) pitch mode and in the "HDG SEL" (heading select) roll mode.

With these modes selected, the autopilot would hold the heading that the crew selected on the mode control panel (MCP) and would command changes in elevator position, effectively adjusting the airplane's pitch attitude, to maintain the airspeed selected on the MCP (210 kt in this case). Vertical speed would be maintained with thrust; in this case, with the autothrottle system on "HOLD," the thrust levers would remain in their current positions until manually moved by one of the pilots.

The PF announced, "I am intercepting the localizer," and selected the "LOC" mode, which causes the autopilot to capture and track the localizer course. The selected altitude was changed to 3,100 ft, which corresponded with the minimum altitude for crossing a step-down fix just outside the final approach fix for the published localizer approach procedure.

## Drifting High

The 777 was descending through 5,300 ft at about 210 kt when it intercepted the localizer course 15 nm (28 km) from the runway threshold. The PM said, "Let's descend slowly to one thousand eight hundred feet," which was the published minimum altitude for crossing the final approach fix, 5.4 nm (10.0 km) from the threshold.

The PF replied, "Yes, sir, I will set to one thousand eight hundred," and set 1,800 ft in the altitude selector.

The approach controller then told the crew to reduce their airspeed to 180 kt and to maintain that speed until they were 5 nm (9 km) from the airport. The PM read back the instruction, and the PF changed the selected airspeed to 180 kt.

The reduction in the selected airspeed caused the autopilot to increase the airplane's pitch attitude to maintain that speed. As a result, the descent rate decreased to 300 fpm. "The PF did not appear to promptly recognize that the airplane was drifting above the desired glidepath," the report said, noting that the deviation would have been shown graphically on the pilots' navigation displays.

The airplane was descending through 4,300 ft about 12 nm (22 km) from the runway when the PF changed the autopilot pitch mode from "FLCH SPD" to "VS" (vertical speed), selected a vertical speed of 1,000 fpm and selected the autothrottle speed ("SPD") mode. "The airplane's vertical speed began to increase toward the target value," the report said. "However, a descent rate of 1,000 fpm was not high enough to maintain, let alone recapture, the desired glidepath, so the airplane continued to drift above it."

The airplane was descending through 3,400 ft about 9 nm (17 km) from the runway when the pilot called for the landing gear to be extended. The additional drag from the landing gear would have facilitated deceleration, the report said, but the crew did not use the speed brakes or select a higher flap setting (flaps 20 at this point), either of which would have helped in managing the descent.

## 'It's Too High?'

Apparently referring to the airplane's height (900 ft) above the desired glidepath, the PM said, "This seems a little high." After a few seconds, the PF replied, "Do you mean it's too high? … I will descend more," and changed the selected vertical speed from 1,000 fpm to 1,500 fpm.

"This exchange was followed by 21 seconds of no communication between the pilots as the airplane's descent rate increased and the airplane drew closer to the desired glidepath," the report said.

However, the PF changed the selected vertical speed back to 1,000 fpm when the airplane was about 6 nm (11 km) from the runway, descending through 2,600 ft at 178 kt — and still well above the desired glidepath.

"By examining the altitude and distance to the runway, both of which were displayed on the instrument panel, and applying the well-known rule of thumb that a 3-degree glidepath requires about 300 ft of altitude loss per nautical mile, the pilots could have quickly estimated that they were still several hundred feet high," the report said. "The flight crew needed to continue descending the airplane at more than 1,000 fpm to return to the desired glidepath.

"The crew's action indicated a lack of awareness of the airplane's position relative to the desired glidepath and of cues in the cockpit that could have alerted them to this. As a result of this lack of awareness and their early reversion to a descent rate of 1,000 fpm, the airplane remained high."

The airplane crossed the final approach fix at 2,250 ft — 450 ft high. The crew selected flaps 20, and the PF set 150 kt in the airspeed selector. He also entered 3,000 ft, the published missed approach altitude, in the altitude selector.

At the time, indicated airspeed was about 4 kt higher than the maximum speed for selection of flaps 30, which would have allowed a steeper descent while maintaining the selected airspeed. "Clearly, the airplane's excess altitude increased the difficulty of achieving a stabilized approach," the report said.

The report noted that when Boeing test pilots later attempted to conduct an approach from this point in a flight simulator, they had difficulty achieving a stabilized approach before reaching 500 ft above ground level (AGL). "In fact, they found it impossible to do so without exceeding maximum descent rates published in Asiana's FOM [flight operations manual]," the report said.

## Mode Confusion

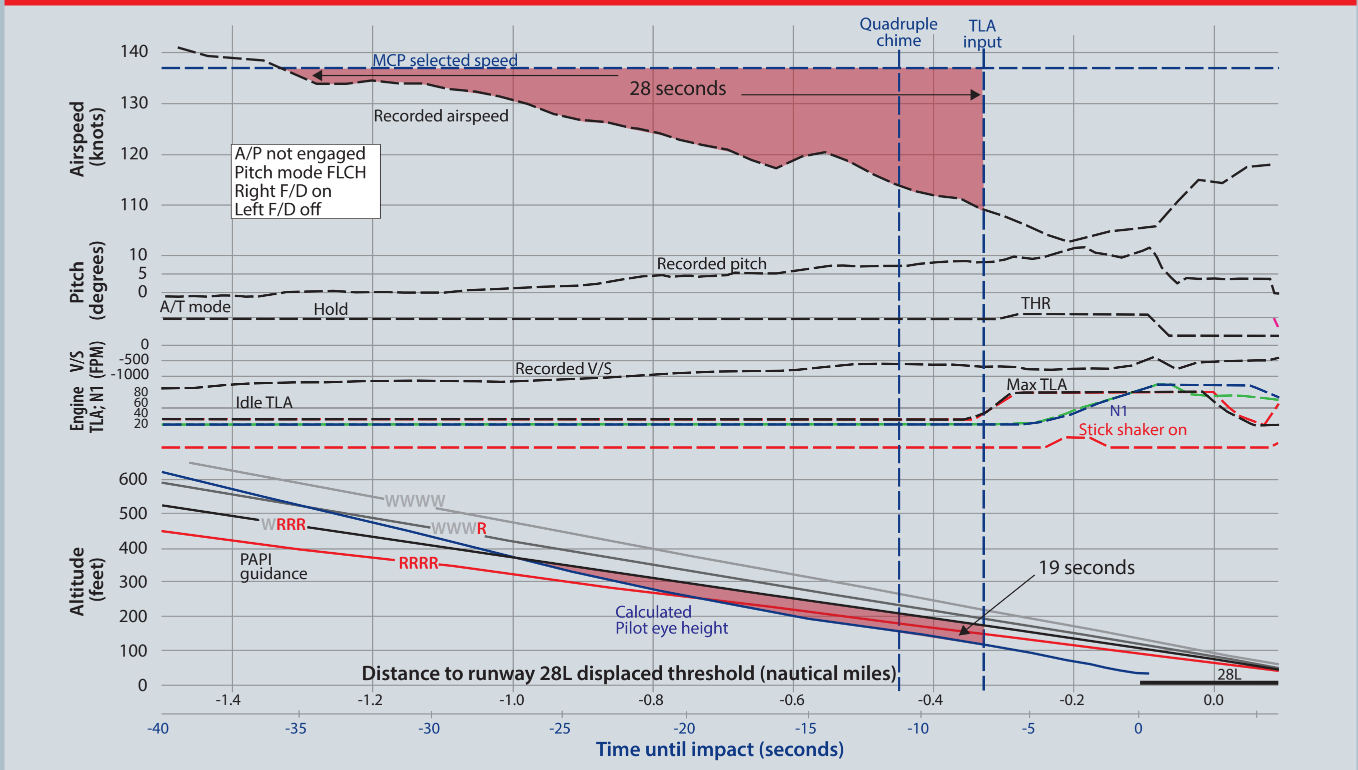
"The flight crew's difficulty in managing the airplane's vertical path continued as the approach progressed" beyond the final approach fix, the report said. Aware of the need to lose the excess altitude, the PF changed back from the "VS" mode to the "FLCH SPD" mode, believing that this would increase the descent rate.

Instead, however, selection of the flight change speed mode at this point caused the autopilot to command an increase in pitch to slow the airplane to the selected airspeed, 150 kt. Simultaneously, the autothrottle system responded, as designed, by entering the thrust mode and moving the thrust levers forward to attain the selected altitude, 3,000 ft.

The PF reacted to the unexpected pitch-up by disengaging the autopilot,

National Transportation Safety Board

**Profile View of the Last 40 Seconds of Asiana Airlines Flight 214**




A/P = autopilot; A/T = autothrottle; F/D = flight director; FLCH = flight level change; FPM = feet per minute; MCP = mode control panel; N1 = engine low pressure spool speed; PAPI = precision approach path indicator; THR = thrust; TLA = throttle lever angle; V/S = vertical speed

Source: National Transportation Safety Board

**Figure 1**

moving the thrust levers to idle and manually pitching the airplane nose-down. The manual change in thrust lever position caused the autothrottle system to enter the "HOLD" mode, which effectively disengaged the system. Neither the pilots nor the observer noticed this mode change. "This is not surprising in light of human factors research demonstrating that pilots frequently do not notice mode changes on the FMA [flight mode annunciator], especially those that are unexpected," the report said.

The report noted that the PF had not announced any of the mode changes he had made, which reduced the ability of the PM and the observer to cross-check and monitor his actions.

The airplane was descending through 1,300 ft at 165 kt and 1,000 fpm when the PM said "speed." The PF replied, "Target speed one three seven" ($V_{REF}$ plus 5 kt) and selected 137 kt on the MCP. The PM then said, "It's high," and the PF responded by manually increasing the descent rate.

"By this point, the flight crew should have been able to clearly see the precision approach path indicator (PAPI) lights," the report said. "The PAPI indication would have been four white lights, showing that the airplane was significantly above the PAPI glidepath angle of 2.98 degrees."

The observer called out "sink rate, sir" three times as the descent rate increased to 1,500 fpm and then to 1,800 fpm. He later told investigators that he made the callouts because Asiana required that the descent rate be no more than 1,000 fpm below 1,000 ft. "He further stated that the PF and PM were slow to respond to his sink rate callouts, but they did respond, and the sink rate decreased," the report said.

## Decision Time

Indicated airspeed was 137 kt when the airplane descended at 1,200 fpm through a radio altitude of 500 ft about 1.3 nm (2.4 km) from the runway. The thrust levers were still at idle, and the engines were at 24 percent N1 (low-pressure spool speed). The PAPI lights showed the airplane to be slightly above the 3-degree glidepath.

"Although, at 500 ft, the airplane met some of Asiana's stabilized approach criteria … (including being on target airspeed, in the landing configuration and on the correct flight path), it failed to satisfy other criteria," the report said. "It was descending at greater than 1,000 fpm, and the thrust setting was not appropriate (it should have been about 56 percent N1 speed).

"Because the approach was not stabilized at 500 ft AGL, the flight crew should have conducted a go-around. Either the pilots did not notice that these parameters exceeded stabilized approach criteria or they believed that the deviations were minor and could easily be corrected. In either case, the crew's decision to press ahead was not unusual, as industry statistics indicate about 97 percent of unstable approaches are continued to landing."

As the airplane descended below 500 ft, the PM said, "Landing checklist complete, cleared to land … on glidepath, sir." The PF replied "check."

## Red Lights

About five seconds later, all the PAPI lights turned red, indicating that the airplane was significantly below the glidepath. At this point, the 777 was 219 ft over San Francisco Bay and 0.7 nm (1.3 km) from the runway, descending at 900 fpm and about 130 kt.

"Both the airspeed indication, which was more than 5 knots below target approach speed, and a PAPI indication of four red lights required a go-around, but the flight crew continued the increasingly unstabilized approach," the report said.

The PM, referring either to the airspeed or the airplane's position below the glidepath, said, "It's low." The PF, still under the impression that the autothrottle system would adjust thrust to maintain the target airspeed, apparently took the PM's callout as referring to the glidepath; and he responded by pulling back the control column. The pitch attitude increased from 5 degrees to 7.5 degrees, and airspeed decreased further.

Aural and visual master warnings were generated when airspeed decreased to 120 kt. When airspeed dropped to 114 kt, the PM called out "speed" and moved the thrust levers forward. Airspeed continued to decrease, however, and the stick shaker (stall warning) activated at 103 kt.

"At this time, the airplane was about 0.35 nm [0.65 km] from the runway at 39 ft RA [radio altitude], the descent rate was about 700 fpm, the N1 speeds for both engines were increasing through about 50 percent, and the pitch attitude reached about 12 degrees nose-up," the report said. "The airspeed then began to increase."

The PM called out "go around," and the PF responded. At this point, however, the airplane lacked the performance capability to accomplish a go-around, the report said. The main landing gear and aft lower fuselage struck the seawall about three seconds later, at 1128 local time.

"Video from airport surveillance cameras showed that following the initial impact, the tail of the airplane separated, the airplane slid along the runway, and the rear of the fuselage lifted up, tilting the airplane into about a 30-degree nose-down angle," the report said. "The airplane pivoted counterclockwise about 330 degrees before impacting a second time and coming to rest off the left side of the runway, about 2,400 ft [732 m] from the initial seawall impact point."

The 777 was destroyed by the impact and subsequent fire. Two of the three passengers who died in the accident had been ejected from the airplane after it struck the seawall. In addition to the fatalities and serious injuries, 134 passengers, two flight attendants, the relief first officer and the PM sustained minor injuries; 114 passengers, two flight attendants and the relief captain were not hurt.

## 'Faulty Mental Models'

"In postaccident interviews, the PF made several statements that indicated he had an inaccurate understanding of some aspects of the airplane's autoflight system," the report said. For example, as demonstrated during the approach to San Francisco, he believed that the autothrottle system was "always working" and would maintain the selected airspeed even after a manual change of thrust lever setting with the autoflight system in the "FLCH SPD" mode.

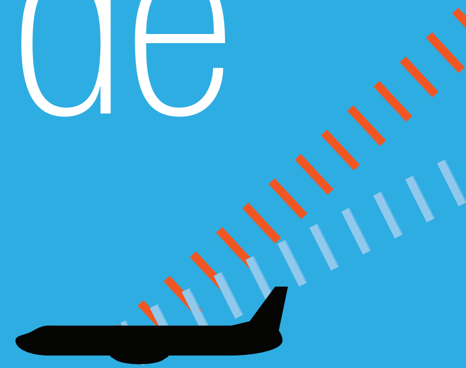
Interviews with other Asiana pilots and instructors revealed similar misunderstandings. Investigators also found deficiencies in Boeing's documentation of the autoflight system and in the airline's training on the system.

Moreover, the report cited human factors research showing that due to the complexity of autoflight systems and subsystems in airplanes such as the 777, "faulty mental models" of how they work are fairly common among pilots.

Improvement of 777 autoflight system training was among the specific recommendations included in the NTSB report (*ASW*, 9/14, p. 8). The safety board also called for an expert panel to be convened to evaluate methods of training pilots on automated systems and to identify the most effective training methods.

*This article is based on NTSB Accident Report AAR-14/01, "Descent Below Visual Glidepath and Impact With Seawall; Asiana Airlines Flight 214; Boeing 777-200ER, HL7742; San Francisco, California; July 6, 2013." The report is available at <ntsb.gov/investigations/reports.html>. The report provides an in-depth examination of cabin safety issues involved in the accident; those issues will be discussed in the November* AeroSafety World.

# Altitude



**FAA's air traffic SMS unravels factors in pilots' noncompliance with clearances and procedures.**

Results of data analysis, voluntary safety reporting and stakeholder collaboration prompted an official of the U.S. Federal Aviation Administration's (FAA's) Air Traffic Organization (ATO) to conclude in June that "the future is bright" for further reducing altitude deviations in the National Airspace System. Solutions will hinge on joint efforts by agency safety specialists and their counterparts in the aviation industry, a partnership enabled by the ATO safety management system (SMS) framework that protects information sharing and builds trust, he told the Airborne Conflict Safety Forum, held in Brussels, Belgium (*ASW*, 9/14, p. 38).[1]

Joseph Teixeira, the ATO's vice president of safety and technical training, said, "For the past decade, altitude deviations [have] been the single largest reported item by those voluntary safety programs that pilots [use to] report, so it is a big issue in the United States. We're no strangers to altitude deviations. … We have robust programs that incentivize pilots to report. … [Even] the contributing factors for these have contributing factors — dozens, maybe more than dozens. Trying to fix this problem requires a diverse approach. … As we measure these events, we see a huge decrease in their occurrence in the United States but 'huge decrease' … means we still have hundreds of them, so there's a lot of work left to do."[2]

The ATO leaders' thought process has been simple, however, he said. The first principle is to "fix what we can fix." The second is that the earliest, best and most effective solutions and behavioral changes emerge from empowering local professionals — in both government and industry — to solve problems as they arise. The third is to tap into as many data sources as possible, conduct an appropriate level of data analysis for each issue, and then count on the overall process to yield positive results.

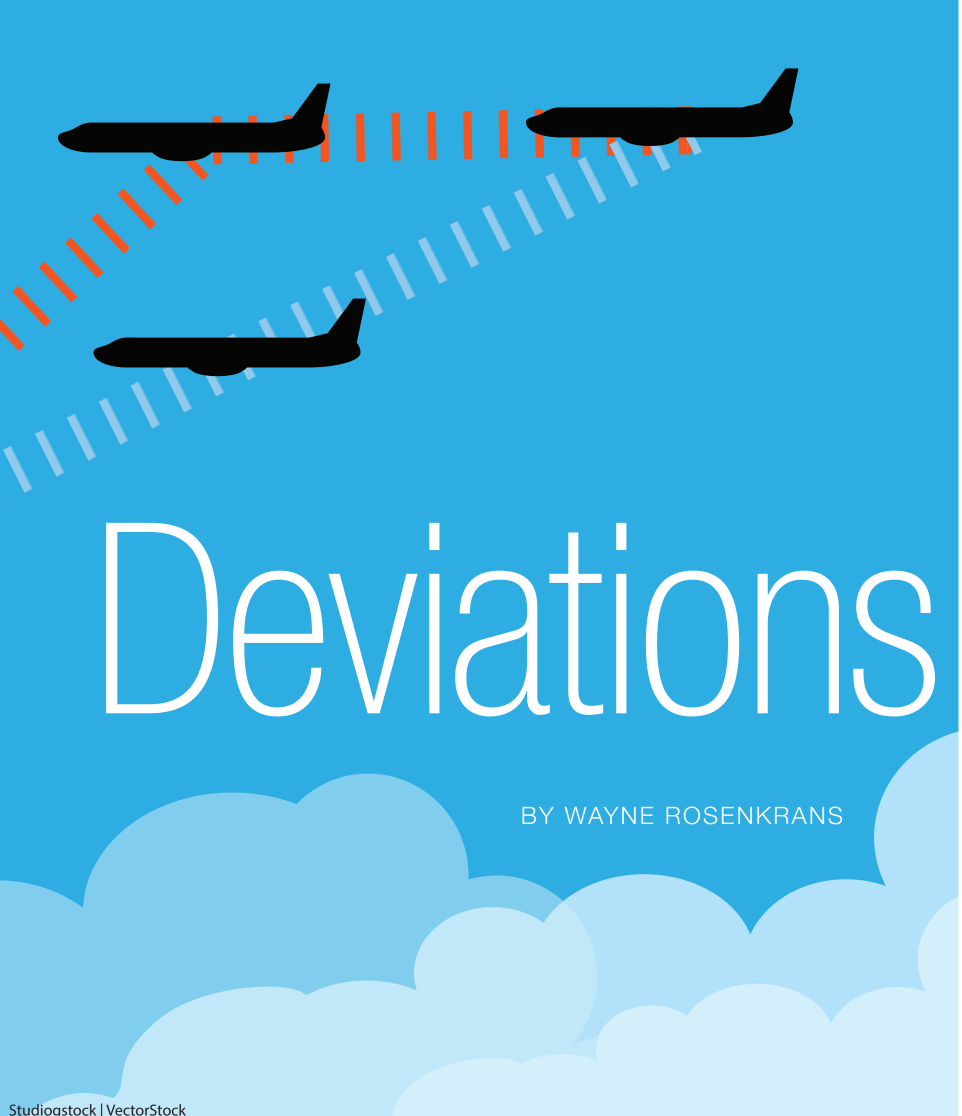
"We've aligned a lot of our programs around those three principles — from occurrence reporting to voluntary reporting, quality control, partnership at the local level. … We give particular emphasis to those programs that partner either with pilots or with controllers 'where they live.' … Changing what's happening in the operation is what's actually going to get you better metrics," Teixeira told the forum. "We will continue to focus on 'What can we fix today, tomorrow and the day after?' That's how we're managing this situation."

## Partnership for Safety

Under the ATO's three-year-old Partnership for Safety program, every air traffic control (ATC) terminal and en route facility maintains a local safety council, made up of front line personnel and management, to identify and solve local safety issues such as altitude deviations. About 19 airlines also now participate on the program's national risk panel. In 2012, the panel rated altitude deviations as a major contributor to high-risk events (Table 1, p. 22), he said. At the agencywide level, altitude deviations still are addressed in various ways as "Top 5 Interventions."

"The risk panel … came up [initially] with contributing factors that weren't all-inclusive

U.S. Federal Aviation Administration



# Deviations

BY WAYNE ROSENKRANS

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of … things we knew in the other programs," Teixeira said, noting the role of subsequent evolution of SMS processes and capabilities. "We've created voluntary reporting programs[3] that give partial immunity to controllers to report anything they want.

"Well over 80 percent of our controllers have, at one time or another, participated in this program in the past five years. … We get about 18,000 to 20,000 reports per year, and … we have [received] over 72,000 reports [and] catalogued well over 200 corrections of local procedures. It is a wealth of information — the kind of information that [we] need to target those things that really need to get fixed."

The airline pilot community benefits from a complementary form of online report exchanges — called the Confidential Information Share Program — also enabling participation in risk-reduction efforts related to altitude deviation. "[The ATO and pilots] exchange information — pretty much fully identified — so that we actually can do good analysis," he said.

## Pilot-Controller Conversations

One of the most productive tactics for resolving causes of altitude deviations has been providing opportunities for pilots and controllers to simply meet in the same room.

"Sharing information [from] the pilot's view of an event and the controller's view of an event … produces solutions that neither side had anticipated," he said. "Finally, [pilots feel they] have somebody that they can talk to and get resolution to the things they didn't know were occurring. And we have the same situation for controllers. [Controllers] finally get to understand why [pilots] did what they did," he said.

The complexity of required navigation performance–area navigation (RNP RNAV) procedures has been among the most significant factors contributing to altitude deviations in recent years, Teixeira said. The ATO services 20,000 procedures overall and, in each of the past few years, has introduced at least 500 new RNAV procedures.

"A lot of those procedures are extremely complex, designed for avionics, and many of the aircraft cannot, on their own, follow those waypoints for a variety of reasons," he said. "Older aircraft have extremely limited capability, and count on the pilot to actually manage that procedure along with the avionics. [Another] problem is there hasn't been a complete resolution of what's on the chart [versus] controllers' training and controllers' procedures. So, for example, a controller may be expecting someone at 10,000 ft, but the chart will say 'cross between 8,000 and 10,000,' giving the pilot that discretion."

Some flight crews involved in altitude deviations have reported that route names had confused them. Others reported that they did not realize that their aircraft actually was not performing at the level of precision required by the performance-based navigation procedure.

"We really need them at 10,000 ft — not 9,000 or 9,800 ft — creating huge difficulties," Teixeira said. "We also know that, on many

**Top Five Interventions for Fixing Hazards, 2012**

| Issue | Contributing Factors | Mitigations |
|---|---|---|
| Turns to final | | |
| Parallel runway operations | | |
| Go-arounds | | |
| **Clearance compliance altitude** | • Incorrect readback<br>• Wrong aircraft readback<br>• Controller missed readback<br>• Frequency congestion<br>• Blocked readback<br>• Radio interference<br>• Landline interference<br>• Similar call signs<br>• Misstated altitude | • ATSAP safety briefings<br>• LOAs — pilot training<br>• Partnership with NATCA, ALPA and AOPA<br>• Mitigated similar call signs<br>• RNAV — procedures review<br>• PBN — procedures review |
| Coordination | | |

ALPA = Air Line Pilots Association, International; AOPA = Aircraft Owners and Pilots Association; ATSAP = air traffic safety action program; LOA = landing operations area; NATCA = National Air Traffic Controllers Association; PBN = performance-based navigation; RNAV = area navigation

Source: U.S. Federal Aviation Administration

Table 1

occasions, airlines had not updated their charts. So we have new procedures with old charts, and it creates this problem. Hundreds of events are associated with these chart issues."

Partnership for Safety participants also have addressed pilots' difficulty in recognizing critical information on instrument flight charts; problems embedded in letters of agreement involving ATC facilities, airlines and airports; correction of pilots' expectations of controllers and vice versa; enhanced education of pilots about airspace issues; and de-confliction of similar aircraft call signs.

"We have four-letter and four-number call signs, multiplying the [huge] problem," he said, noting that many airlines' marketing departments have been unwilling to change marketing schemes when flight number changes are proposed by safety departments. "We're working on it slowly [with input from Eurocontrol and others]."

The possibility of ATC systems to exploit enhanced Mode S data from aircraft transponders — as part of technological solutions to altitude deviations — has run into roadblocks in the United States and elsewhere. The key benefit discussed at the forum is enabling controllers to confirm in real time pilots' altitude-data inputs to the flight management system after accepting ATC clearances. "A solution like [enhanced Mode S] is a major endeavor, requiring rulemaking so that the airlines equip and for FAA to also equip, and the cost of doing that was prohibitive," Teixeira said.

## Chicago Departures

Not all of ATO's efforts to accommodate airline pilots' suggested solutions have proved to be as straightforward as expected, however. One effort was intended to reduce altitude deviations that followed the introduction of four new departure routes in the airspace around Chicago airports.

"They had speed control as part of the instructions to pilots," Teixeira said. "The proper [standard chart] placement of those [instructions] is in the upper right-hand corner of the chart. We had hundreds of altitude deviations and speed control violations out of these departures because pilots operating out of Chicago [assumed that they] knew the airspace. They do [these] several times a day, [and] they just didn't pay any attention to the chart."

In meetings with controllers, pilots got agreement that the best solution — while contrary to charting standards — would be to publish the overlooked instructions in the center of the chart to capture the typical pilot's attention.

"Once we developed that nonstandard charting solution, we eliminated this problem — and thus eliminated hundreds of altitude deviations," he said. "Eighteen months after we put this in place, we started seeing these altitude deviations again." The cause that emerged was that, unknown to the safety council, different FAA chart specialists had put the speed control instructions back in their standard position and had issued this "corrected" chart. In response, the safety council requested that the more effective, nonstandard version be restored.

### Notes

1. The forum's final report is available at no cost at Eurocontrol's SKYbrary website at <www.skybrary.aero/index.php/Portal:Airborne_Conflict>.

2. FAA. "Air Traffic Organization Safety Report 2013." April 30, 2014. <www.faa.gov/about/office_org/headquarters_offices/ato/service_units/safety/media/ato_2013_safety_report.pdf>

3. FAA controllers voluntarily submit safety reports through the agency's non-punitive Air Traffic Safety Action Program (*ASW*, 8/12, p. 40).

Outside the software engineering teams conducting research and development of ACAS X — i.e., *airborne collision avoidance system X* — aircraft operators, pilots and other stakeholders seem most interested in its safety enhancements and user interface, one team member says. Details will continue to be refined by an RTCA special committee, EUROCAE working group and others[1] until the final approval of a minimum operational performance standard, anticipated by the U.S. Federal Aviation Administration (FAA) in 2018.

Michael Castle, a systems engineer at Aurora Sciences and a contracted subject matter expert for the FAA, describes ACAS X essentially as the agency's "solution going forward for how we are going to conduct collision avoidance." His overview of the nine-year project was part of the Airborne Conflict Safety Forum held on June 10–11 in Brussels, Belgium (*ASW,* 9/14, p. 38). At that time, prototype testing had focused on the new system's capability to avoid issuing non-safety-critical (nuisance) alerts and to demonstrate a risk ratio[2] significantly better than that of the traffic-alert and collision avoidance system known as TCAS II (or ACAS II) Version 7.1.

"TCAS II has been a fantastic system in terms of providing a safety margin for the airspace," Castle said. "Since 1990, when it was mandated, there's been no commercial [air transport] midair collision, and it's been noted

BY WAYNE ROSENKRANS

# ACAS X

**The reinvention of ACAS II/TCAS II cloaks major advances in a familiar interface and enables rapid upgrades.**


© Bailey|AirTeamImages

by many people that TCAS has saved situations and encounters. … We're not here to bury TCAS, we're here to evolve it." In comparisons, computer simulations suggest a future probability of near midair collision (NMAC) avoidance 10 to 20 times better than TCAS II if an ACAS X–equipped *ownship* experiences an encounter in which separation from the *intruder* has been lost, he said.[3]

## Circumventing Limitations

An extensively studied limitation of TCAS II is that more than 80 percent of its alerts are triggered by situations in which the ownship and the intruder actually are intentionally, safely separated. "We want to try to reduce those while also maintaining the safety factor. This is the central idea," Castle said. "TCAS II [is] a less flexible system than what we'd like. The [software logic] changes seemed like very simple procedure changes, but it took a lot longer to do them than what we would have liked. … Accounting for new surveillance systems, new users of airspace [i.e., unmanned aircraft systems, known internationally as *remotely piloted aircraft systems*] and new procedures [by further upgrading would have been] a challenge, and the challenges are rooted in the structure of TCAS II."

Technically speaking, TCAS II has relied on a *rule-based pseudocode* — a combination of deterministic rules and heuristics (essentially, a trial-and-error process that compares stored rules to predictable encounter geometries) — that specifies the threat logic. "Legacy TCAS first … projects the time of closest approach," Castle said. "[The logic] decides what sense it wants to provide the alert in. Is it a climb sense or a descend [sense]? Then it tries to choose the rate that is the least disruptive [climb/descend maneuver] that also meets the thresholds."

Overall, TCAS II functions by using highly complex logical interdependencies, and it requires uncommon expertise to modify safely. "A small set of people really understand the pseudocode … and those are the people that we have to rely upon to improve [it with] changes," he said. Collision-avoidance experts in recent years agreed to move beyond pseudocode to a more flexible decision-making structure. Many years of peer-reviewed academic papers vetted the basic concepts, followed in 2009 by the FAA's launch of formal research on ACAS X.

ACAS X (or more precisely, its *ACAS Xo* variant) has been designed to look like TCAS II in its interface and functionality so that pilots will get, for example, identical resolution advisories (RAs) on the same flight deck displays and apply the same general training to respond to them.

Expected benefits of the flexible structure include implementing reduced minimum aircraft separation, driving down the unnecessary alerts, adding new airspace-user classes as noted, and dynamically adapting future U.S. airspace to traffic.

## Different Logic

Advanced algorithms and analytical methods today enable robust systems to make critical decisions in uncertain, dynamic environments while maintaining safety and efficiency. Forum attendees learned from Castle how that theoretical underpinning has influenced ACAS X.

"We have an uncertain situation in the airspace," Castle said. "[We] never have perfect information. What is the best choice to be made? That's what ACAS X was founded on. So it uses decision-theoretic safety logic and a flexible surveillance tracker."

Three major challenges have to be addressed when designing threat logic into software that will choose among alternative ways that a collision-avoidance system should respond. "The first [challenge] is that you have imperfect sensor information, and so there's uncertainty associated with the position and the velocity of the aircraft," Castle said. "[Secondly,] you have dynamic uncertainty of 'How is the pilot going to respond?' and 'How will the encounter develop?' Then, the third challenge is that the system not only has to be safe, but it also has to be operationally suitable.

"We could design a perfectly safe system that just alerted [pilots] all the time — well in advance of the encounter — and, in theory, the aircraft would never come close to each other. … ACAS X tries to answer each of those by using a probabilistic sensor model, a probabilistic dynamic model and … a multi-objective utility tool … in a way that balances all these things."

## Intruder Threats

ACAS X software logic estimates the *state* of the ownship every second. "It's looking at … what the ownship 'thinks' the world looks like," he said. "So [it 'asks'] 'Where are all the intruders? Where are all the threats?' We reduce what the world looks like down to a set of state variables.

"In the current design, we have five state variables … to define what choices we're going to make in terms of [pilot] alerting. … A special data structure, that we call the *lookup table,* is pre-encoded and loaded into the avionics. And so when [the ownship has] a certain set of state variables, [ACAS X will] index into that lookup table and try to determine for each action that is possible, 'What is the cost?' So these lookup tables are sets of costs, and then [we] basically do a comparison. In [the third] step, [the software logic will] choose the action that has the lowest cost."

As one example, the cost of "not alerting" the pilot was 0.8 and the cost of the pilot "leveling off" was 0.1. Because leveling off entailed the lowest cost, ACAS X selected that action. "These costs are recomputed every second by looking up the values in the lookup table," Castle said.

## Simplifying Upgrades

Ease of upgrade was an important factor in the clean-slate design of ACAS X software logic, influenced by engineering teams' difficulty with TCAS II changes. "With legacy TCAS, we would have [had] to change either some of the assumptions about [how] the models interoperate in terms of ownship or intruder aircraft," he said. "We could change some of the thresholds that are embedded into TCAS II design or we could change the existing pseudocode. Each of these [choices] has different levels of complexity associated with it."

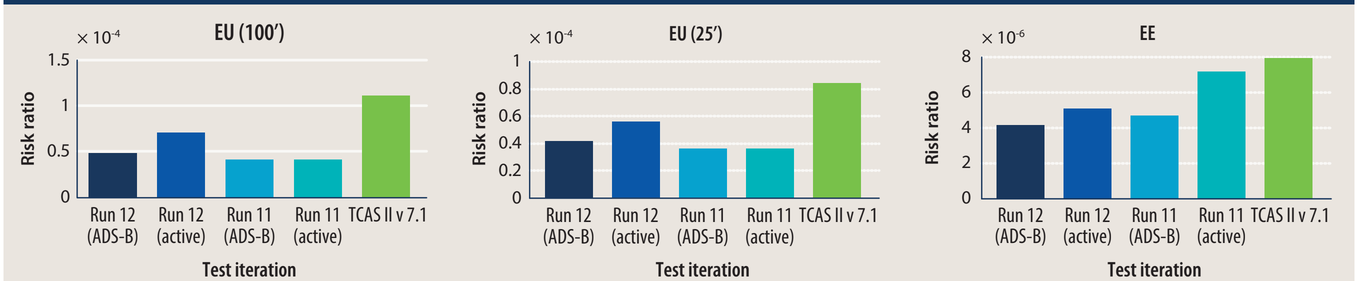
In contrast, changing the system behavior of ACAS X is analogous to turning three knobs to tune a radio, with many combinations possible. Castle said, "One [method changes] the belief states and the state transitions. … We would possibly modify [the dynamic model] to try to change the behavior. And we could [also adjust] the off-line costs … embedded in the cost table." The most costly off-line event — an NMAC — could be assigned a weight (value) of minus 1 in the cost table.

"Then we would have the relative weights of the other events determine the behavior of the system," he said. "[If] an alert is [weighted as] minus 0.01, it's 1/100th of the importance of the NMAC. We can play with these relative weights to try to tune the system to the behavior that we desire. … We give a small benefit, a small reward, for the 'clear of conflict' [alert, weighted as 0.0001]."

ACAS X also compares factors — such as the relative costs of strengthening an RA versus issuing a climb/descend reversal RA or changing vertical rate — to replicate the functionality of TCAS that is already familiar to today's pilots but with fewer non-safety-critical alerts as noted, he said.

Some costs cannot be computed in advance or loaded into a lookup table, however, Castle said, referring to dynamic changes of state as the aircraft flies. For example, the altitude at which the ownship actually is flying during a given second cannot be precomputed by the ACAS X to establish the *inhibit altitude*. "As the system

**ACAS X vs. TCAS II Test Results for Risk Ratio, June 2014**




EU (100′) = Equipped-Unequipped, a test scenario in which an ACAS X/TCAS II–equipped ownship encounters an ACAS X/TCAS II–unequipped intruder that carries an operating transponder encoding its altitude into 100-ft (30-m) quantization

EU (25′) = Equipped-Unequipped, a test scenario in which an ACAS X/TCAS II–equipped ownship encounters an ACAS X/TCAS II–unequipped intruder that carries an operating transponder encoding its altitude into 25-ft (8-m) quantization

EE = Equipped-Equipped, a test scenario in which an ACAS X/TCAS II–equipped ownship encounters an ACAS X/TCAS II–equipped intruder

NMAC = near midair collision

Run = ACAS X test run in computer simulation using the same ownship-intruder encounter dataset (scenario) as TCAS II

TCAS = traffic-alert and collision avoidance system test results

v = version of TCAS II software logic tested (latest)

**Notes**: The ACAS X software engineering team, by this development stage, had conducted 12 computer-simulation test cycles (iterations) of the design to adjust the costs (risks) assigned to the possible alerting actions stored in a data structure called the *lookup tables*, which are loaded into ACAS X avionics. Lower bars show better performance, so all ACAS X results were well below the corresponding probability of NMAC when using the latest TCAS II. (Risk ratio is the probability of an NMAC with a collision avoidance system divided by the probability without the system.)

Source: U.S. Federal Aviation Administration

**Figure 1**

flies, if it's below that inhibit altitude, it won't issue RAs," he said.

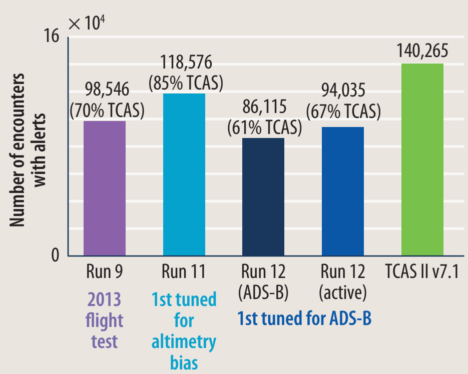
## Results-Based Optimism

Castle's first metric to demonstrate ACAS X versus TCAS II performance was the probability of an NMAC for a specific ownship-intruder encounter dataset. Simulator test scenarios include combinations of ownship equipped with TCAS II or ACAS X; and the intruder equipped with TCAS II, or ACAS X, or equipped with neither but carrying a transponder. "We have formal cycles; [as of June we're] on Run 12," he said. "The green bars on the right side of each graph [Figure 1, p. 24] represent TCAS II 7.1 performance." Four differently colored bars on the left side of each graph show the corresponding ACAS X performance.

In the encounter dataset discussed at the safety forum, Castle said, "In each of these cases, we're well below the probability of NMAC with TCAS [II alone]." With ACAS X combining different surveillance sources, however, "We're something on the order of 40 [percent] to 60 percent of the probability of NMAC of TCAS II 7.1," he said.

Another metric (Figure 2) enabled a comparison of the overall non-safety-critical alert proportion from legacy TCAS versus ACAS X. Castle said, "We reduced the [ACAS X RA rates to] between 30 and 40 percent [below] TCAS II 7.1 alert rates. [Run 12] was our first attempt to do the tuning with ADS-B [automatic dependent surveillance–broadcast] surveillance data. … We didn't have it in the earlier runs. But there's a trend here, which is [that] we're getting to the point where the results are quite promising."

**ACAS X vs. TCAS II Test Results for Non-Safety-Critical RAs, June 2014**




__% TCAS = fraction of TCAS II v7.1 test result (i.e., 70 percent is 30 percent better)

active = active surveillance of transponder data (i.e., not ADS-B)

ADS-B = surveillance using automatic dependent surveillance–broadcast data

RAs = resolution advisories (alerts)

Run = ACAS X test run in computer simulation (or flight test if indicated) using the same ownship-intruder encounter dataset (scenario) as TCAS II; runs include closely spaced parallel operations, military aircraft and formation flying

TCAS = traffic-alert and collision avoidance system test results

**Notes**: Lower bars show relatively better performance in rate of non-safety-critical (nuisance) RAs.

Source: U.S. Federal Aviation Administration

**Figure 2**

## Computer Advantages

A basic working principle within ACAS X engineering teams is to harness the power of computers to the extent that the computers produce optimum conflict resolutions, yet the engineers must oversee the processing and final results. "Computers are quite good at optimizing, given a set of assumptions and a set of parameters," Castle said. "The human effort [then] is really focused on the performance metrics and evaluating how the system looks. [Humans will ask,] 'What scenarios and encounters are important? Did the ACAS X system respond in the way that we expected and wanted?"

As for its surveillance-source flexibility, the *front-end surveillance and tracking module* of ACAS X converts sensor data from proprietary formats into a generalized format that has a standard interface to the *threat side* of the system architecture. "The threat side is where all the logic tables reside and where the choice of what TA [traffic advisory] or RA to issue is made," he said. The significance is that ADS-B data, for example, is acceptable today and sensors not even invented yet should be compatible.

### Notes

1. ACAS X is now being standardized through RTCA Special Committee 147, Traffic Alert and Collision Avoidance System, and the European Organisation for Civil Aviation Equipment (EUROCAE) Working Group-75, Traffic Collision Avoidance System.
2. Risk ratio is the probability of a near midair collision with a collision avoidance system divided by the probability without the system.
3. When describing in-flight collision scenarios and computing threshold times/distances at which pilots should be warned to respond to a collision threat, researchers and software engineers call the aircraft flown by the pilots who would receive the alert the *ownship* and the conflicting-traffic aircraft the *intruder.*

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Inset photos courtesy of (L to R): Michael McLaughlin, Greenville Downtown Airport, Yeager Airport and Key West Int'l Airport

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# High Terrain, LOW CLOUDS

BY LINDA WERFELMAN



**The pilot of an EC130 sightseeing flight and all four passengers were killed after the helicopter struck a Hawaiian mountainside.**

An air tour pilot's decision to fly into an area of rising Hawaiian terrain and low clouds led to the 2011 crash of a Eurocopter[1] EC130 B4, which killed the pilot and all four of his passengers, the U.S. National Transportation Safety Board (NTSB) says.

In its final report on the Nov. 10, 2011, accident, issued in late July, the NTSB said the probable cause was the pilot's "failure to maintain clearance from mountainous terrain while operating in marginal weather conditions." The horizontal stabilizer and the lower forward portion of the fenestron (the shrouded tail rotor) struck either the ground or vegetation as the helicopter flew along a ridge leading from the center of the Hawaiian island of Molokai to lower land near the shoreline, the report said. The impact separated the fenestron from the helicopter, and as a result, the pilot lost control of the helicopter, the report added.

The accident flight — the pilot's third flight of the day in the accident helicopter — began at 1144 local time, when it departed from Kahului Airport on the neighboring island of Maui. The flight was scheduled to last 70 minutes, traveling north-northwest over Maui and across the channel to Molokai to view two waterfalls. If weather conditions were acceptable, the helicopter was to proceed to the Wailau Valley and over the valley wall to the southern part of Molokai; the alternate route called for the pilot to reverse course to Molokai's northern shoreline and then continue around the eastern tip of the island to the south.

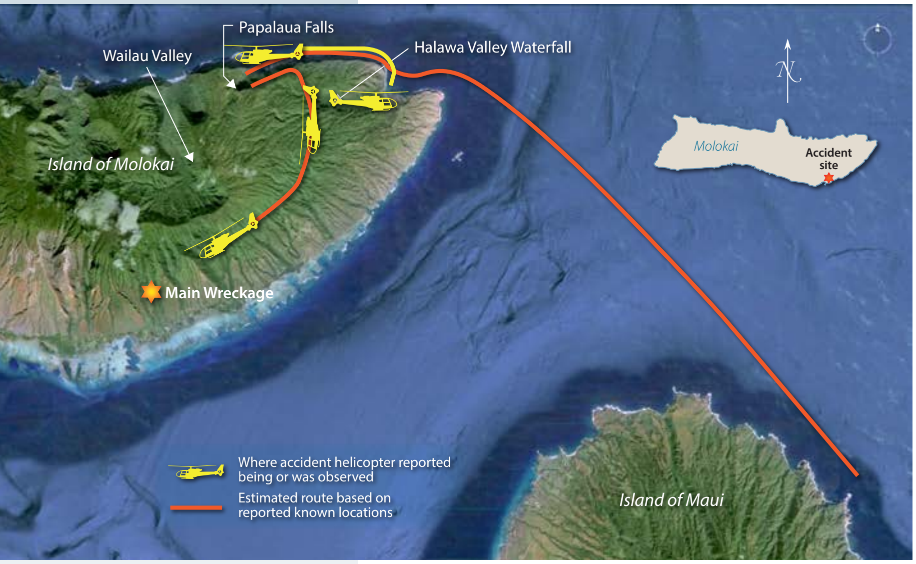
Visual meteorological conditions prevailed when the helicopter departed, but other air tour helicopter pilots operating around Molokai at the time of the accident said that weather conditions would have precluded flight through the Wailau Valley. They said that they had seen the accident helicopter and talked by radio with the pilot several times during the flight.

The last pilot to see the accident helicopter said that it was flying west in straight and level flight above the mountains and just below the cloud base — reported by the pilot at 2,000 ft mean sea level (MSL) — on the southern side of the island, and "did not appear to be in any form of distress," the report said.

"Ground witnesses reported that their attention was drawn to the helicopter when they heard some form of 'woop wooping' sound," the report added. "One witness observed the helicopter descending from the island's central ridgeline; he reported that he observed pieces falling from the helicopter as it descended. Another witness, who was closest and had the clearest view of the accident helicopter, reported that the helicopter went 'straight down' and impacted the ground sideways. Other witnesses reported that they observed a large 'fire ball' when the helicopter impacted the ground."

The witnesses on the ground said that weather conditions at 1214 local time, when the accident occurred, were poor, with rain in the area. Several said that the accident occurred between rain squalls, and one said that it had occurred during a heavy squall. One witness said the wind, which he estimated at 45 kt out of the northeast, was stronger than usual in that area and that it shook his house. Another said he could see that, in the mountains, "it was very dark and rainy, with limited visibility," the report said.

The 30-year-old accident pilot held a commercial pilot certificate with a rotorcraft helicopter rating, a helicopter instrument rating, a certified flight instructor




U.S. National Transportation Safety Board; background © Google

The planned 70-minute sightseeing flight departed from the neighboring island of Maui for a tour of some of Molokai's waterfalls and valleys.

certificate with a rotorcraft helicopter rating, and a private pilot certificate for single- and multi-engine land airplanes. His second-class medical certificate was issued in March 2011.

Before starting work in July 2011 with Blue Hawaiian Helicopters, he had flown Bell 407s and 206Bs for Bristow International Helicopters in the Gulf of Mexico. When he started the job at Blue Hawaiian, he had 4,500 flight hours, with no time in EC130 B4 helicopters. His initial company training included ground and flight training in the EC130 B4, and he accumulated 306 flight hours in type during his months with the company.

The day before the accident, he completed a U.S. Federal Aviation Regulations Part 135 check ride and was characterized by the Federal Aviation Administration (FAA) principal operations inspector as "capable and current in all of his required pilot tasks and training," including instrument navigation, inadvertent entry into instrument meteorological conditions and unusual attitude recovery.

The morning of the accident flight, the pilot arrived at his usual starting time of 0730, checked the weather and conducted two sightseeing flights without incident.

## Manufactured in 2010

The accident helicopter — an eight-seat, single-engine helicopter with a Turbomeca Arriel 2B1 turboshaft engine and a three-blade main rotor — was manufactured in France in 2010 and received an FAA airworthiness certificate the same year. On Nov. 8, when the most recent 100-hour inspection was completed, it had accumulated 2,431 hours. During that inspection, maintenance personnel performed Eurocopter Emergency Alert Service Bulletin 53A019, which called for a check of the tail boom/fenestron junction frame for cracks; no defects were found, the NTSB report said.

The helicopter was equipped with a Garmin G500H electronic flight display system that included a primary flight display, multi-function display, air data computer and altitude heading reference system, along with a synthetic vision technology system that offered the pilot a moving map with a "three-dimensional view of terrain and obstacles with visual and audio alerts for terrain or obstacles," the report said.

The helicopter was not required to have a cockpit voice recorder or flight data recorder, and it did not.

It was equipped with four color cameras — three mounted on the helicopter's exterior and one mounted internally — that were controlled by the pilot with a four-way switch on the cyclic. The cameras were used to record video for passengers as mementos of the flight; they also were reviewed by the operator "for the purpose of operational quality control," the report said. However, the camera system was not designed to withstand a crash, and the recordings of the accident flight were destroyed in the post-crash fire.

The operator is a Part 135 air carrier authorized by the FAA for on-demand air carrier operations. At the time of the accident, Blue Hawaiian operated Eurocopter AS350s and EC130 B4s, which were flown under day and night visual flight rules. Flights under instrument flight rules were not permitted.

## 'Fast-Moving' Squalls

The pilot of another air tour helicopter, which departed from Maui for a sightseeing flight around Molokai a few minutes before the accident helicopter, told investigators that cloud bases around Molokai were about 2,000 ft MSL and that visibility was "great" below the clouds and away from the heavy rain. He added that conditions deteriorated throughout the morning, however, with a strong wind from the northeast and "fast-moving" rain squalls. At one point, while flying near the accident area, "he had experienced many updrafts, downdrafts and microbursts, to the point that it scared him," the report said.

He was the last pilot to see the accident helicopter, which was heading west, just below the clouds, along the south side of Molokai's central mountain ridges.

The pilot of another air tour helicopter said that shortly after he heard about the accident, he observed that weather near the site was "really poor," with heavy rain. He landed his helicopter in a schoolyard and waited about five minutes until the weather improved, then flew to survey the accident scene.

That pilot told accident investigators that radar and pilot reports were the best sources of weather information for the area. Information in the NTSB's accident docket quoted him as saying that the island did not have enough weather stations and that weather conditions could "change dramatically from where the stations are to … the other side of the island." The morning of the accident, he said, conditions shifted about every 15 minutes, alternating between visual meteorological conditions and heavy rain with low visibility.

Area forecasts in effect for Molokai at the time of the accident called for surface winds from the east-northeast at 25-30 kt over mountain ridges and through valleys, scattered clouds at 2,500 ft and a broken ceiling at 4,500 ft; a forecast issued about 30 minutes before the accident said that in isolated conditions, ceilings would be broken at 1,500 ft, with visibility at or below 3 mi (5 km) in heavy rain showers and mist. An airman's meteorological information report (AIRMET) that was in effect at the time of the accident called for moderate turbulence below 10,000 ft above the mountains throughout Hawaii and in areas to the south through west.

## Wreckage Analysis

The NTSB report said that the helicopter struck terrain in the mountains about 5 mi (8 km) west of Pukoo, Hawaii, at about 530 ft MSL on a north-south ridgeline near an area of thorny trees and other vegetation. The report said the ridgeline was one of several that runs from the mountaintops near the center of Molokai to lower elevations near the shore.

The fenestron was found in several pieces, northwest of the main wreckage, and pieces of it, along with the tail boom and horizontal stabilizer, were sent to NTSB facilities for analysis. Results showed that, when the horizontal stabilizer and the lower forward portion of the fenestron struck terrain or vegetation, the resulting upward and aft loading at the horizontal stabilizer "sheared the right attachment fittings, which allowed the right side of the stabilizer to travel aft," the report said.

"The combined loading from the horizontal stabilizer and the fenestron's impact with vegetation and/or terrain caused the stress in the forward flange of the junction frame to exceed its ultimate design strength. The forward flange of the junction frame fractured, which allowed the fenestron to separate from the tail boom. The torque input from the tail rotor drive shaft caused the separated fenestron to rotate counterclockwise, which drove the lower portion of the fenestron into the main rotor disc, where it was impacted at least three times on the left side. After the fenestron separated from the tailboom, the helicopter lost yaw control and its center of gravity shifted forward, which caused it to become uncontrollable."

## Other Accidents

Eurocopter said that four other accidents also have involved separation of the fenestron from the tail boom at the junction frame. Of these, three accidents involved a failure "at the forward flange of the junction frame, similar to the accident junction frame failure," the report said. The fourth accident involved a failure at the junction frame's aft edge.

The report noted that the four accidents involved varying circumstances:

- In one accident, the helicopter's horizontal stabilizer struck electric power lines;
- Another accident was a crash landing, with the right horizontal stabilizer striking a vehicle before the helicopter hit the ground;
- The third accident involved controlled flight into terrain with significant damage to the right horizontal stabilizer; and,
- The fourth accident was a hard landing with "significant tail skid impact" and failure at the junction frame's aft edge.

*This article is based on NTSB accident report WPR12MA034 and associated docket material. The report is available at <www.ntsb.gov>.*

### Note

1. Eurocopter was rebranded as Airbus early in 2014.

# IASS 2014

## International Air Safety Summit

### November 11–13, 2014 • Abu Dhabi, United Arab Emirates


## Preliminary Agenda

(as of September 19, 2014)

### Monday, November 10, 2014

0900–noon **International Advisory Committee Meeting**

1400–1500 **Flight Safety Foundation Affiliates Meeting**

1500–1800 **Registration**

1600–1700 **Moderators' and Speakers' Meeting**

### Tuesday, November 11, 2014

0730–1700 **Registration**
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0730–0830 **Coffee with Exhibitors**

### Opening Ceremonies

0830–1000 Jon Beatty, President and CEO, Flight Safety Foundation

Kenneth J. Hylander, Incoming Chairman, Flight Safety Foundation Board of Governors

Danny Ho, Chairman, Flight Safety Foundation International Advisory Committee

**Keynote Address** — Richard Hill, COO, Etihad Airways

**Flight Safety Foundation/Eurocontrol SKYbrary Cooperative Agreement**

Joe Sultana, Director of the Network Manager Directorate, Eurocontrol

Jon Beatty, President and CEO, Flight Safety Foundation

1000–1030 **Refreshment Break with Exhibitors**

### Session 1 — Leadership in Safety

Session Chair: Jon Beatty, President and CEO, Flight Safety Foundation

1030–1100 **International Civil Aviation Organization Task Force on Risks to Civil Aviation Arising From Conflict Zones (TF RCZ)**

David McMillan, Chairman, Flight Safety Foundation Board of Governors, and Chairman, TF RCZ

1100–1130 **Global Aircraft Tracking**

Capt. Kevin Hiatt, Senior Vice President, Safety and Flight Operations, International Air Transport Association

1130–1200 **Gulf Flight Safety Council Report on Regional Safety Issues**

Capt. Mohammed A. Malatani, Chairman, Gulf Flight Safety Council

1200–1330 **Lunch**
Sponsored by The Boeing Co.

### Session 2 — Big Data: Locally, Regionally, Globally

Session Chair: Corky Townsend, Director of Aviation Safety, Boeing Commercial Airplanes

1330–1410 **Development and Implementation of Safety Performance Measurement and State Safety Program in UAE**

Capt. Nasir Iqbal, Senior Safety Risk Specialist, UAE General Civil Aviation Authority

1410–1450 **International Civil Aviation Organization Regional Aviation Safety Group — Pan America: Data Driven Regional Risk Management**

Gerardo M. Hueto, Chief Engineer, Aviation System Safety, Boeing

Loretta Martin, Regional Director, North American, Central American and Caribbean Office, International Civil Aviation Organization

1450–1520 **Refreshment Break with Exhibitors**

1520–1600 **International Civil Aviation Organization Regional Aviation Safety Groups**

Ismaeil Al Balooshi, Chairman, Regional Aviation Safety Group — Middle East

1600–1620 **Deployable Flight Data Recorders**

1620–1640 **Data Protection**

Kenneth Quinn, General Counsel and Secretary, Flight Safety Foundation

1700–1730 **Moderators' and Speakers' Meeting**

TBD **Gala Opening Reception Hosted by Etihad Airways**

## Wednesday, November 12, 2014

0730–1700 **Registration**

0730–0830 **Coffee with Exhibitors**

### Session 3 — Approach, Landing and Go-Around: A Flight Plan Ahead

Session Chair: Craig Hoskins, Vice President, Safety and Technical Affairs, Airbus

0830–0910 **Operational and Human Factors in the Asiana Airlines Flight 214 Accident Investigation**

Roger Cox, Senior Air Safety Investigator, U.S. National Transportation Safety Board's Operational Factors Division

William Bramble, Human Performance Investigator, U.S. National Transportation Safety Board's Office of Aviation Safety

0910–0950 **Increasing Trend of Landing Short/Premature Descent Incidents and Ways to Reduce the Risk**

Yasuo Ishihara, Technical Fellow, Honeywell

0950–1030 **Non-Compliant Approach**

André Vernay, Human Risks Programme Manager, Direction Générale de l'Aviation Civile, France

1030–1100 **Refreshment Break with Exhibitors**

1100–1140 **Coordinating Go-Around Procedures Between Flight Crew and ATC Organization**

Paul Miller, Director of Safety Policy, Safety Forecast

David Williams, Director of Training Policy, Safety Forecast

1140–1220 **Flight Safety Foundation Go-Around Decision Making and Execution Project Report**

Tzvetomir Blajev, Chairman, European Advisory Committee, Flight Safety Foundation; Eurocontrol

Capt. William Curtis, Vice Chairman, International Advisory Committee, Flight Safety Foundation; Presage Group

1220–1400 **Lunch**
Sponsored by Airbus

1400–1440 **The Go-Around Maneuver — How to Make it Safer**

David Carbaugh, Chief Pilot, Flight Operations Safety, Boeing Test and Evaluation

Capt. Bertrand de Courville, former Corporate Safety Manager, Air France

1440–1520 **A Day You Will Always Remember**

Harry Nelson, Executive Operational Advisor to Product Safety, Airbus

1520–1550 **Refreshment Break with Exhibitors**

1550–1700 **Panel Discussion: Approach, Go-Around, Landing**

1730–1800 **Moderators' and Speakers' Meeting**

1900–2200 **2nd Annual Flight Safety Foundation Benefit Dinner**

Saadiyat Beach Club, Abu Dhabi, UAE

## Thursday, November 13, 2014

0730–1600 **Registration**

0730–0830 **Coffee with Exhibitors**

### Session 4 — Enhancing Flight Crew Performance

Session Chair: Ratan Khatwa, Senior Chief Engineer, Human Factors, Honeywell Aerospace

0830–0910 **Surprise on the Flight Deck — A Full Motion Simulator Study**

Shawn Pruchnicki, Faculty Member, Research Coordinator and Ph.D. Candidate, The Ohio State University

David Woods, Professor, The Ohio State University

0910–0950 **Improving Crew Resource Management Through Sociometric Data**

Robert J. de Boer, Professor of Aviation Engineering, Aviation Academy, Amsterdam University of Applied Sciences

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**Thursday, November 13, 2014** Continued

0950–1030 **Loss of Control Due to Flight Crew Loss of Airplane State Awareness**

Dr. Michael P. Snow, Aviation Safety Group Human Performance Specialist, Boeing

James Wilborn, Aviation Safety Engineer, U.S. Federal Aviation Administration's Aircraft Certification Service

1030–1100 **Refreshment Break with Exhibitors**

1100–1140 **Monitoring of Automation (Pilot Monitoring)**

Helena Reidemar, Director of Human Factors, Air Safety Organization Human Factors and Training Group, Air Line Pilots Association, International

1140–1310 **Lunch**

Sponsored by Embraer

## Session 5 — Unique Operational Challenges

Session Chair: Frank Hilldrup, International Aviation Advisor, U.S. National Transportation Safety Board

1310–1350 **Basic Aviation Risk Standard (BARS) and BARS Operators**

Greg Marshall, Acting Vice President, Global Programs, Flight Safety Foundation

1350–1430 **Panel Discussion on Turboprop Operations**

1430–1500 **Refreshment Break with Exhibitors**

1500–1540 **Refining the Approach Toward Training and Licensing Airline Pilots**

Charles S. Hogeman, Air Safety Chair, Air Line Pilots Association, International

1540–1610 **CRM-Based Training and its Effect on Accident Rates in the U.S. from 1960–2013**

Lukas Rudari, Graduate Student, Purdue University

1610–1650 **An Innovative Approach to Assessing Accidents and Incidents**

Guillaume Adam, Air Safety Investigator, Bureau d'Enquetes et d'Analyses, France

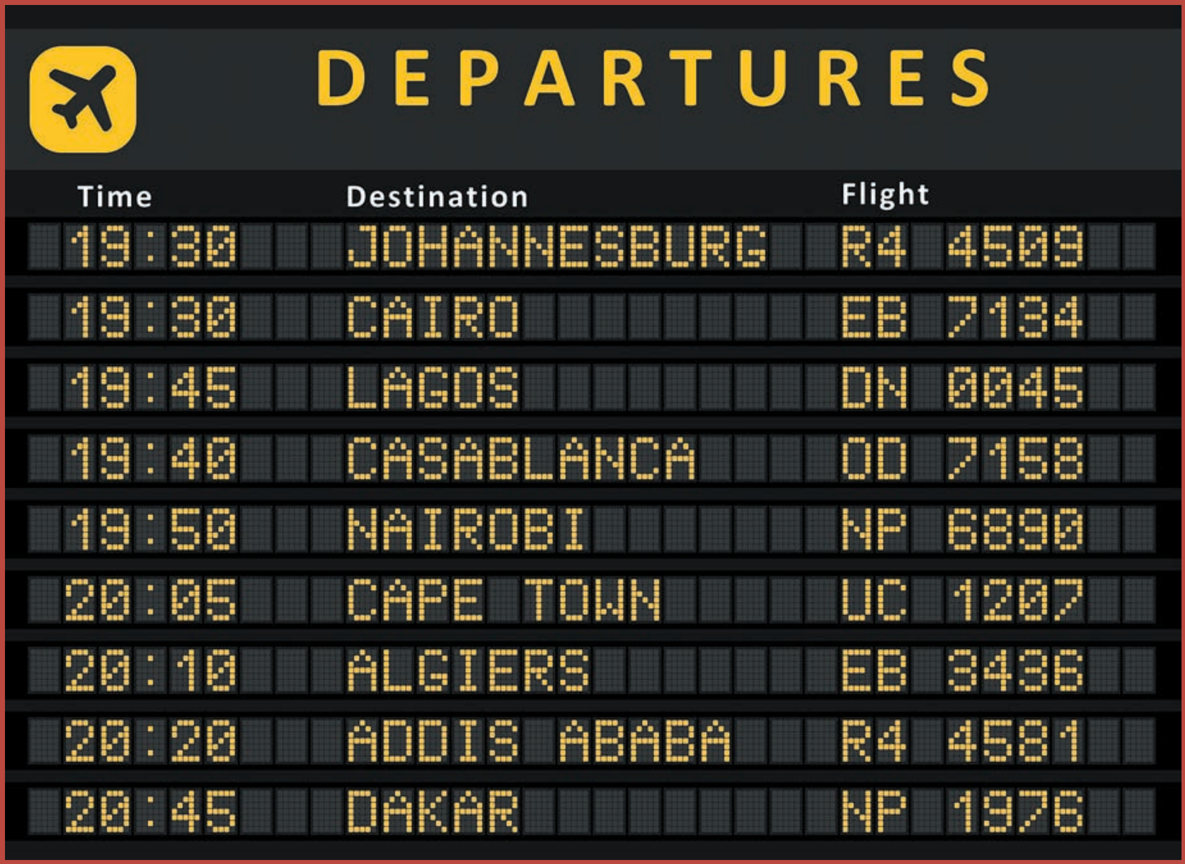
Johan Condette, Air Safety Investigator, Bureau d'Enquetes et d'Analyses, France

1650–1700 **Closing Remarks**

Jon Beatty, President and CEO, Flight Safety Foundation

BY WAYNE ROSENKRANS

**Assessments of air safety in sub-Saharan Africa cite achievements by states and operators but slow progress overall.**




# TAKING STOCK

Monitoring major accomplishments and unmet safety challenges within sub-Saharan Africa has become simpler today than in the recent past (*ASW,* 11/06, p. 18). Effective global exchanges of safety data, the transparency of initiatives involving the International Civil Aviation Organization (ICAO) and detailed reporting by regional aviation safety groups have made this possible, say a number of the organizations with expertise. They typically point to remarkable advances by some states, airlines and airports that demonstrate what is possible. Nevertheless, they still see too many of the broadest initiatives falling behind agreed-upon timetables.

One new monitoring aid is ICAO's Regional Performance Dashboards, interactive website information displays posted in May at <www.icao.int/safety/pages/regional-targets.aspx> that enable users to cross-reference relevant organizations, see map locations and the scope of safety initiatives, check the status of effective implementation of Universal Safety Oversight Audit Programme (USOAP) critical elements by state, and determine sources of funding and other assistance. Information regularly published by assisting

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Bujumbura International Airport, Bujumbura, Burundi



organizations (see "World Bank Project Examples") also offers insights.

## High-Level Critique

In May, leaders from states that cooperate through the ICAO Regional Aviation Safety Group–Africa–Indian Ocean (RASG-AFI) described their involvement in projects during the AFI Safety Symposium in Dakar, Senegal. In his message to the symposium, Raymond Benjamin, secretary general of ICAO, said, "There are certain positive safety performance results which ICAO has seen in Africa over the last several years, largely as a result of our intensified cooperation. For instance, between 2010 and 2013, the accident rate in Africa has fallen by 45 percent, from 16.8 accidents per million departures to 9.3. Notably, the number of fatal accidents over this same period dropped from three to one per year."

The wealth of readily available information has helped states take on challenges such as meeting the need to triple current capacity for training the aviation professionals who influence airline safety in Africa, which he called critical to overcoming shortages otherwise projected through 2030. "For Africa, [the] dashboards provide real-time monitoring on the achievements of the Abuja [Declaration safety] targets,[1] as well as key efficiency performance indicators," Benjamin said.

"ICAO has been very encouraged by the level of commitment shown up to this point by African states," he said. "However, continued political will is still required in order to succeed. Your commitment is primarily demonstrated through the establishment and strengthening of autonomous civil aviation authorities [CAAs] with independent regulatory oversight and sustainable sources of funding. … Establishment of … regional safety oversight organizations has posed challenges of sustainability and coordination that need to be addressed."

Tony Tyler, director general and CEO of the International Air Transport Association (IATA) — who had said in a 2012 speech in Africa that "everyone knows what needs to be done" — wrote in April 2014, "The Western-built jet hull loss rate improved 55.4 percent between 2012 and 2013, while the region's accident rate for all aircraft types improved nearly 50 percent (7.45 accidents per million flights, [down] from 14.80 in 2012). … There has been some significant [state safety oversight] progress. But, to be very frank, overall, there has not yet been sufficient urgency in dealing with this fundamental issue. Meeting the [2012] Abuja Declaration's 2015 commitment will require a major acceleration in the pace of implementation. … As of the end of 2013, only 11 [of 54] African states had achieved 60 percent implementation of ICAO's safety-related standards and recommended practices."

In Africa, as in several other parts of the world, ICAO collaborates with organizations such as RASGs and regional safety oversight organizations, says the *ICAO Safety Report, 2014 Edition,* which focused on scheduled commercial air transport.

"While the RASG-AFI in 2013 had the highest regional accident rate, it also accounted for the lowest percentage of global traffic volume [an estimated 0.7 million departures]," the ICAO report said, counting nine accidents in 2013 for a rate of 12.9 per million departures, which compared with a global rate of 2.8.

"In 2013, the 38th Session of the ICAO Assembly acknowledged that actions taken by ICAO under the [2008 Comprehensive Regional Implementation Plan for Aviation Safety in Africa] had begun to demonstrate positive progress in enhancing aviation safety in the continent," the report said, noting the plan's add-ons to Abuja targets as of 2013 for air navigation services, airports and ground aids, and the investigation of aircraft accidents and incidents.

"Twenty-eight ICAO plans of action have been developed for states with significant safety concerns and a low level of effective implementation of the critical elements of a safety oversight system with the objective of assisting those states in addressing their serious safety deficiencies in a prioritized manner," the report said. "Congo, Guinea, Guinea-Bissau, Mali, Mozambique, Rwanda, Seychelles, Sudan and Zambia have addressed their significant safety concerns; Mauritania and Sudan have met the target of 60 percent of effective implementation of the critical elements of a safety oversight system, and significant improvements were also noted by the [USOAP] in Benin and Madagascar."

## Front Line Voices

Several symposium presenters provided candid summaries of their work. External and internal resources provide windows of opportunity for states to fully implement ICAO's eight critical elements of aviation safety oversight, but the local challenges remain complex, said Kwame Mamphey, director general, Ghana CAA (*ASW,* 4/09, p. 42).

Ghana CAA had to weigh the pros and cons of adopting the different model regulations of the European Aviation Safety Agency (EASA), the U.S. Federal Aviation Administration or ICAO, or a mixture of them, or drafting entirely new regulations patterned after

## World Bank Project Examples

States in sub-Saharan Africa have the world's largest number of projects under way among The World Bank Group's programs that, in one small aspect, develop infrastructure and institutional capacity to manage risk in commercial air transport.[1] The bank group includes in the term *infrastructure* physical assets plus laws/regulations and state safety oversight. Ongoing commitments as of early 2014 included projects in Burkina Faso, Côte d'Ivoire (Ivory Coast), the Democratic Republic of Congo and Tanzania.

"The focus of these projects is primarily on safety, infrastructure rehabilitation, institutional strengthening and capacity building," said a 2013 activity report, referring to the broad-scale transportation objectives. Project completions were reported — using investments by the International Bank for Reconstruction and Development, International Finance Corp. (IFC), IFC Advisory Services and International Development Association — in Benin, Cameroon, Guinea, Kenya, Mali, Nigeria, Senegal and Sierra Leone.

Various phases of the West and Central Africa Air Transport Safety and Security Project, begun in fiscal years 2006–2009, aimed to improve by 2013–2014 the compliance level of civil aviation authorities (CAAs) with International Civil Aviation Organization (ICAO) safety oversight standards in Benin, Burkina Faso, Cameroon, Guinea, Mali, Nigeria and Senegal, the report said. "Overall positive developments" were cited along with "moderately unsatisfactory progress ratings for some of the states" under criteria weighted heavily toward ICAO audits of the states.

"The most notable achievement of the whole program was Nigeria's reception of a U.S. Federal Aviation Administration International Aviation Safety Assessments (IASA) Category 1 rating in August 2010. … As a result, Nigeria's registered carriers, such as Arik Air, can now offer direct flights to the [United States] for the first time in nearly 30 years," the report said.

Another example of a locally positive result was Burkina Faso's readiness to prepare in early 2014 for an IASA audit after significant improvements to Ouagadougou International Airport and its establishment of a new autonomous civil aviation authority, the Agence Nationale de l'Aviation Civile.

In Burkina Faso, Cameroon, Guinea and Mali, local advances included "robust training for the CAA and airport staff … and technical staff's skills in safety and security oversight have drastically improved," the report said. The bank group's aviation safety–focused grants to the Democratic Republic of Congo enabled the national airports authority, the Regie des Voies Aeriennes, to upgrade air-ground communication, to add air traffic surveillance equipment based on automatic dependent surveillance–broadcast technology and to equip Kinshasa/N'Djili International Airport with a new instrument approach system combining a category II instrument landing system (ILS), very high frequency omnidirectional range station and distance measuring equipment. "Project indicators show that a significant reduction in average annual number of air traffic system … incidents related to failed communications has been achieved," the report said.

The aviation component of a 10-year project in Sierra Leone concluded in 2013 with the final stages of rehabilitation of Freetown International Airport, including installation of navigation equipment in the control tower, enhancement of airport management capabilities and safety training of airport employees. "This included, among other things, the rehabilitation and strengthening of the runway, with upgrading of turning loops and taxiway entrances to safely accommodate modern aircraft. Through the project, the government has procured and installed power generators, an [ILS] and an air/ground communications system," the report said.

—WR

### Note

1. The World Bank Group. *Air Transport Annual Report 2013*. March 2014.

the models, he said. A related challenge was how to present draft regulations for a vote in parliament and later amend them, and to identify and file differences with ICAO standards and recommendations.

For one element — providing technical guidance material to the industry — the CAA had difficulty developing the material. Its aviation safety inspectors found editing tasks time consuming because they had no assistance, the option of obtaining guidance material from consultants proved to be very expensive, and either too few consultants were available or they failed to customize material to fit the requirements in Ghana, he said.

Gen. Yousif Ibrahim Ahmed, deputy director general, Sudan CAA, described how his country resolved a significant safety concern identified in December 2011 by an ICAO USOAP assessment team. At issue was air operator certification.

"By the time the preliminary report was received, the [CAA] had already reorganized its aviation safety system by establishing the Standards and Safety Management Office within the Office of the Director General to be responsible for all safety-related activities, to work to resolve the [significant safety concern] as a priority and also to ensure continuity and sustainability in safety oversight," Ahmed said.

By mid-January 2012, ICAO provided feedback to the CAA's detailed corrective action plan, and implementation began. Teams of CAA technical experts, industry experts within Sudan and four international consultants were trained to conduct recertification of air operators using ICAO recommended practices. Five holders of Sudanese air operator certificates (AOCs) then were asked to submit new documentation by the end of January 2012, and twice-weekly CAA meetings were held to oversee the recertification process.

"The plan was to complete the certification of the five air operators by 30 April or revoke their permit for international operation if not successful," Ahmed said. "However, at the end of the process, only four of the five air operators were recertified, and the AOC of the fifth air operator was suspended. … Today, two years down the line, some of the operators certified at the time are no [longer] operating, as they could not survive the stringent process of surveillance and [ensure] the resources required to maintain an acceptable level of operations and maintenance control. … Unlike the previous years when there were three to four accidents or serious incidents a year, Sudan has experienced no accident or serious incident over the last two years."

Gabriel Lesa, acting director, Department of Civil Aviation of Zambia, recounted how a significant safety concern was addressed after an ICAO USOAP inspection in early 2009. "The significant safety concern was based on Zambia's failure to comply with the [ICAO] requirements and processes for the five-phase air operator certification," he said. "Zambia's experience with the [significant safety concern resolution] has been immense. It was both a trigger to immediate action on issues of safety concern and has also been a serious learning curve and a turning point on how things are done henceforth."

Behind the scenes, however, the resolution was considered complex and expensive. The steps included obtaining ICAO's technical assistance on the corrective action plan, obtaining African Civil Aviation Commission assistance by establishing CAA membership in the Africa and Indian Ocean Cooperative Inspectorate System, hiring contract consultants from Denmark and Germany, and securing other technical support from ICAO's East and Southern African Office regional office safety teams. The significant safety concern was cleared during a December 2012 follow-up visit by the ICAO Coordinated Validation Mission.

## Regional Group Efforts

ICAO this year singled out two regional aviation safety groups as examples of collaborative recent projects to emulate. The Banjul Accord Group Aviation Safety Oversight Organization — teaming specialists from Cape Verde, The Gambia, Ghana, Guinea, Liberia, Nigeria and Sierra Leone — formed a cost-effective core group of aviation safety inspectors who can share their expertise among states, train national inspectors, harmonize regulations and procedures, and coordinate external technical assistance programs to resolve safety oversight deficiencies and address new issues.

Assistance from the U.S. Safe Skies for Africa program and EASA's Support to the Improvement of Aviation Safety in Africa program in 2013 provided training to 258 aviation professionals from these states in safety management systems (SMS), introduced the Inspector Training System for Air Navigation Services database, and assisted in risk management and how to oversee operations specifications under AOCs. The Banjul Accord Group organization also has been a central resource providing database tools for aviation safety inspector training and personnel qualification records, foreign aircraft safety assessment and work-tracking software.

The other regional aviation safety group cited — the Civil Aviation Safety and Security Oversight Agency, teaming specialists from Burundi, Kenya, Rwanda, Tanzania and Uganda — has focused on upgrading safety inspection processes and harmonizing civil aviation regulations and technical guidance on flight safety, SMS, aviation security, airports and air navigation services. ICAO noted this agency's implementation throughout the East African Community of EASA's Safety Oversight Facilitated Integration Application, a tool for operator/aircraft certification, licensing and inspection; exchange of technical experts; a common licensing examination system for aviation professionals; and the new Centre for Aviation Medicine, based temporarily in Entebbe, Uganda, with plans for a permanent facility in Nairobi, Kenya.


Julius Nyerere International Airport, Dar es Salaam, Tanzania



## IATA Perspectives

A report summarizing IATA's interpretation of key safety issues affecting sub-Saharan Africa describes the issue of major advances at the levels of states and operators but slow progress on the regional level.[2]

"The region continues to have the weakest safety performance in the world by a considerable margin," the report said. Airlines based in the AFI region that are on the registry of the IATA Operational Safety Audit (IOSA) program, however, had no accidents in 2012 or 2013. In that context, IATA in 2013 joined ICAO and other organizations and companies in pursuing "world-class safety performance by the end of 2015" by addressing deficiencies through the Africa Strategic Improvement Action Plan.

As in previous initiatives, the plan reemphasizes the urgency of creating independent CAAs that have sufficient resources to perform effective oversight. IATA also says continued replacement of legacy fleets with new aircraft providing advanced operational capabilities will have a strong positive influence on flight operations risk management within many airlines.

The action plan prioritizes implementing effective and transparent regulatory oversight systems in states, completing IOSA by all African airlines, implementing runway safety measures, training pilots to reduce risk of loss of control–in flight, providing routine flight data analysis, certifying all international airports, and implementing SMS for states and service providers.

At the symposium, Kevin Hiatt, IATA's senior vice president, flight operations, said that IOSA-registered airlines in AFI — counting all Eastern-built and Western-built large commercial jets and turboprops — had about one-fourth the hull-loss accident rate of non-IOSA-registered airlines in the 2009–2013 period. This registry as of mid-August listed Aero Contractors Company of Nigeria, Air Botswana, Air Burkina, Air Madagascar, Air Mauritius, Air Namibia, Air Seychelles, Air Uganda (Meridiana Africa Airlines), Air Zimbabwe, ALS, Arik Air, Comair, DHL Aviation EEMEA, Equaflight Service, Ethiopian Airlines Enterprise, Go, Interair South Africa, Kenya Airways, LAM Linhas Aéreas de Moçambique, Precision Air Services, SA Airlink, SAFAIR Operations, South African Airways, South African Express Airways, Sudan Airways Co., TAAG Angola Airlines, TACV Cabo Verde Airlines and Trans Air Congo.

Currently, these airlines collectively have a hull-loss accident rate about seven times better than non-IOSA operators in the region, according to IATA.

### Notes

1. Abuja safety targets were endorsed as part of the Abuja Declaration by the Ministerial Meeting on Aviation Safety and Security of the African Union in July 2012, and endorsed at the Assembly of the African Union in January 2013.

2. IATA. *Safety Report 2013: 50th Edition,* April 2014.

# COGNITIVE DECLINE

BY PETER v. AGUR, JR.

**Some aging pilots struggle to respond appropriately to this insidious threat.**

When it comes to assuring safety in business aviation, operators can become more focused on the airworthiness of the aircraft than on the cognitive health of pilots, despite estimates that about 70 percent of accidents are the result of human factors.

"Cognitive decline, most prevalent among aging pilots, is a threat to safety that is similar to fatigue and substance abuse," says Dr. Quay Snyder, president and founder of Virtual Flight Surgeons. Like the effects of fatigue and substance abuse, cognitive deficiencies are insidious, have a substantial negative impact on performance and are hardest to identify when the crewmember is performing routine activities. One reason symptoms go unnoticed is that with practice and routine, the brain adjusts to mild to moderate cognitive impairment. In other words, normal activities can mask the severity of the deficiency.

However, if the flight crew's routine is interrupted by an urgent or stressful situation, like an in-flight emergency or an en route clearance change, then the extent of cognitive impairment may become more evident. Unfortunately, even those events are sometimes downplayed by both pilots as an inconsequential aberration.

Since 1956, over 6,000 adults ranging in age from 22 to more than 100 have participated in the Seattle Longitudinal Study conducted by K. Warner Schaie, Ph.D., a psychologist and gerontologist. The study has tracked the cognitive performance, relative to variance from the established norms, of the subjects as they aged. The study focused on six key factors in cognitive performance (the definitions shown are interpretations of clinical terms):

- Inductive reasoning — problem solving;
- Spatial orientation — comprehension of one's surroundings;
- Perceptual speed — pace of understanding;
- Numeric ability — pace and accuracy of mathematical problem solving;
- Verbal ability — conversational competence; and,
- Verbal memory — recollection of aural input.

Each of these factors also can be considered a critical cognitive element for the safe performance of flight deck duties. Figure 1 displays the average of the study group's performance. Individual rates of change varied, both positively and negatively.

Schaie's findings show that, on average, cognitive skills remain good through age 60 or so. Verbal skills remain acute longer than spatial orientation and perceptual speed. In other words, as the error rate increases in other areas, the subject's ability to 'talk his way out of it' remains high.

Is cognitive decline a real threat, or is it purely an academic concern? While presenting this subject during Flight Safety Foundation's 2014 Business Aviation Safety Summit (BASS) in April in San Diego, I used electronic polling software to solicit answers to questions that would reflect opinions, attitudes and perspectives of the attendees. The number of respondents ranged from 72, as we were beginning the survey, to 115 for the last question.

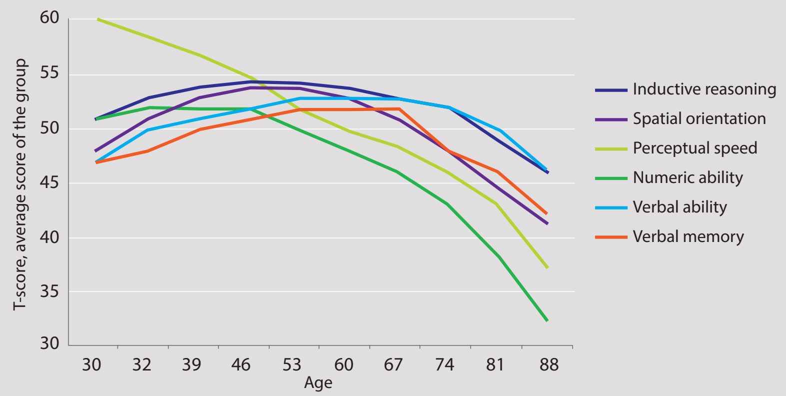
As you look at the results, remember that these respondents were already safety-focused and representing organizations willing to make significant investments in furthering their safety efforts. Therefore, the data are not representative of the entire industry. Their responses are biased by an above-average level of concern for risk management. As a result, I believe you can assume a more representative group's responses would be more risk-tolerant.

The first question I asked was, "In your personal experience, how significant are the risks associated with cognitive decline in aging pilots?" In other words, I explained, who believed they had actually witnessed substandard performance that is characteristic of cognitive decline? Eighty-two percent of the respondents indicated the risks were moderate to high (Figure 2).

With that level of concern, I would assume the issue would have been previously addressed by aviation safety professionals. In fact, regulations do attempt to cover all the bases on this question. The U.S. Federal Aviation Administration (FAA) and the European Union, for example, both have set mandatory retirement ages for airline pilots. The use of regulations is an attempt to create a limit on the risks associated with aging crewmembers.

However, it is also a blanket approach to an issue that is unique to each individual. I have had dear pilot friends succumb to Alzheimer's disease before age 60. I also have observed my 85-year-old father, a retired military and airline pilot, climb into an unfamiliar airframe with a sidestick and glass

**Aging Pilot Cognitive Decline**

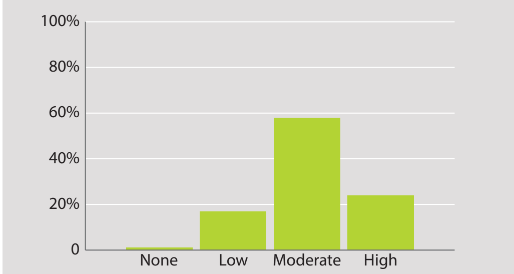



**Note**: Plotted lines show longitudinal estimates of within-participant age changes on the latent ability constructs (from 7-year longitudinal data).

Source: *The Seattle Longitudinal Study: Relationship Between Personality and Cognition* by K. Warner Schaie, Sherry L. Willis, and Grace I.L. Caskie <www.ncbi.nlm.nih.gov/pmc/articles/PMC1474018/>

**Figure 1**

**How Significant Are Aging Pilot Risks?**

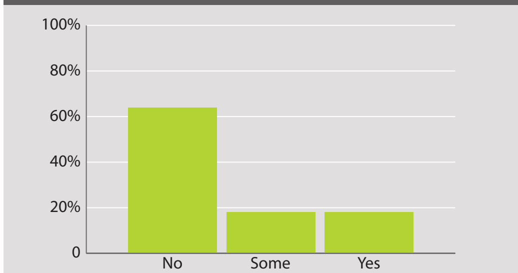



**Note:** Results of audience poll during the Business AviationSafety Summit, April 2014

Source: Peter v. Agur, Jr.

**Figure 2**

**Do You Have Policies That Address Aging Pilot Risks?**




**Note:** Results of audience poll during the Business Aviation Safety Summit, April 2014

Source: Peter v. Agur, Jr.

**Figure 3**

cockpit displays (the first time he had encountered either). Within five minutes, he had the airplane 'wired.' He easily maintained the airplane's heading within two or three degrees and limited altitude deviations to less than 30 ft. An arbitrary, regulatory flight crewmember age limit may not catch the early onset of cognitive decline and does not allow older, but fully competent, crewmembers to continue their careers.

FAA partly relies on the provisions of Federal Aviation Regulations (FARs) Part 61.53, which says, in part that "no person who holds a medical certificate issued under Part 67… may act … as a crewmember, while that person: (1) Knows or has reason to know of any medical condition that would make the person unable to meet the requirements for the medical certificate."

Some business aviation operators have taken the added step of establishing policies and practices that further address aging pilot issues. This is an initiative often driven by senior executives' concerns. Other operators say they are concerned about the issue but are daunted by state and federal laws designed to prevent employment discrimination and breaches of healthcare privacy. The BASS audience was polled about the status of their companies' policies addressing aging pilots. Sixty-four percent indicated that no policies were in place, and only 18 percent indicated their policies appeared to adequately address the issue (Figure 3, p. 42).

Even with policies in place, operators are not protected against the risk of cognitive deficiencies without the organizational norms and behaviors needed to make the policies effective. That raises some challenging issues.

Self-reporting is not likely to be a reliable approach to policy implementation for several reasons:

- Cognitive impairment is like alcohol or drug impairment — the people affected are likely to be less aware of the condition than those around them. When a family member or friend is ready to urge a person to discontinue driving for this reason, it is usually well past the point of incapacitation.
- For many pilots, aviation is as much an avocation as it is a vocation. It is part of their sense of personal identity. The fear of losing that connection may be very strong — strong enough for people to be in denial that they may be putting themselves and others at risk.
- Many pilots are not prepared economically to either retire or change their careers. This puts strong financial pressure on them to continue to fly.

Operators cannot count on self-reporting as their primary method of identifying a crewmember who is symptomatic of significant cognitive decline.

If self-reporting is not the answer, should we look for a more intrusive regulatory solution? I asked the BASS audience if they thought current regulations effectively addressed the risks associated with cognitive decline. Ninety-four percent answered "no." The logical next step would be to call for a change in the regulations to more effectively address the issue. In the United States, those regulations would most likely be implemented through the FAA's aviation medical examiner (AME) network. However, the flaw there is, according to a number of different pilots with whom I have spoken, it is relatively easy to find AMEs in the network that are less than comprehensive in their examinations. Therefore, the pilot's work-around— selecting such an AME — would be too easy for this approach to be effective.

Without regulatory assurance of cognitive competence, the operators themselves are left with a blend of policies and performance assessments for dealing with the threat.

A possible policy would call for pilots to notify management when a fellow crewmember is suspected of being cognitively impaired. This sounds reasonable. After all, who is more likely to actually observe substandard performance than the person in the other seat?

However, there are challenges to using this approach alone for detecting the risks associated with cognitive decline.

By definition, the single-pilot operations in business aviation typically do not have another qualified flight crewmember to observe the pilot's performance. That leaves the passengers as the primary observers of the pilot's performance, but they are likely to be at risk long before a pilot's performance declines to a level that would cause most passengers to notice.

It is tempting to ignore single-pilot operations as an issue because they comprise a tiny fraction of all business aviation operations. However, the continued emergence of very light jets and high-performance, pressurized, single-engine turboprop aircraft will cause this segment to grow. The risks will grow with it.

In two-pilot operations, the operator's policy could make it mandatory for any observers to report their concerns to their manager. How effective would that policy be if the person who is demonstrating decline is the senior manager of the department? Or, what if the fading flyer is the mentor and "bestower of breaks" to the observer?

Other concerns about disclosure policies include fear of legal, financial and social exposure for the observer. On a higher level, disclosers indicated potential remorse at being part of a series of events that would lead to the unplanned end of a pilot's flying days as well as the sudden loss of his or her income.

The structural and social barriers to a standalone policy's effectiveness therefore are substantial. That is why the full integration of a just culture forms the foundation for the effective mitigation of the risks associated with cognitive decline in aging flight crewmembers.

Safety theorist James Reason's extensive work in the arena of cultural impact on an organization's safety performance was ground breaking and continues to evolve. His founding definition is:

> *In a* just culture*, errors and unsafe acts will not be punished if the error was unintentional. However, those who act recklessly or take deliberate and unjustifiable risks will still be subject to disciplinary action.*

During my BASS audience polling, I asked, "How important is a just culture in addressing aging pilot risks?"

The response was overwhelming: 96 percent of respondents said a just culture was important in addressing the issue (Figure 4).

I then probed the status and strength of just culture in the organizations represented by audience members.

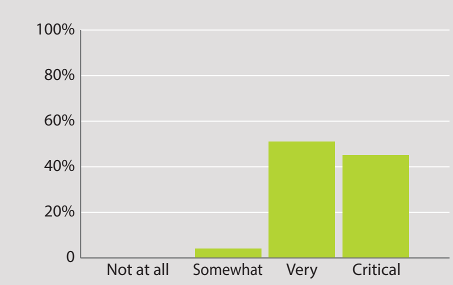
These two responses reveal that, despite this audience's nearly universal understanding of the value and impact of a just culture on the quality of organizational performance, fewer than 10 percent of respondents whose organizations have implemented just culture precepts agreed that their organization actually ensures that they are effective. For a just culture to work, it must be applied comprehensively and consistently. Otherwise, by definition and in reality, it is neither just nor is it truly in effect.

For an excellent description of why and how to implement a just culture, refer to Flight Safety Foundation's legacy magazine, *Flight Safety Digest*, March 2005, for the article, "A Roadmap to a Just Culture: Enhancing the Safety Environment." This was compiled by the Global Aviation Information Network (GAIN) Working Group E. One of the points the paper makes is, "When hazards are reported, they are analyzed using a hazard-based methodology, and *appropriate action is taken*." That phrase encompasses a performance assessment-based answer to effectively addressing the threat of crewmember cognitive decline.

Another logical approach to cognitive assessment of pilots would be to have training companies incorporate it into their recurrent training curriculum. In fact, the president of a major charter management company made that request over a decade ago. He asked the CEO of a major training company if his staff could design and conduct a cognitive competence diagnostic of the charter management company's flight crews. The response was, "Yes, but we won't do it." There were two reasons: marketing and legal concerns. The charter management company president then approached the CEO of another large training company and received the same answer.

Considering the lack of an established model, I offer the following as a recipe for addressing concerns about flight crew cognitive performance. Like all recipes, skipping steps and using inferior substitutes will cause the end product to vary, usually negatively. Flight departments will need to collaborate with human resources and legal departments to

**How Important is a Just Culture in Addressing Aging Pilot Risks?**




**Note:** Results of audience poll during the Business Aviation Safety Summit, April 2014

Source: Peter v. Agur, Jr.

**Figure 4**

assure the policies and practices are equitable and defensible. If operators do not have the internal expertise to develop such policies and practices, they should use outside experts.

Here is a proposed outline of steps toward cognitive competence assurance, assuming the use of professional advice from AMEs and other health care specialists qualified in this field:

- Establish and maintain a comprehensive just culture. This lays the foundation for self-reporting, as well as observer reporting of significant and sustained variations from normally expected cognitive performance.
- Establish policies that apply to all flight crewmembers for:
  - Company approved AME selection and use; and,
  - Obtain loss of license and disability insurance coverage that is adequate to assure equitability in the case of identified deficiencies.
- Consistently use only valid cognitive assessment tools and tests:
  - Online, written and practical tests are widely available;
  - Conduct routine cognitive assessments to establish baselines and to identify variations;
  - Develop and consistently administer a periodic flight simulator session that incorporates proven elements of cognitive assessment that are easily observed and scored; and,
  - Use internal observers or consultants to conduct the flight simulator observations. The simulator training companies typically will not do this for the operator.
- When a significant variation is observed, conduct additional and more in-depth diagnostics to determine if the variation is:
  - Transient due to fatigue, a temporary or treatable medical condition, medications, etc. Address the source of the transient variation and have an AME reconfirm fitness for return to duty; or,
  - Permanent and progressive.
- When confirmed cognitive decline is severe enough to affect flight safety and is not correctible, deal with the results humanely and equitably:
  - Use the loss of license insurance benefits in place;
  - Use supplemental disability insurance benefits to compensate for gaps in income replacement;
  - Provide career-related and personal counseling; and,
  - Consider offering the person a non-flying position in the flight department.
- If separation is necessary, consider celebrating the person's legacy of contributions and accomplishments. It may help provide the most positive transition possible for the person and the department.

"The risks to flight operations from cognitive decline in aging flight crewmembers are significant," says Snyder. In the U.S., there are currently no adequate regulatory or industry safeguards that can assure business aviation operators that their pilots are cognitively competent. That puts the ball squarely in the operator's court.

*Peter v. Agur Jr. is chairman and founder of The VanAllen Group, a business aviation consultancy team with expertise in safety, aircraft acquisitions, and leader selection and development. A member of the Flight Safety Foundation Business Advisory Committee and the National Business Aviation Association (NBAA) Corporate Aviation Managers Committee (emeritus), he has an MBA and an airline transport pilot certificate, and is an NBAA certified aviation manager.*

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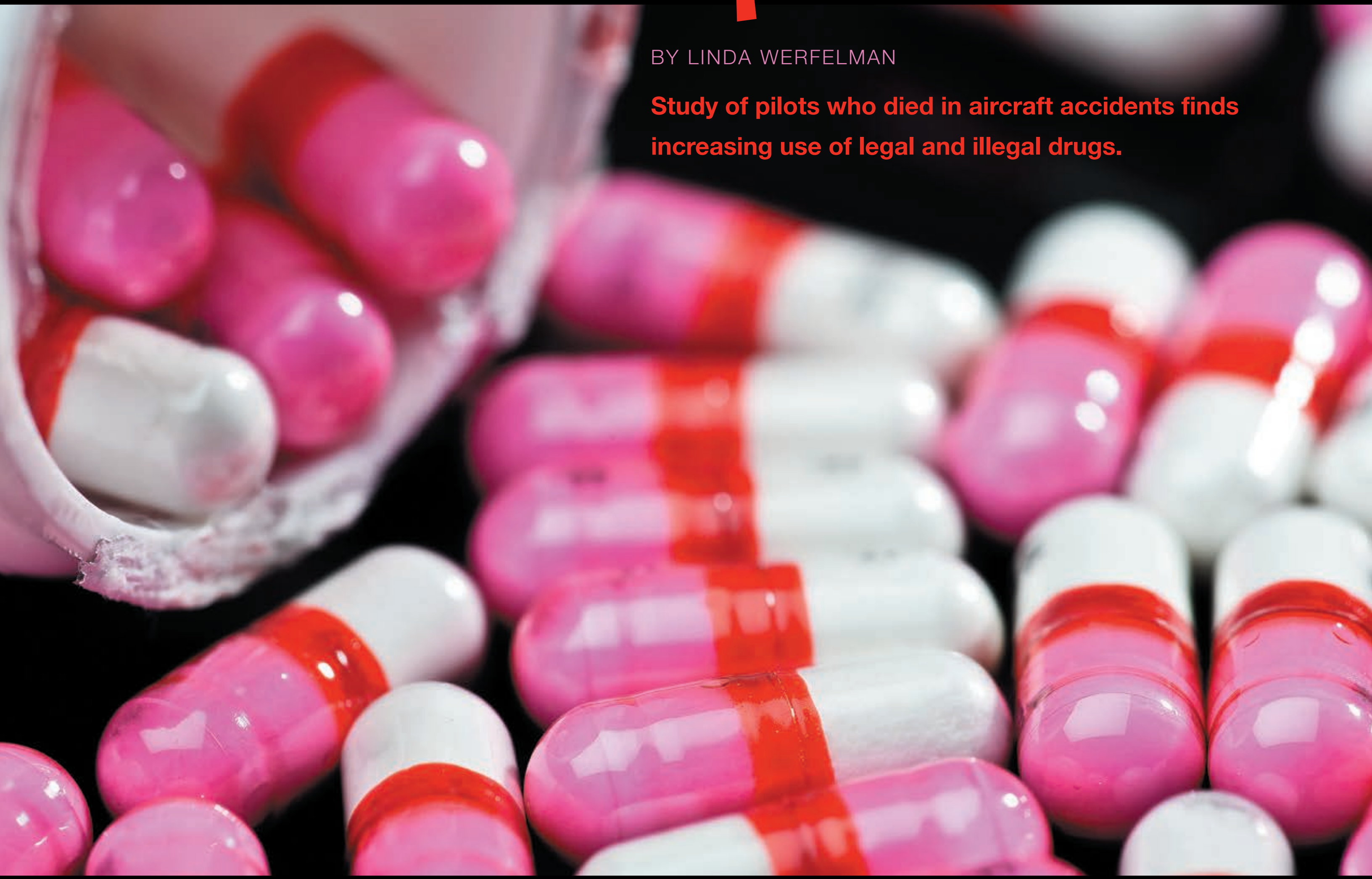
# FLYING WHILE Impaired?



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BY LINDA WERFELMAN

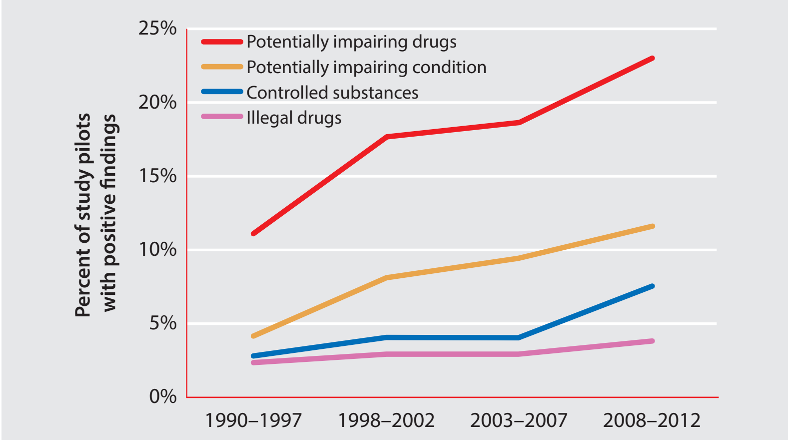
**Study of pilots who died in aircraft accidents finds increasing use of legal and illegal drugs.**

The use of potentially impairing medications and illegal drugs by pilots killed in aircraft crashes increased dramatically between 1990 and 2012, according to a study by the U.S. National Transportation Safety Board (NTSB), which warned that growing use of the substances heightens the overall risk of drug-related pilot impairment during flight.

The NTSB emphasized that the study did not conclude that pilots who tested positive for impairing drugs were actually impaired at the time of the crash.

Data were gathered through post-accident toxicology testing of 6,677 pilots who were killed in aircraft accidents; the number represents 87 percent of the U.S. civil aviation accidents involving a pilot fatality during the years of the study. The risk categories analyzed by the study were potentially impairing drugs, potentially impairing conditions, controlled substances and illegal drugs. Most of the pilots

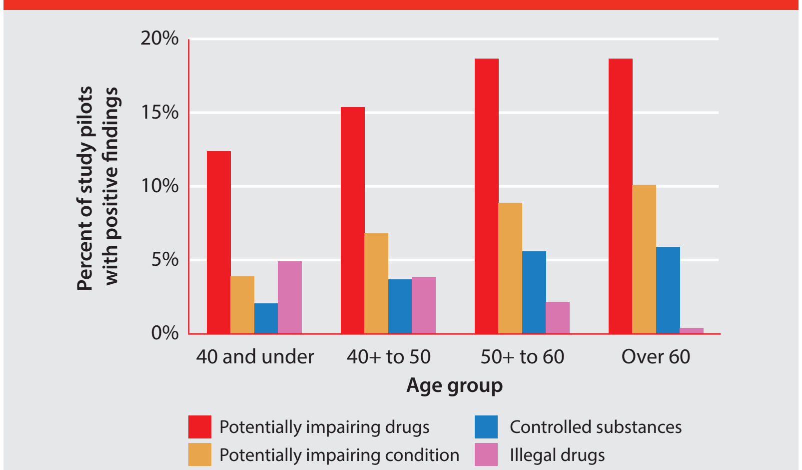
**Toxicology Findings by Category, 1990–2012**




Source: U.S. National Transportation Safety Board

**Figure 1**

**Toxicology Findings by Age Group, 1990–2012**




Source: U.S. National Transportation Safety Board

**Figure 2**

studied were general aviation pilots because general aviation aircraft are more frequently involved in fatal accidents than those used in air carrier operations, according to the study, which was the subject of an NTSB public hearing in early September.

The data, stored in the toxicology database maintained by the U.S. Federal Aviation Administration's (FAA's) Civil Aerospace Medical Institute and the NTSB aviation accident database, measured an increase from 1990 through 2012 in use of illegal drugs, prescription medications and over-the-counter (OTC) preparations by pilots in fatal crashes.

The study singled out diphenhydramine, described as a "sedating antihistamine and an active ingredient in many OTC allergy formulations, cold medicines and sleep aids," as the most commonly used potentially impairing drug used by the accident pilots.

"The key take-away from this study for every pilot is to think twice about the medications you're taking and how they might affect your flying," said acting NTSB Chairman Christopher A. Hart. "Many over-the-counter and prescription drugs have the potential to impair performance, so pilots must be vigilant to ensure that their abilities are in no way compromised."

The NTSB emphasized that it could not be determined whether more pilots actually are flying while impaired, adding, "While the study noted that the greater use of medications pointed to an increasing *risk* of impairment, it stressed that further research is needed to better understand the relationship between drug use and accident risk."

Throughout the study period, pilot impairment was cited as the probable cause or a contributing factor in about 3 percent of all fatal accidents, the NTSB said.

The study found that of the 6,677 pilots included in the study, the proportion who tested positive for potentially impairing drugs had increased from about 11 percent in 1990 to about 23 percent in 2012 (Figure 1). Increases also were recorded in the proportion of those who tested positive for having a potentially impairing condition, use of controlled substances and use of illegal drugs.

## Pilot Characteristics

None of the pilots involved in fatal crashes of large commercial jets had tested positive for recent use of illegal drugs, but some had used potentially impairing medications, the NTSB said.

Ninety-eight percent of all the pilots studied were male, ranging in age from 16 to 92, with an average age that increased over the life of the study from 46 in 1990 to 57 in 2012.

Forty-seven percent (3,144 pilots) held private pilot certificates, 34 percent (2,241) had commercial pilot certificates, and 15 percent (983) had airline transport pilot certificates. Smaller percentages were student pilots, sport/recreational pilots or people flying without a license.

Broken down according to age, the oldest pilots were found to be most likely to have been flying with potentially impairing drugs in their systems. About 18 percent of pilots between age 50 and 60 and a similar percentage of those over 60 had taken such drugs, compared with about 12 percent of pilots age 40 and younger (Figure 2).

Illegal drugs, however, were most frequently found in pilots in the age 40 and younger group, the NTSB said, noting that nearly 5 percent of those in that age group tested positive. Pilots over age 60 were least likely (less than 1 percent) to have tested positive for illegal drugs.

Among pilots of all ages, illegal drug use was "relatively uncommon among the study population," with about 4 percent of those killed in accidents testing positive in 2012, up from 2.4 percent in the early 1990s, the NTSB said. The increase was attributed largely to growth in marijuana use over the last 10 years.

In all categories analyzed by the study, general aviation pilots were more likely than their commercial counterparts to have tested positive (Figure 3).

In addition, pilots with expired medical certificates and those flying without a medical certificate were more likely than those with valid medical certificates to have had positive test results, the NTSB said.

"The accident risk for pilots flying without a medical certificate cannot be accurately determined because the [FAA] does not collect information about the number of these pilots or their flight activity," the agency said. Nevertheless, it added that the number of pilots flying without a medical certificate is increasing and that those pilots "will likely make decisions about their medical fitness to fly, including use of drugs while flying, without periodic interaction with an aviation medical examiner."

The study concluded that the FAA does not provide adequate information for pilots to determine whether individual drugs are safe or unsafe to take while flying (*ASW*, 6/14, p. 20).

## Recommendations

Recommendations included a call for the FAA to "develop, publicize and periodically update information to educate pilots about the potentially impairing drugs identified in [FAA] toxicology test results of fatally injured pilots, and make pilots aware of less impairing alternative drugs if they are available."

An accompanying recommendation said that the FAA should require pilots who are permitted to fly without medical certificates (such as sport/recreational pilots) to periodically inform the agency about whether they remain active pilots and to provide a summary of recent flight time.

The FAA also should conduct a study to determine the extent of usage of OTC, prescription and illegal drugs by pilots who have not been involved in accidents and compare those findings with the results of studies of pilots who have been killed in aircraft accidents "to assess the safety risks of using those drugs while flying," the NTSB said.

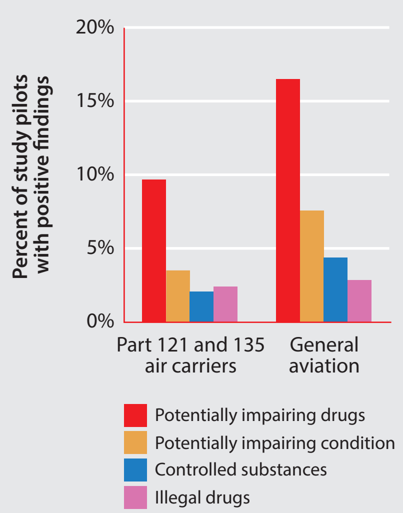
Recommendations to state governments said that they should develop guidelines calling on health care providers to talk to the patients for whom they prescribe controlled substances as pain-killers about how the drugs are likely to affect their medical condition and their ability to safety operate any type of vehicle. The states should include similar information in existing newsletters and other communications with health care providers and pharmacists, the recommendations said.

A final recommendation to the FAA said the agency should develop "a clear policy regarding any marijuana use by airmen, regardless of the type of flight operation."

The study's authors described their work as "an early step toward understanding the specific relationships among a drug's effects, the effects of the underlying medical condition and the risk of a transportation accident over time," and said more research will be required to increase understanding of the relationship between drug use and accident risks.

*This article is based on the executive summary of NTSB Safety Study SS-14/01, "Drug Use Trends in Aviation: Assessing the Risk of Pilot Impairment" and related presentations to the NTSB during a board meeting on Sept. 9, 2014. The complete report will be available later this year at <www.ntsb.gov>.*

**Toxicology Findings by Operation Type, 1990–2012**




Source: U.S. National Transportation Safety Board

**Figure 3**

BY LINDA WERFELMAN

# Measures of Safety

**Report says its analysis of aviation safety data from multiple sources shows progress in the Middle East.**

Countries in the Middle East with oversight systems that have been audited by the International Civil Aviation Organization (ICAO) have scored above the world average for their effective implementation (EI) of eight critical elements (CEs) of aviation safety, the ICAO Regional Aviation Safety Group–Middle East (RASG-MID) says.

The group said, in its second *MID Region Annual Safety Report,*[1] that the 13 audited Middle East states[2] had an average EI score of 69.85 percent, compared with the worldwide average of 61.70 percent, (Figure 1).

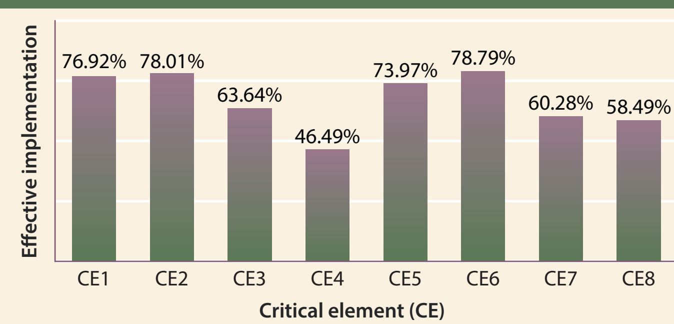
The report said the EI scores were derived from results of ICAO's Universal Safety Oversight Audit Programme (USOAP), which showed that the region's highest average scores were in areas involving licensing and certification (CE6), operating regulations (CE2), primary aviation legislation (CE1) and technical guidance materials (CE5). The lowest average score was 46.49 percent in qualification and training of the technical staff involved in carrying out regulatory functions (CE4), the report said.[3]

The report's objective was to use the safety information gathered from various sources — Boeing, the International Air Transport Association (IATA), ICAO, airline operators and individual states — to "identify the main aviation safety risks in the Middle East Region in order to deploy mitigation actions for enhancing aviation safety in a coordinated manner. …

"Every entity involved in aviation safety collects safety data and produces safety information with a different perspective."

Five states — not identified by name in the report — provided individual answers to ICAO requests for data on safety occurrences within their jurisdictions. Their information identified

**Average Overall Effective Implementation Rates in Middle East Region**




**Key**

CE1 = primary aviation legislation
CE2 = specific operating regulations
CE3 = state civil aviation system and safety oversight function
CE4 = technical personnel qualification and training
CE5 = technical guidance, tools and the provision of safety-critical information
CE6 = licensing, certification, authorization and approval obligations
CE7 = surveillance obligations
CE8 = resolution of safety concerns

Source: International Civil Aviation Organization

**Figure 1**

the most frequently reported occurrences as air traffic control–related reports, including reports about conflicting traffic and airspace deviations; diversions; level busts (altitude deviations); unstable approaches; controlled flight into terrain; and wake turbulence.

The primary root causes, according to the information supplied by the five states, were human errors, wind shear and other weather conditions, and aircraft system malfunctions.

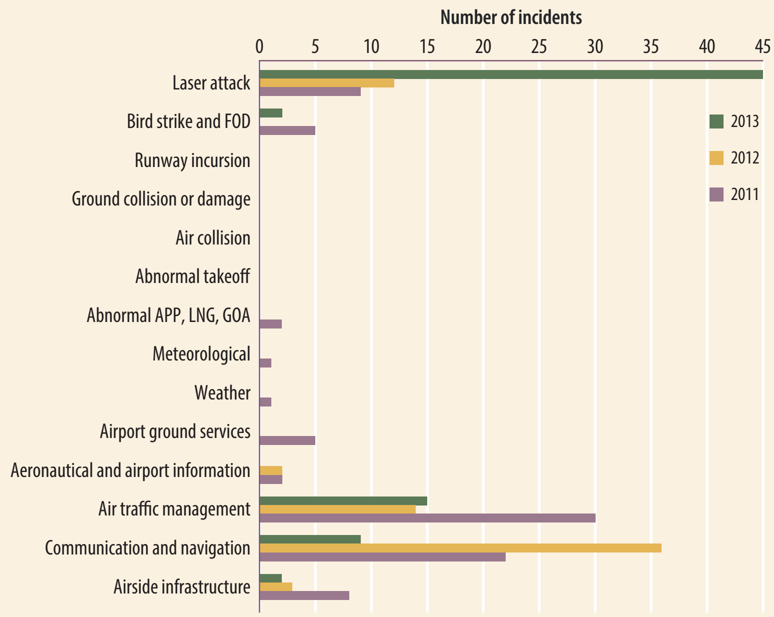
According to reports by airlines to IATA's Middle East and North Africa Office, laser attacks (also called *illuminations* or *strikes*) on their aircraft were the most frequent occurrences in 2013, when 40 attacks were reported, up from nine in 2011.[4] Air traffic management factors accounted for 15 occurrences in 2013, and communication and navigation accounted for nine, the report said (Figure 2).

Overall, the accident rate in the MID region in 2012 was 2.13 per million flight sectors, compared with 2.06 per million worldwide, the report said, citing IATA data (Figure 3). That MID number represented a decline from 11.78 accidents per million sectors in 2009. Two accidents occurred in the MID region in 2012; that was the lowest annual number in the 2008–2012 study period cited in that section of the report.

Fatal accidents declined in the MID region over the same five-year period from 4.03 fatal accidents per million departures in 2008 to 0.71 per million departures in 2012 (Figure 4).

Runway and taxiway excursions occurred more frequently than any other type of accident and accounted for nearly 20 percent of all accidents in 2008–2012, the report said. Loss of control–in flight (LOC-I) accidents were

## Middle East Region Occurrences Reported by Airlines[1]




APP = approach; FOD = foreign object damage; GOA = go-around;
IATA = International Air Transport Association; LNG = landing

**Note**

1. Occurrences reported to IATA, January 2011–July 2013

Source: International Air Transport Association

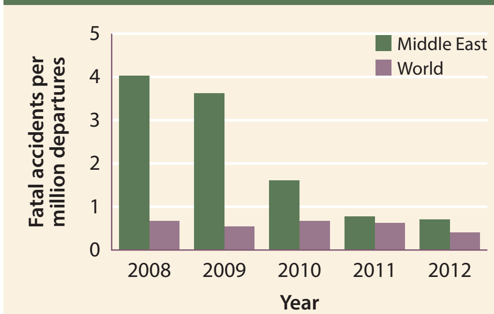
**Figure 2**

## Middle East Region Accident Rate, 2005–2012


Source: International Air Transport Association

**Figure 3**

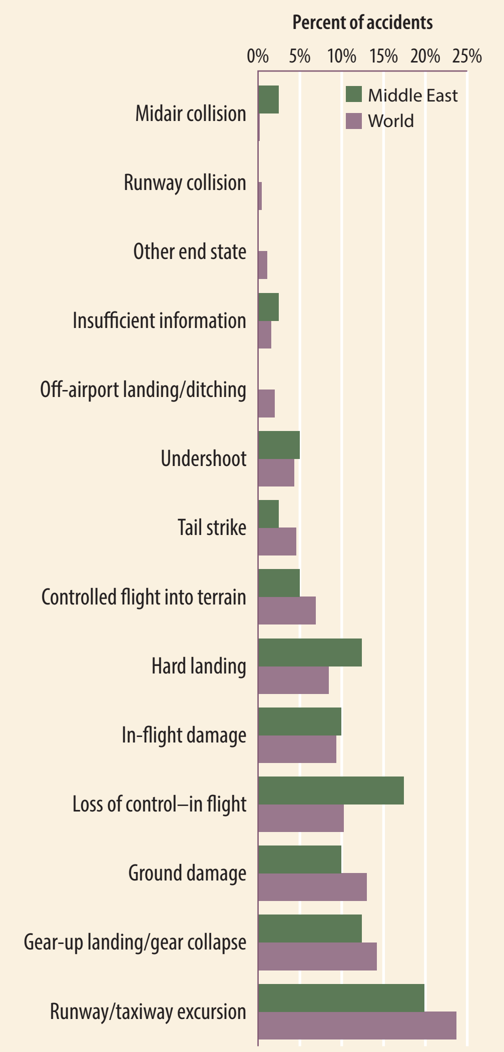
## Middle East Region Fatal Accidents




Source: International Air Transport Association

**Figure 4**

**Accidents by Category, 2008–2012**



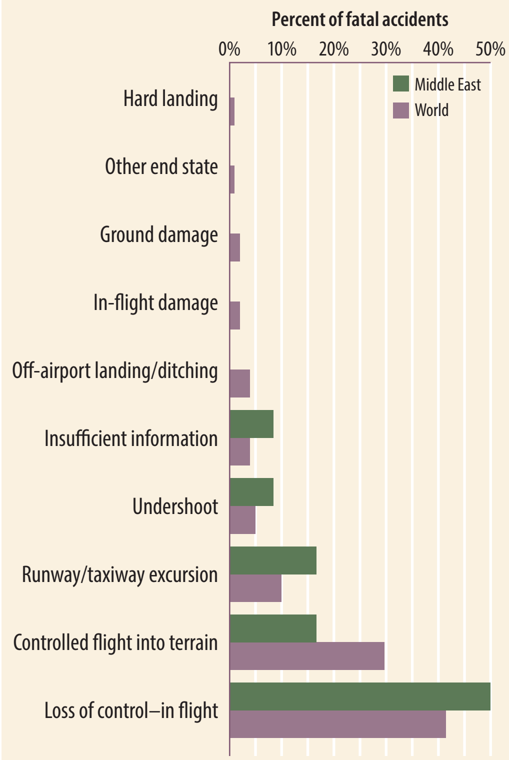

Source: International Air Transport Association

**Figure 5**

next-most frequent and accounted for about 17 percent of all accidents (Figure 5). Worldwide, runway/taxiway excursions, gear-up landing/gear collapse and ground damage all occurred more often than LOC-I accidents. In both the MID region and the world, accidents were more likely during landing than in any other phase of flight.

However, both in the MID region and worldwide, more fatal accidents involved LOC-I than any other category, followed by controlled flight into terrain and runway/taxiway excursions (Figure 6). Fatal accidents occurred most

**Fatal Accidents by Category, 2008–2012**




Source: International Air Transport Association

**Figure 6**

often during the landing phase in the MID region but during approach worldwide.

## Notes

1. RASG-MID. *MID Regional Annual Safety Report*, second edition. January 2014. Available at <www.icao.int/MID/Documents/2013/rasg-mid3/RASG-MID3-WP5-%20Review%20of%20the%20Second%20MID%20Regional%20Annual%20Safety%20Report.pdf>.

2. The 13 audited states listed include Bahrain, Egypt, Iran, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Sudan, and UAE. The report did not identify the three other audited states.

3. ICAO. *USOAP CSA Audit Results — Glossary.* Available at <www.icao.int/safety/iStars/Pages/USOAP-CSA-Audit-Results.aspx>.

4. The report said that, when using IATA data for the Middle East and North Africa, the authors attempted to narrow the data to include only the 15 states of the Middle East region — the 10 listed in Note 2, plus Iraq, Lebanon, Libya, Syria and Yemen.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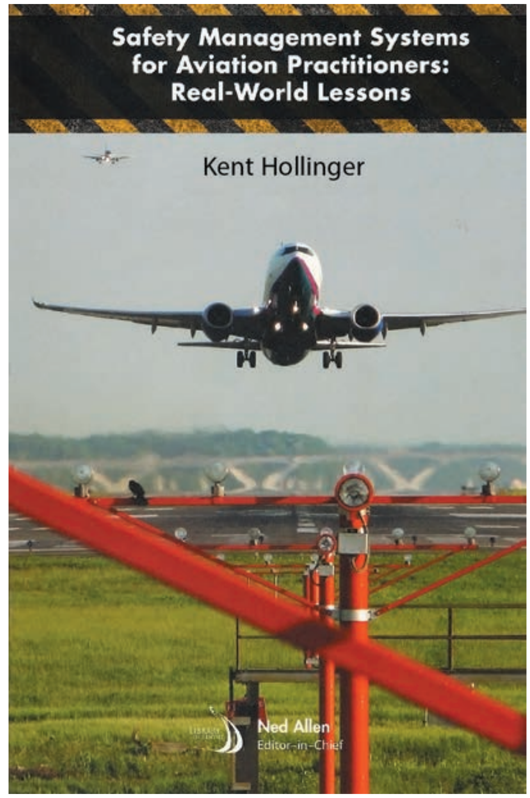


BY RICK DARBY

# SMS: Up for Discussion

**An interactive course probes the practical dimensions of safety management systems.**

**BOOKS**

## Stuck 7s

**Safety Management Systems for Aviation Practitioners: Real-World Lessons**

Hollinger, Kent. Reston, Virginia, U.S.: American Institute of Aeronautics and Astronautics, 2013. 221 pp. Figures, tables, references, appendixes, index. Hardcover.

Kent Hollinger's account of safety management systems (SMS) is presented in an unusual and possibly unique format. It approximates a classroom experience of the kind led by Hollinger on behalf of The MITRE Corp., a not-for-profit company that operates research and development centers funded by the U.S. government.

As in an actual interactive teaching situation, the text incorporates dialogue involving Hollinger and the students in one of MITRE's five-day SMS classes.

"This book is specifically intended to avoid an academic approach," the author says. It is written for "practitioners, those people on the front lines who will benefit from, and interact with, SMS every day. SMS principles are introduced to explain and give context to the concepts, but the emphasis is on actual usage and examples."

The 12 students quoted, given fictional names, represent a cross section of aviation personnel. Among their functions are cabin crewmember, pilot, safety director, maintenance manager, operations manager, safety office manager and senior inspector. Hollinger leads the class but also encourages the students to discuss their own thoughts and experiences.

The book is arranged according to modules like those of the class: an introduction; the SMS "table" (a pictorial representation of the system elements and how they relate to one another); the business case for SMS; an SMS look at human error; positive safety culture; SMS requirements and standards; SMS policy; SMS management structure; safety risk management; safety assurance; safety promotion; and next steps. An appendix summarizes key points.

In setting the stage for the discussions that follow, Hollinger cites David Marx's *Whack-a-Mole: The Price We Pay for Expecting Perfection*.[1] Hollinger says, "Has anyone here not made an error yet today? No one? It is to be hoped that you recognized your mistake and corrected it before anything bad happened. Humans will always make errors, no matter how hard they try to do the right thing.

"So, if we have a system that relies on everyone doing everything perfectly every time or else it falls apart, that's not a very good system, is it? … We need systems that are designed so that the chance for errors is reduced, those errors that do occur are captured before creating a bad result, and the systems are tolerant of those errors that are not captured."

As an example of the discussion format, here is an exchange about hazard identification and tracking:

**Kent (Hollinger):** If we have a hazard that poses a low risk, why would we want to track that hazard?

**Hans:** It might trend upward in the future.

**Kent:** And in that case, it might present a high risk. We will discuss risk analysis in Module 10, but it involves looking at the severity and the likelihood of a consequence (or outcome) arising from a hazard. Severity means the degree of harm posed by the outcome, whereas the likelihood (or probability) is how often it would occur. Of those two dimensions of risk, studies have shown that people are good at estimating one and not so good at the other. Which one do you think we are good at — estimating the probability of something happening or estimating the severity if it did happen?

**Derek:** Severity. People can always envision what might happen, but they usually don't have enough information to accurately predict the probability. That is why they play the lottery.

**Kent:** Exactly. There are 14 of us in this class. Let's pretend we all work for the same company. What if something happened and each one of us knew about one different occasion of this thing happening in the past year? If someone doing a risk analysis asked us, "How often does this event happen at your company?" I would say, "Once a year." You would say, "Once a year" and the rest of us would say, "Once a year," but it really occurs 14 times a year. Is that a different risk exposure if it's happening 14 times a year instead of once a year? This is another benefit of a centralized safety database, because if we had 14 different data storage locations, each one might know about it happening once and we would underestimate our exposure.

The following is another example (abbreviated) of the dialogue format in Hollinger's classes.

**Kent:** If I asked you to describe the weather, what indicators would you use?

**Felix:** Temperature.

**Ali:** Wind speed.

**Linda:** Wind direction.

**Pedro:** Humidity.

**Kent:** There are many indicators to describe the weather and there are many indicators to describe safety. Safety targets are the indicator values that we want to achieve. … The state might say, "In three years, we want to reduce runway incursions to a rate of not more than 0.5 per million operations."

To achieve the target, the state could create an action plan to install surface movement radar systems at the three largest hub airports within the next 12 months, with a 98 percent availability rate. … If there were zero incursions at the three largest hub airports, and the national rate would only reduce to 0.7 per million operations, perhaps the radar system should be installed at more airports.

If the state were able to achieve this target and reduce runway incursion, does that mean it has a safe airspace system?

**Ali:** It's safer.

**Kent:** Yes, but is it safe? If there were zero runway incursions, would the aviation system be safe?

**Derek:** No, there might be a midair collision every day.

**Kent:** Exactly. The point here is that just one indicator is not sufficient. Just like in describing the weather, it takes numerous indicators, along with their targets, to know if we have a safe system or organization. The indicators can be very different across the organization.

Hollinger finds new ways to frame principles that may have become clichés that no longer register strongly. Take, for instance, safety theorist James Reason's famous model of layered defenses against risk, each layer represented by a slice of Swiss cheese, with the holes representing gaps in each layer of the defense. The slices are constantly shifting, so that occasionally some holes line up, the defenses fail and an accident results.[2]

Hollinger found the idea of spinning cheese slices unrealistic, so he created a new model to illustrate Reason's thesis. His version is called "Stuck 7s," based on old-style gambling machines with five wheels that turn when the player pulls the lever. Depending on what symbols are visible on the centerline when the wheels stop, the result may be (but usually is not) a money prize. If all five wheels stop at 7, the gambler hits the jackpot.

Should one wheel be stuck showing a 7, that slightly increases the odds of five 7s lining up. The probability is still low, but not as low as with a correctly operating machine.

**Kent:** How does that relate to the aviation safety model? Well, when we've established multiple defenses, and then we negate one of them, basically we have given ourselves a Stuck 7.

Stuck 7s come when we do nonstandard procedures or workarounds, when we do a checklist by memory because, "Oh, I have that thing memorized. Why do I need to pull the card out?" … That's how we get into trouble in aviation. We do this shortcut, this omission or this nonstandard practice and give ourselves a Stuck 7 and nothing bad happens. Everything's fine. So we gain …

**Greg:** Confidence.

**Kent:** You get confident with this new shortcut or workaround. You keep using it for three weeks and now you're really feeling good about it. Three months go by and you're convinced that it is the right thing to do and there is no harm. … You may even go on to create a second Stuck 7. Then finally the odds catch up with you.

An SMS is often described as being more than a kind of organization or a set of procedures, as an underlying attitude. Greg, one of the class members, describes how he and his wife were walking down an aisle in a grocery store when he saw a glass jar of pickles fall onto the floor, spreading broken glass and liquid. He found an employee and reported it.

But he also guarded the mess until it was cleaned up, which he says "drove my wife crazy." She wanted to get on with shopping.

**Greg:** I explained that an elderly person might come around the corner, not see the spill, slip on it, fall down, break a hip, have to go to the hospital and get a hip replacement, all because I couldn't spend 10 minutes on guard until the store cleaned up the spill. I couldn't live with that.

**Kent:** You have no stake in the store and do not know the person who might slip, but you have an inner sense of responsibility for safety. …

**Hollinger finds new ways to frame principles that may have become clichés that no longer register strongly.**

So, what would people in your organization do if they saw a fuel spill, or some hydraulic fluid on the floor? Would they think, "Management had better clean that up before someone gets hurt"? Would they report the spill? Or would they also take action to make sure no one was injured until the spill is cleared? If they are too busy to stand by the spill, they could always place some cones or other objects around the spill. That is what is meant by a shared responsibility for safety, not just telling everyone to work safely.

By now, most people in safety-related positions in aviation are familiar with the basics of SMS, but even those who have been introduced to them through classwork will find Hollinger's book a vivid and thought-provoking refresher.

## Notes

1. Marx, David. *Whack-a-Mole: The Price We Pay for Expecting Perfection*. Plano, Texas, U.S.: By Your Side Studios, 2009. Discussed in *ASW*, 7/09, pp. 52–54.

2. Reason, James. *Managing the Risks of Organizational Accidents*. Farnham, Surrey, England, and Burlington, Vermont, U.S.: Ashgate, 1997.

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## PATRONS

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# Airspeed Fluctuations

**Pitot icing suspected of causing incidents involving air data disruptions.**

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

### Pitot Heat Ineffective

Airbus A321-231. No damage. No injuries.

Icing conditions that rendered the A321's pitot heating system ineffective are believed to have caused serious fluctuations in indicated airspeed during two separate flights within a couple of months, said a report by the U.K. Air Accidents Investigation Branch (AAIB).

The first, and more serious, incident occurred the afternoon of April 20, 2012, as the aircraft neared London Heathrow Airport during a flight from Stockholm, Sweden, with 182 passengers and seven crewmembers. St. Elmo's fire was visible, but the flight crew saw no sign of airframe icing as the aircraft descended in light turbulence to Flight Level (FL) 140 (approximately 14,000 ft). Total air temperature at the time was 3 degrees C (37 degrees F).

"Shortly after the aircraft entered cloud tops, there was a white flash of lightning, without any associated noise," the report said. "Both pilots recalled that about one second after the flash [as the aircraft was descending through 14,800 ft], the airspeed indications on their primary flying displays (PFDs) fluctuated, with both the high- and the low-speed ends of the scale alternately visible." The standby airspeed indicator also showed fluctuating airspeed indications, and there was a brief disruption of all three sources of altitude data.

"The pilots commenced the procedure for 'Unreliable Speed Indication' and turned off the flight directors," the report said. The fluctuations lasted less than two minutes, but during that time, the master warning horn sounded, the autopilot disconnected and a traffic-alert and collision avoidance system (TCAS) resolution advisory (RA) was generated, calling for a descent. Shortly thereafter, a TCAS "clear of conflict" advisory sounded, and the crew leveled the aircraft at FL 140.

The crew received clearance from air traffic control (ATC) to enter a hold in visual meteorological conditions (VMC). The instrument fluctuations had stopped, and the pilots consulted the pitch-versus-power tables in the quick reference handbook (QRH) to confirm that the airspeed indications, all of which were showing 240 kt, were correct.

The electronic centralized aircraft monitor displayed an "AOA DISCREPANCY" message, indicating that the problem had been caused by a mismatch between the three angle-of-attack (AOA) probes, the report said.

"The crew discussed the implications of the failures and considered various scenarios, utilising the company's decision-making tool, and decided to divert to London Stansted Airport, which was clear of adverse weather," the report said. The subsequent landing was uneventful.

The pilots later told investigators that the company training they had received on unreliable airspeed indications had allowed them to handle the incident in a "straightforward" manner.

The second incident occurred on June 16, 2012, as the aircraft was climbing through 26,500 ft in VMC during a flight from Edinburgh, Scotland, to London Heathrow. As the A321 entered the top of what was described as a "dome of cloud," the airspeed indications on both PFDs decreased to nearly zero twice before returning to normal.

"Disruption to the ASIs [airspeed indicators] ceased on or shortly after the aircraft left cloud," the report said. The flight crew analyzed the situation and diverted the flight to London Stansted, where the winds were more favorable for landing.

The report said that the first incident occurred while the aircraft was being flown "within the boundary of current icing certification standards, which only consider supercooled water droplets." The second incident occurred outside the icing-certification altitude/temperature envelope and may have involved an encounter with ice crystals.

Although a flash of lightning was seen shortly before the first incident began, there were no signs that lightning actually struck the aircraft. The erroneous TCAS RA was found to have been caused by the brief disruption of altitude data.

Noting previous events involving erroneous air data, including the accident involving Air France Flight 447, an A330 that stalled and descended into the Atlantic Ocean on June 1, 2009, the report said, "Airbus has conducted studies including investigating reported airspeed-indication problems, icing wind tunnel testing and instrumented flight tests, [and] is in the process of developing expanded envelopes for inclusion in the [icing certification] requirements."

The report said that, meanwhile, the hazard of unreliable airspeed indications persists and that the A321 incidents discussed above "indicate that training to deal with unreliable air data can be effective."

## Entertainment System Ignites

Boeing 747-400. Minor damage. No injuries.

Inbound from Dallas, Texas, U.S., the 747 was about two hours from London Heathrow Airport the morning of Oct. 14, 2013, when the flight crew and some cabin crewmembers detected an "acrid, electrical burning smell," said the AAIB report.

The engine indicating and crew alerting system then displayed a "SMOKE LAVATORY" message, indicating that smoke had been detected either in a lavatory or in the cooling duct for the in-flight entertainment (IFE) system.

The commander transferred control to the copilot and consulted the QRH while cabin crewmembers checked the lavatories and galley. Smoke and flames were found to be emerging from an IFE unit in Galley 4. The cabin crew used fire extinguishers, but the fire reignited repeatedly. The flames finally disappeared after five extinguishers were emptied.

The IFE unit was designed to self-extinguish after it was isolated from electrical power. "An internal investigation by the operator concluded that it was likely the [IFE unit] had remained powered during the incident, and this was the reason it continued to re-ignite," the report said. Although a crewmember believed that he had isolated the IFE, investigators determined that he had completed only part of the isolation procedure.

## Standing Water on Runway

Beech 400. Substantial damage. Three minor injuries.

A witness told investigators that there was a heavy downpour shortly before the Beechjet arrived at Macon (Georgia, U.S.) Downtown Airport the morning of Sept. 18, 2012. VMC prevailed, but the rainfall had left standing water on the ungrooved runways at the uncontrolled airport, said the report by the U.S. National Transportation Safety Board (NTSB).

The pilots chose to land on Runway 28, which was 4,694 ft (1,431 m) long, and calculated a reference landing speed ($V_{REF}$) of 108 kt. The report said, however, that they likely did not consult the airplane's performance charts, which showed that the required landing distances on a runway contaminated with standing water were 4,800 ft (1,463 m) at a $V_{REF}$ of 110 kt and 6,100 ft (1,859 m) at $V_{REF}$ plus 10 kt.

The copilot attempted to activate the airport's lights, but the precision approach path indicator (PAPI) lights illuminated only briefly and could not be reactivated. Investigators later found that an open circuit breaker had prevented reactivation of the PAPI lights.

Analysis of recorded radar data indicated that the Beechjet crossed the runway threshold at about 125 to 129 kt and touched down within 1,000 ft (305 m) of the threshold. "Both crewmembers reported that although they used maximum thrust reverse, brakes and ground spoilers, they could feel a 'pulsation' in the brake system [and perceived] that the airplane hydroplaned," the report said.

The airplane overran the wet runway onto a short grassy area, traveled down an embankment and across a highway, and came to a stop in a wooded area. The pilots and their passenger sustained minor injuries.

The investigation concluded that the flight crew "lacked a clear understanding of the actual wet-runway landing distance" and "exhibited poor crew resource management by not using the appropriate chart for the contaminated runway, not recognizing that the runway was too short based on the conditions … and not recognizing and addressing the excessive approach speed."

## TURBOPROPS

### Radio Volume Misset

Fairchild Metro, Bell 47G. No damage. No injuries.

A flight instructor and pilot aboard the helicopter were conducting closed-pattern work as the pilot of the Metro prepared to depart for a cargo flight from the uncontrolled airport in Ballina, New South Wales, Australia, the afternoon of Oct. 9, 2013.

The helicopter was landed about two-thirds of the way down Runway 06 and remained stationary while the instructor briefed the pilot for another circuit, said the report by the Australian Transport Safety Bureau.

The Metro pilot had seen the helicopter land and had broadcast on the common traffic advisory frequency (CTAF) that he was taxiing to Runway 06. The pilot made three more calls and, hearing no response on the CTAF, began the takeoff.

"Just prior to rotation, he sighted [the helicopter] stopped on the runway," the report said. "He elected to continue the takeoff and increased the climb angle to provide separation with [the helicopter]."

The instructor aboard the helicopter told investigators that he had been making "appropriate calls" on the CTAF but had heard no calls from other pilots. After seeing the Metro pass overhead, he attempted to contact the Metro pilot on the CTAF but, after receiving no response, realized that the helicopter's radio volume was set too low to hear other transmissions.

### Faulty Contactor Drains Battery

De Havilland DHC-8-402. No damage. No injuries.

The Dash 8 was at 25,000 ft, en route with 20 passengers and four crewmembers from Edinburgh, Scotland, to Brussels, Belgium, the morning of Oct. 23, 2013, when the flight crew saw a "PUSHER SYSTEM FAIL" on the central warning panel (CWP). The flight crew conducted the appropriate QRH checklist and decided to continue to Brussels, the AAIB report said.

Shortly thereafter, a cabin crewmember told the pilots that the cabin lights were dimming. Eventually, all the lights extinguished, and several more cautions and warnings appeared on the CWP. As the flight crew consulted the QRH, the copilot's electronic flight displays failed.

As electrical system failures continued to occur, the crew noticed that there was no load on the no. 2 generator. They declared an urgency and diverted to Manchester Airport, where the aircraft was landed safely.

"It is suspected that there had been a failure of the right starter/generator or its generator control unit and that a further latent failure of a contactor had prevented automatic connection of the right DC [direct current] bus to the left DC bus," the report said. "The services normally powered by the right DC bus would now be powered by the main aircraft battery, which would progressively discharge."

### 'Improper Fuel Planning'

Beech King Air C90. Destroyed. Two fatalities.

The pilot was receiving ATC flight-following service during a visual flight rules (VFR) flight from Pine Bluff to Bentonville, both in Arkansas, U.S., the afternoon of Nov. 1, 2013. During descent, the pilot told ATC that he needed to divert to a closer airport because he was "low on fuel," the NTSB report said.

Shortly thereafter, while diverting to Fayetteville, Arkansas, about 9 nm (17 km) away, the pilot said that he needed an even closer airport. The approach controller recommended Springdale, which was about 4 nm (7 km) away at his 12 o'clock position.

The pilot said that he had Springdale in sight, and the approach controller provided the airport traffic control tower frequency. When the pilot contacted the tower controller, he reported that he was low on fuel.

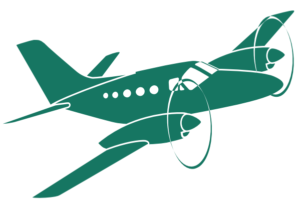
The tower controller issued wind conditions and the altimeter setting, and cleared the pilot to land on Runway 36. "Approximately 30 seconds later, the pilot advised that he was not going to make the airport," the report said.

The pilot apparently attempted to land the King Air on a field. "Three witnesses reported seeing the airplane pull up abruptly and fall from about 300 feet to the ground in a right-wing-low, nose-low attitude," the report said. Investigators determined that the airplane likely had stalled when the pilot attempted to avoid power lines crossing the field at 311 ft.

There was no sign of fuel spillage and no odor of fuel at the accident site. About 1.0 qt (0.9 L) of fuel remained in each fuel tank, but the fuel totalizer — a fuel quantity indicator that displays the total amount of fuel remaining in all of an aircraft's fuel tanks — indicated that 123 gal (466 L) remained aboard the King Air.

"The pilot was likely relying on the fuel totalizer instead of the fuel gauges for fuel information," the report said. "Information in the fuel totalizer is based on pilot inputs, and it is likely the pilot did not update the fuel totalizer properly before the accident flight."

The NTSB concluded that fuel exhaustion leading to a total loss of power was the probable cause of the accident and that "improper fuel planning" and the "pilot's reliance on the totalizer rather than the fuel quantity gauges" were contributing factors.



## PISTON AIRPLANES

### Descent Into the Sea

Piper Aztec. Substantial damage. Three fatalities, one serious injury.

The pilot departed with three passengers from Christiansted, on St. Croix, U.S. Virgin Islands, about 0445 local time the morning of Oct. 13, 2012, to deliver newspapers to Charlotte Amalie, on St. Thomas. Recorded radar data showed that the airplane initially was flown at 1,700 ft above the water before making a gradual descent to 200 ft.

"The airplane continued at 200 ft above the water for another 18 seconds before its radar target disappeared about 5 miles [8 km] from the destination airport," the NTSB report said.

The surviving passenger told investigators that the pilot had flown progressively lower to "get under the weather." She remembered seeing lights on the shoreline before the airplane "hit a wall" and filled with water. The pilot broke the left cockpit window and exited through it. The passenger also exited through the broken window.

"Examination of the wreckage revealed damage consistent with a high-speed, shallow-angle impact with the water," the report said. The two rear-seat passengers were killed. The pilot also is believed to have been killed; his body had not been found when the report was published.

There was no record that the pilot obtained a preflight weather briefing. "Weather data and imagery were consistent with the passenger's account of flying beneath the outer rain bands associated with a developing tropic storm southeast of the accident site," the report said.

### Heavy and Off-Balance

Britten-Norman Trislander. Minor damage. No injuries.

There were 11 passengers and a company employee aboard for a scenic flight from Pauanui Beach (New Zealand) Aerodrome the afternoon of Oct. 22, 2011. The pilot had conducted only one previous takeoff from the 782-m (2,566-ft) sand-and-grass runway, and that takeoff had been in a light airplane eight years earlier.

"The pilot did not check the expected aeroplane performance at Pauanui because, she said, the airline's chief executive officer had told her that the runway was adequate for the expected takeoff weight of 4,080 kg [8,995 lb]," said the report by the New Zealand Transport Accident Investigation Commission (TAIC).

Witnesses said that the Trislander accelerated slowly, and the pilot perceived that airspeed "stagnated" at 60 kt. The airplane did not rotate when she pulled the control wheel fully aft. "The pilot then closed the throttles and braked hard," the report said. "The aeroplane did not stop before the end of the runway and went through a low wooden rail marking the end of the runway."

TAIC investigators found that neither the pilot nor the airline had performed weight-and-balance calculations before the flight. The actual takeoff weight was within limits, but the investigation concluded that the airplane was too heavy to provide adequate performance for a takeoff from the unimproved runway.

The report said that "the primary reason for the aeroplane's failure to take off was that its centre of gravity was well forward of the maximum permissible limit," which prevented rotation.

## HELICOPTERS

### Mast Bumping

Robinson R66. Destroyed. One fatality.

The turbine helicopter was en route from Gillette, South Dakota, U.S., to Winner the morning of Oct. 1, 2011, when the main rotor mast separated 8 in (20 cm) below the teeter bolt. The R66 then struck terrain and burned near Philip, South Dakota.

"Examination of the mast revealed fracture features consistent with overload failure and mechanical damage indicative of mast bumping [contact between the rotor hub and rotor mast]," the NTSB report said. "The reason for the mast bumping event could not be determined due to the amount of thermal damage to the wreckage."

### 'Better to Continue'

Bell 206B. Substantial damage. One minor injury.

The JetRanger was in cruise flight at 2,000 ft near Shrewsbury, England, the afternoon of Oct. 4, 2013, when the pilot noticed that engine turbine temperature was near the maximum limit. He prepared to conduct a precautionary landing, but, as power was reduced during the approach, turbine temperature decreased.

Seeing no other abnormal engine indications, the pilot decided to continue to the destination, only a few miles away. "As the helicopter climbed away, the engine failed," the AAIB report said. "The pilot carried out a forced landing, during which the tail boom struck the ground.

"He candidly commented that, on reflection, it would have been better to continue with the precautionary landing rather than having to attempt a forced landing without power from low altitude."

Investigators determined that the engine likely failed due to oil starvation that caused a bearing to disintegrate. A foreign object, an O-ring, had entered the oil filter and lodged against a check valve that opens to provide oil to the bearings when the engine is running.

### 'Self-Imposed Pressure'

Bell 407. Substantial damage. Two fatalities, one serious injury.

Shortly after departing from Elmira, New York, U.S., for a VFR business flight to White Plains the night of Oct. 9, 2012, the helicopter encountered instrument meteorological conditions. The pilot, who held an instrument rating for airplanes but not for helicopters, decided to divert the flight to Mount Pocono, Pennsylvania.

Vertical visibility was estimated at 200 ft, and visibility was about 1/2 mi (800 m) in fog when witnesses saw the 407 flying very low over a highway in Coolbaugh Township, Pennsylvania. "Minimal ground lighting was present in the heavily wooded area surrounding the interstate," the NTSB report said.

The helicopter was being flown at about 30 kt when it struck trees and crashed about 200 ft (61 m) off the shoulder of the highway. The pilot and one passenger were killed; another passenger sustained serious injuries.

The NTSB report concluded that the probable cause of the accident was "the pilot's decision to continue VFR flight into instrument meteorological conditions due to self-imposed pressure to complete the trip."

## Preliminary Reports, July 2014

| Date | Location | Aircraft Type | Aircraft Damage | Injuries |
|---|---|---|---|---|
| July 2 | Nairobi, Kenya | Fokker 50 | destroyed | 4 fatal |
| Night visual meteorological conditions prevailed when the aircraft crashed in a residential area during takeoff for a cargo flight. | | | | |
| July 2 | Wilcox, Arizona, U.S. | Rockwell Aero Commander 500S | substantial | 2 none |
| The Aero Commander encountered a quartering tail wind and veered off the side of the runway on landing. | | | | |
| July 2 | Harrison, Arkansas, U.S. | Piper Twin Comanche | destroyed | 1 serious |
| Witnesses saw the airplane enter a steep left turn on takeoff and strike terrain off the side of the runway. | | | | |
| July 2 | Cox's Bazar, Bangladesh | ATR 72-212 | sub stantial | 48 NA |
| The ATR's nose landing gear collapsed on landing. | | | | |
| July 3 | Fallon, Nevada, U.S. | Eurocopter AS350B | substantial | 1 minor |
| The pilot jettisoned the external load when the helicopter began to yaw left and descend as it neared a drop zone at 8,600 ft. The rotation and descent continued until the AS350 struck terrain and rolled over. | | | | |
| July 5 | Częstochowa, Poland | Piper Chieftain | destroyed | 11 fatal, 1 serious |
| Witnesses said that an engine was misfiring as the Chieftain took off for a skydiving flight. The aircraft crashed in a prairie about 2 km (1 nm) from the airport. | | | | |
| July 6 | Monkey Mountain, Guyana | Britten-Norman Islander | substantial | 2 none |
| The landing gear was damaged when the Islander touched down short of the runway. The aircraft then veered off the side of the runway. | | | | |
| July 6 | Chirundu, Zambia | Britten-Norman Islander | destroyed | 2 serious |
| The Islander struck a cliff during an attempted emergency landing on a road after engine problems occurred during a positioning flight from South Africa to the Democratic Republic of Congo. | | | | |
| July 17 | Hrabove, Ukraine | Boeing 777-200 | destroyed | 298 fatal |
| The 777 was cruising at 33,000 ft during a flight from Amsterdam, Netherlands, to Kuala Lumpur, Malaysia, when it was struck by a surface-to-air missile. | | | | |
| July 23 | Magong, Taiwan | ATR 72-200 | destroyed | 48 fatal, 10 serious |
| The flight crew abandoned a nonprecision approach in instrument meteorological conditions after the ATR drifted 340 m (1,116 ft) left of the extended runway centerline. The aircraft then struck trees and crashed in a residential area. No one on the ground was hurt. | | | | |
| July 24 | Gossi, Mali | McDonnell Douglas MD-83 | destroyed | 116 fatal |
| Radar contact with the MD-83 was lost after the flight crew diverted from the planned route from Ouagadougou, Burkina Faso, to Algiers, Algeria, because of adverse weather conditions and then requested clearance to return to the departure airport. The wreckage of the aircraft later was found about 50 km (27 nm) from Gossi. | | | | |
| July 25 | Boulder City, Nevada, U.S. | de Havilland Twin Otter, Eurocopter EC-130 | substantial | 9 none |
| The Twin Otter crew was taxiing for takeoff for a positioning flight and the helicopter pilot was descending to land after a sightseeing flight when the aircraft collided on a taxiway at the uncontrolled airport. | | | | |
| July 28 | Foz do Iguaçu, Brazil | Embraer Bandeirante | substantial | 1 minor, 3 none |
| The flight crew encountered unspecified technical problems during takeoff for a scheduled flight and conducted an emergency landing in a cornfield with the landing gear retracted. | | | | |

NA = not available

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

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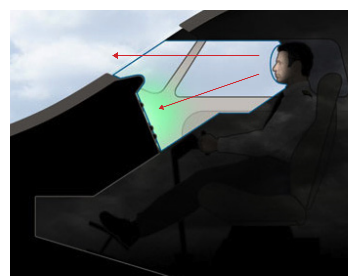

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