AeroSafety WORLD

SRM IS NEW CRM
UAS management

ENGLISH TAKES FLIGHT
Using a common language

MIND GAMES
Studying pilot thinking

PLUGGED IN
PED ISSUES IN THE CABIN

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

JULY–AUGUST 2014

67th annual International Air Safety Summit

IASS 2014

November 11–13, 2014

Jumeirah at Etihad Towers
Abu Dhabi, United Arab Emirates

FLIGHT SAFETY FOUNDATION

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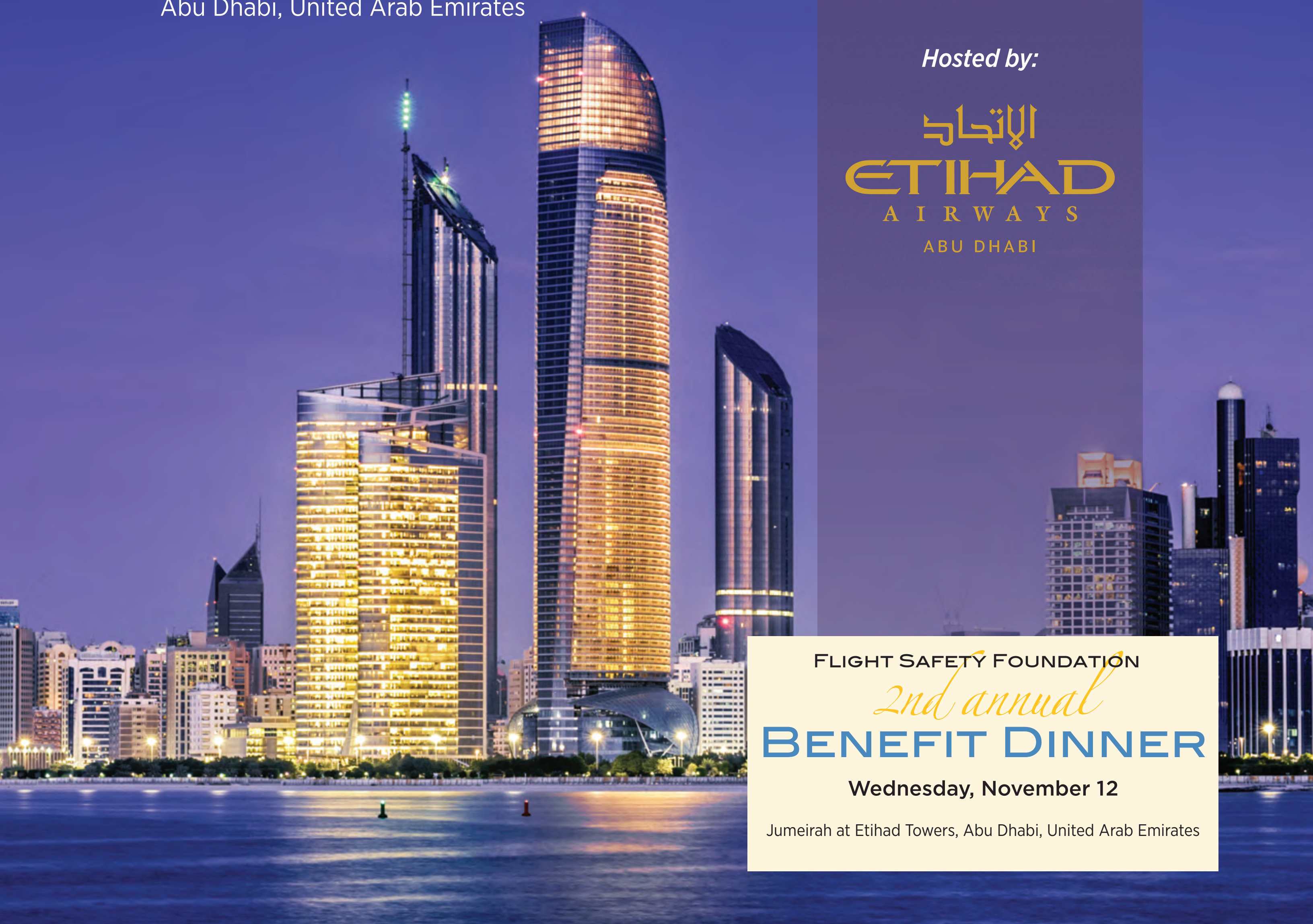

FLIGHT SAFETY FOUNDATION
2nd annual
BENEFIT DINNER
Wednesday, November 12

Jumeirah at Etihad Towers, Abu Dhabi, United Arab Emirates

The 67th annual International Air Safety Summit (IASS) will be held November 11–13, 2014 at the Jumeirah at Etihad Towers, Abu Dhabi, United Arab Emirates. In conjunction with 2nd annual Foundation Benefit Dinner — Wednesday, November 12. Details coming soon! Please visit the website below for hotel information and further details about the event as they become available.

flightsafety.org/IASS2014

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WITHSTANDING Risks

Throughout the past year, Flight Safety Foundation has been focusing on several important issues, including runway safety and go-arounds; data analysis, sharing and protection; and operating in remote and dangerous environments. Late last year, we added airborne conflict to this list. These are all areas that affect aviation safety — and all areas where we can make a difference.

The absence of recent large-scale airborne conflict accidents does not mean the system is without risk. In fact, our data-driven approach to safety, in which we look specifically at incident precursors during normal operations in order to identify not only the areas of greatest risk but also paths to mitigation, shows that we have had some alarming near-midair collisions recently. These "near accidents" remind us that, while we may have escaped disaster, we need to examine what happened and ensure that the safety buffers we have built into the system are sufficient and not being compromised.

In these near accidents, the system worked, as it does every day when the layers of safety protection we have developed over the years kick into action to prevent tragedy. But we must continue to report and analyze these and other similar incidents so that we can ensure our system is strong enough to withstand the risks lurking out there.

We are seeing the results of an increased effort to encourage more and better reporting of safety incidents by individuals. With a just culture and the protections put into place surrounding data, the reporting of these incidents is becoming more robust. This data is invaluable in advancing our understanding of the risks in the airspace. Ours is a system that ultimately is operated by humans using the best tools and technology that we have developed over the decades.

But humans make mistakes, and technology can sometimes let us down. And the airspace is getting more crowded every year, with commercial and business jets, and private pilots in single-engine aircraft — not to mention the promised influx of unmanned aircraft.

The Foundation can play an important role in the discussion of airborne conflict. We recently hosted a meeting in Brussels, Belgium, to bring together experts on this issue. Working with Eurocontrol, the European Regions Airline Association and our advisory committees, we'll use what we learned in Brussels to help address the problem.

Jon L. Beatty
President and CEO
Flight Safety Foundation

AeroSafety WORLD

contents

July–August 2014
Vol 9 Issue 6

features

departments

About the Cover
Expanded use of portable electronic devices and uninvited attention in social media complicate life for U.S. cabin crews.

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

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PLEASE PREPARE The Cabin

Twenty-five years ago, on July 19, 1989, a Douglas DC-10 crash landing in Sioux City, Iowa, U.S., became an archetypal example of successful crew resource management. United Airlines Flight 232 was on its way from Denver to Chicago when the tail-mounted engine exploded approximately 37,000 ft over northwestern Iowa. Separation, fragmentation and forceful discharge of stage 1 fan rotor assembly parts from the no. 2 engine rendered the hydraulics useless. Fortunately, the airplane's two wing-mounted engines were still operable, as differential thrust was all the crew had to control the airplane.

Capt. Al Haynes alerted his crew to brace 285 passengers for a crash landing. But there was no way to properly prepare the four lap-held children younger than 2, who were unrestrained. As instructed, the parents wrapped their babies in towels and blankets, placed them on the floor and braced them with their hands and legs. This was the protective measure the airlines had in place at the time for the plane's most precious cargo.

Amazingly, 185 people aboard the plane survived the crash landing and subsequent fire, including lap children recovered by strangers after they were found in the luggage bins of the upside down fuselage. But one child was not found. Not surprisingly, hands, feet, blankets and towels could not restrain the lap children on that flight.

Twenty-five years later, airlines still do not require child restraints.

Juxtapose the aviation exemption from restraints for lap children with the standard of care for children in motor vehicles. Since 1989, there have been significant data-driven paradigm shifts in traffic safety. Today, every state in the United States requires that children be restrained in size-appropriate restraints, and 49 of the 50 states require seat belt use. In 2011, seat belts saved an estimated 11,949 lives, and child restraints saved an estimated 263 lives among children younger than 5, according to the National Safety Council. Because of the efficacy of child passenger restraints, lower anchors and top tethers for children, or LATCH systems, are required in motor vehicles manufactured after 2001.

Passenger restraint improvements have been made in aviation safety since 1989. Today, 16-g dynamic seats are the standard for newly manufactured commercial aircraft, and some seating positions have seatbelt-mounted airbags. However, only general aviation aircraft manufacturers, like Cirrus, have installed LATCH-compatible seats.

In the end, failing to require that all passengers, including children younger than 2, be restrained is a glaring safety gap in what is otherwise a safety-centric industry.

Many are committed to closing that gap. In May, the International Air Transport Association hosted its inaugural Cabin Operations Safety Conference in Madrid, with 250 attendees from more than 30 worldwide airlines. They focused on infant safety restraints in cabins. While the regulations haven't been updated in half a century, the airlines may just provide the leadership we need on this issue.

Today, airlines with code-share agreements face a patchwork regulatory system around the world. Some airlines encourage parents to install their own FAA-approved child safety seats, other airlines provide already installed seats, and still others discourage the use of the seats. It depends on the country in which your flight originates. Harmonization is overdue.

We dutifully restrain luggage, coffee pots and laptops on every flight — why not our most vulnerable and valuable cargo?

Deborah A.P. Hersman is president and CEO of the U.S. National Safety Council, which identifies causes of unintentional injuries and deaths and seeks prevention strategies. She previously was chairman of the U.S. National Transportation Safety Board.

The opinions expressed are those of the author and not necessarily those of the Flight Safety Foundation.

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.

Member**Guide**

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JULY 3 ➤ Technology: Friend or Foe? The Introduction of Automation to Offshore Operations (Annual Rotorcraft Conference). Royal Aeronautical Society. London. <conference@aerosociety.com>, +44 (0) 20 7670 4345.

JULY 14–15 ➤ Managing Safety for High Performance. Universal Weather and Aviation. London. Sean Wear, +44 7799 623207.

JULY 14–20 ➤ 49th Farnborough International Airshow. Farnborough Airport. Farnborough, Hampshire, England. <enquiries@farnborough.com>, <farnborough.com>, +44 (0) 1252 532 800.

JULY 16–17 ➤ Evidence-Based Training Meeting. International Air Transport Association in collaboration with International Civil Aviation Organization. Lima, Peru. Marcelo Ureña, <murena@icao.int>.

JULY 23–27 ➤ Lawyer-Pilot Bar Association (LPBA) Summer 2014 Convention. Lawyer-Pilot Bar Association. Santa Ana Pueblo, New Mexico, U.S. Karen Griggs, <karen@lpba.org>, <lpba.org>.

JULY 28–AUG. 3 ➤ EAA AirVenture Oshkosh. Experimental Aircraft Association. Oshkosh, Wisconsin, U.S. <eaa.org/en/airventure>.

AUG. 4–7 ➤ ALPA 60th Air Safety Forum. Air Line Pilots Association, International. Washington. Tina Long, <tina.long@alpa.org>, <safetyforum.alpa.org>.

AUG 4–8 ➤ International System Safety Training Symposium 2014 (ISSTS 2014). International System Safety Society. St. Louis. <issc2014.system-safety.org>.

AUG. 11–14 ➤ Bird Strike Committee USA Meeting. Bird Strike Committee USA. Atlanta. John Ostrom, <john.ostrom@mspmac.org>, <www.birdstrike.org>, +1 612.726.5780.

AUG. 13–14 ➤ Maintenance and Engineering Safety Forum. Flight Safety Foundation. Singapore. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

AUG. 18–19 ➤ Approach and Landing Accident Reduction (ALAR) Info Exchange. Flight Safety Foundation. Singapore. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

SEPT. 3–5 ➤ ALTA Aviation Law Americas 2014. Latin American and Caribbean Air Transport Association. Miami. <www.alta.aero>, +1 786.388.0222.

SEPT. 8–12 ➤ Aviation Safety Summit 2014. Latin American and Caribbean Air Transport Association. Curaçao. <www.alta.aero>, +1 786.388.0222.

SEPT. 13–19 ➤ 2014 National Safety Council Congress and Expo. National Safety Council. San Diego. <congress.nsc.org>.

SEPT. 22–24 ➤ Air Medical Transport Conference 2014. Association of Air Medical Services. Nashville, Tennessee, U.S. <www.aams.org>, +1 703.836.8732.

SEPT. 23–24 ➤ Asia Pacific Airline Training Symposium (APATS 2014). Halldale. Bangkok, Thailand. <halldale.com/apats>.

SEPT. 23–25 ➤ International Flight Crew Training Conference 2014. Royal Aeronautical Society. London. <conference@aerosociety.com>, +44 (0) 20 7670 4345.

SEPT. 28–OCT. 1 ➤ 59th ATCA Annual Conference and Exposition. Civil Air Navigation Services Organisation (CANSO). Washington. Anouk Achterhuis, <events@canso.org>, +31 (0) 23 568 5390.

SEPT. 29–OCT. 3 ➤ Aircraft Accident and Incident Investigation: ICAO Annex 13 Report Writing. Singapore. Singapore Aviation Academy. <saa@caas.gov.sg>, <saa.com.sg>, +65 6543.0433.

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

OCT. 26–OCT. 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>.

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. 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. 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>.

MARCH 2–5 ➤ HAI Heli-Expo 2015. Helicopter Association International. Orlando. <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.

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.

Safety News

© Courtesy of BP

UAS Exemption Considered

The U.S. Federal Aviation Administration (FAA) has approved the first commercial flights over land by unmanned aircraft systems (UAS). The flights — by energy corporation BP and UAS manufacturer AeroVironment — were conducted for aerial surveys of BP pipelines, roads and equipment at Prudhoe Bay, Alaska.

The first flight — by an AeroVironment Puma AE, a hand-launched vehicle with a 9-ft (3-m) wingspan — was conducted on June 8.

The FAA also is reviewing requests from seven aerial photo and video production firms for approval to begin operating UAS before the FAA proposes regulations for their use.

The companies have asked to be exempt from certain regulations involving pilot certificate requirements, manuals, maintenance, equipment mandates, aircraft certification and other flight rules, the FAA said. If the FAA agrees, the companies would be permitted to operate UAS aircraft in "narrowly defined, controlled, low-risk situations," the agency said.

In a related development, the FAA said that the third of six UAS test sites had become operational. The site, operated by the state of Nevada, will conduct UAS flights from an airport in Mercury, Nevada, owned and operated by the U.S. Department of Energy.

Research at the site will focus on UAS standards and operations, operator standards, certification requirements and air traffic control procedures.

Two other sites — in North Dakota and Alaska — began operating earlier this year.

Landing Performance Assessments

Landing performance assessments should be mandatory before every landing of a transport category aircraft, the Jamaica Civil Aviation Authority (JCAA) says.

The agency included the recommendation in its final report on a Dec. 23, 2009, runway overrun accident in which an American Airlines Boeing 737-800 overran a wet runway at Norman Manley International Airport (NMIA) in Kingston, Jamaica, crashed through a fence and traveled across a road before stopping on sand dunes and rocks near the Caribbean Sea. Fourteen of the 154 people in the 737 were seriously injured and the airplane was destroyed.

In its final report, the JCAA said that the probable cause was that the airplane touched down 4,100 ft (1,251 m) beyond the threshold of the 8,922-ft (2,718-m) runway. Contributing factors included the decision to land on a wet runway with a 14-kt tailwind.

The JCAA recommended that landing performance assessments be conducted, "based on a standardized methodology involving approved performance data, actual arrival conditions, a means of correlating the airplane's braking ability with runway surface conditions using the most conservative interpretation available and incorporating a minimum safety margin of 15 percent."

The JCAA also recommended that operators of airports serving transport category airplanes include in their standard operating procedures a requirement that either pilot call for a go-around if he or she "sees that the aircraft will not land in the touchdown zone and that the other pilot will follow through with the go-around procedure without question or hesitation."

Other recommendations included calls for more training in tailwind landings, which the JCAA said should be "firmly discouraged" if heavy rain is falling or runways are contaminated with standing water; for improvements in runway end safety areas at NMIA; and for expanded guidance from the International Civil Aviation Organization on determining the frequency of special runway surface condition inspections during or after heavy rain.

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New Approach to Regulation

The U.K. Civil Aviation Authority (CAA) says it is moving toward "regulating in a more proportionate, effective and risk-based way," using the safety management systems in place at airlines, airports and ground handling organizations to help identify areas that present the greatest risks to safety.

"Performance-based regulation takes our safety oversight to a new level," Mark Swan, director of the CAA Safety and Airspace Regulation Group, said in early June. "By working hand-in-hand with the aviation industry, EASA [the European Aviation Safety Agency] and other national authorities to identify and manage risk effectively, we can concentrate our attention where it is most needed."

Swan added that industry cooperation would ensure the success of the new regulatory effort.

The CAA said that the new system would help the agency measure "the true extent of the risks to U.K. passengers and the general public" and identify and implement appropriate actions to manage risks. One key element calls for cooperating with civil aviation authorities in other countries that could take action to mitigate risks to U.K. operations.

The agency expects to have a full performance-based regulation system in place by April 2016 but already has established several elements of the system, including a new method of safety oversight based on identified risks and safety performance and a series of risk-mitigation activities and associated safety projects. The CAA also has established requirements for "an integrated safety risk-reporting and management system to better inform strategic decisions made by the CAA Board and the allocation of resources to act on them."

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Proposed UAS Rules Change in Australia

The Australian Civil Aviation Safety Agency (CASA) has proposed allowing operators of small remotely piloted aircraft — also known as unmanned aircraft systems (UAS) — to be flown in standard conditions without special approval from the agency.

"Standard conditions" involve flights within the operator's line of sight, less than 400 ft above ground level, in non-populous areas, outside controlled airspace and more than 30 m (98 ft) from people and buildings.

The change would mean that UAS aircraft weighing less than 2 kg (4 lb) would no longer require an operator certificate or a remote pilot certificate, CASA said. The documents still would be required for UAS aircraft weighing more than 2 kg, the agency said.

CASA said it proposed the change because "small, remotely piloted aircraft have a very low kinetic energy and thus pose a low risk to people, property and airspace users."

The agency was accepting comments on the proposal until mid-June.

In a related development, CASA is directing a new education campaign at operators of model aircraft, urging them to become more familiar with the rules governing their hobby.

CASA, in cooperation with 16 retailers that sell model aircraft, is distributing a fact sheet that emphasizes that model aircraft must be flown in standard conditions and must not be flown within 5.5 km (3.4 mi) of an airport. The fact sheet also stipulates that model aircraft may not be flown "for money or reward without an approval from CASA."

CASA said that it "wants people to have fun flying their model aircraft, but it is important for everyone to be aware of the rules and to follow them. Even relatively small model or remotely piloted aircraft can cause injuries if not flown safely."

Map: © FrankRamspott | istockphoto.com
UAS: © Big_Ryan | istockphoto.com

Expanding on Flight Tracking

Proposals for enhancing global flight tracking should be ready for consideration by the aviation industry before the end of the year, two international aviation organizations say.

The International Civil Aviation Organization (ICAO) said that its member states and the international air transport industry agreed during a mid-May meeting on the "near-term priority to track airline flights, no matter their global location or destination."

Near-term needs are being addressed by an aircraft-tracking task force coordinated by the International Air Transport Association (IATA), which said that the task force will develop a set of recommendations, giving airlines several options.

The effort to identify and implement flight-tracking procedures was prompted by the March 8 disappearance of a Malaysia Airlines Boeing 777 during a flight from Kuala Lumpur, Malaysia, to Beijing. The airplane, which carried 239 people, has not been found.

"Aviation stakeholders are united in their desire to ensure that we never face another situation where an aircraft simply disappears," said Kevin Hiatt, IATA senior vice president for safety and flight operations.

ICAO said that it would consider performance-based international standards to ensure implementation of airline flight tracking worldwide and would work with the IATA task force to develop "a flight tracking concept of operations covering how the new tracking data gets shared, with whom and under what circumstances."

NextGen Snapshot


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RTCA's NextGen Advisory Committee has narrowed 36 original "focus operational capabilities" from four years ago to four critical tasks in its latest advice to the U.S. Federal Aviation Administration (FAA): encouraging performance-based navigation (PBN) equipage, introducing NextGen surface operations, accelerating use of closely spaced parallel runways and increasing controller-pilot data link communication (CPDLC).

Specialists who briefed the RTCA 2014 Global Aviation Symposium called NextGen the FAA's "top priority from a safety standpoint" but also noted unexpected agency workload related to factors such as flat/unstable funding, legislative mandate for National Airspace System integration of commercial unmanned aircraft systems (also known as remotely piloted aircraft) beginning in 2015, and potential upgrades in global tracking of airliners.

John Hickey, FAA deputy associate administrator for aviation safety, said NextGen "will be one of the biggest, most significant improvements in safety in the modern age." PBN should nearly eliminate risks of unstable approaches and runway excursions, and CPDLC should minimize air-ground miscommunication and data-entry errors for predeparture clearances, he said.

An independent analysis of opportunities to gain immediate operational benefits is under way, said Lillian Ryals, director, senior vice president and general manager of the MITRE Corp. Center for Advanced Aviation System Development. "We need to focus on near-term wins … to show immediate returns [on investments] to keep everybody engaged to make long-term investments," she said.

The simultaneous launch of 61 PBN instrument flight procedures for the Houston metroplex (*ASW,* 7–8/11, p. 28) stimulated enthusiasm, added Dale Wright, director, safety and technology, National Air Traffic Controllers Association. The FAA defines a metroplex as a system of airports, including at least one major commercial airport, in close proximity and with shared airspace. Elsewhere, presenters said, metroplexes have reported aircraft avoidance of terrain hot spots; reduced taxi-out times; fuel savings from flight-idle, optimized profile descents; reduced airport-noise footprints (but noise concentrated by the precise flight paths); and increased departure rates.

— Wayne Rosenkrans

In Other News …

The Air Line Pilots Association, International and the U.S. Federal Bureau of Investigation (FBI) have expanded their campaign to raise awareness of the consequences of **laser illumination** of aircraft to include all 50 states. They say a test program involving 12 FBI field offices is responsible for a 19 percent decrease in laser incidents in those areas. … No fatal accidents related to **air navigation services (ANS)** have been recorded in Europe for more than three years, and the number of reported incidents in 2013 was the lowest in the past 11 years, according to a report by Eurocontrol's independent Performance Review Commission. …A report from the U.S. National Research Council says improvements are needed in the U.S. Federal Aviation Administration's model used in estimating the staffing requirements of **air traffic control centers**.

Compiled and edited by Linda Werfelman.

Remotely piloted aircraft warrant a new CRM.

Situational Resource Management

It is difficult to imagine how the U.S. aviation landscape will look in 20 years assuming the introduction, beginning in 2015, of commercial remotely piloted aircraft (RPA) — also known as unmanned aircraft systems, or UAS — into the National Airspace System under anticipated regulations. It is critical, however, that aviation professionals examine this new paradigm and what it will take to make this transition safely and efficiently. A synergistic relationship between the technology and systems, and the new breed of pilot and crew, is essential to ensuring that both the flying and non-flying public feel that the skies remain safe.

Just as the complex software and hardware systems integrated into today's aircraft, both manned and remotely piloted, must adhere to the applicable aerodynamics, both types of flight operations also must adhere to the fundamental tenets of responsible aviation. Pilots must understand the systems they operate both in normal and failure modes. Flight profiles, mission data (to include weather, aircraft systems status and expected performance) and crew coordination expectations are critical preflight discussion items in either type of operation. One difference, however, is that even if flight crews aboard aircraft are at risk of becoming complacent because of their reliance on automation, they know they normally can take back control of the aircraft and fly it safely to the ground. This capability is impossible by definition in the RPA environment, and is a critically important concept for RPA pilots to understand and accept.

While it is true that an RPA shares many similarities with manned aircraft, the most critical difference is insertion of an unnatural break between the pilot and the aircraft. The nature of this break exceeds the early controversy that surrounded the transition from mechanical control cables to fly-by-wire electrical controls seen in many of today's most sophisticated aircraft. The RPA has introduced a completely separate interface to the aircraft, and this intangible, nonphysical tether becomes a "middleman," or virtual pilot, translating and executing the human commands at a distance.

Because the human crew is physically removed from the aircraft, there is no longer a traditional hand-flying fallback when the technology goes awry or overwhelms either the pilot or an autonomous-recovery flight mode. Stick and rudder is no longer the safety net — literally everything depends first on the pilot communicating with the system that actually flies the aircraft.

Increasing the complexity further are unmanned aircraft systems in which over-the-horizon RPAs are used; in these systems, an induced latency in the data communication link between the crew and the aircraft exists as commands travel along pathways that may include satellites. This is a second, vitally important concept for the RPA pilot to grasp. It sometimes takes several seconds for the RPA to respond to control inputs by the pilot because of the distance the radio signal must travel to the satellite and back. And because the pilot sometimes must transmit commands to the aircraft just seconds before they must be executed, physical reaction time will become less important than anticipatory commands — reactive flying will be forced into proactive and even predictive flying. The skills of an RPA pilot in these scenarios have to be measured equally between his or her ability to manage a system-driven flight and to mitigate hazards, and ability to execute a flawless flight maneuver.

Technology as Crewmember

In the early 1980s, the initial tenets of cockpit resource management (CRM)

BY DAVID ROYO AND THOMAS ANTHONY

U.S. Department of Homeland Security, Customs and Border Protection

U.S. National Aeronautics and Space Administration

were implemented to help commercial transport aircrews better work together to avoid procedural errors and to identify, assess and mitigate hazards that may arise during flight. Shortly thereafter, the word *cockpit* was traded for *crew* to include other in-flight crewmembers and even flight support personnel on the ground. This semantic change was a critical, if not realized then, step in preparing the aviation community to think in terms of systems and not just individuals. The pilots were, and are, arguably the most critical component of CRM, but by using the word *crew,* everyone involved in getting an aircraft from one location to another was now thrust into the process of safely managing and completing the operation.

Concurrently, the glass cockpit was being introduced. The hundreds of dials and switches of the traditional cockpit were replaced first with electronic analog screens that could display essential flight and performance data to pilots in an easily interpreted manner. As these systems evolved, the computational processing power did as well, allowing flight management systems to be implemented.

In the last 30 years, aviation has witnessed a steady further increase in flight deck automation. Integrated digital displays of aircraft systems and flight performance now combine with environmental presentations to allow the pilots to "see" the world around them from terrain to weather to other aircraft. The entire flight can be mapped, monitored and managed by automation with minimal subsequent input from the pilot. More importantly, very affordable technology — derived from avionics once reserved for the large, commercial airliner or sophisticated business or military aircraft — has made its way to small general aviation aircraft. This trickle-down effect has provided an incredible amount of situational awareness and workload management to a large percentage of the aviation community. It also has created a level of trust in the technology that has, at times, made it possible for the capabilities of the pilot to be exceeded through over-reliance on automation.

In effect, automation has become another crewmember that must be incorporated into the CRM process. It has become an integral part of the crew concept and is subject to the same fallacies as its human counterparts, reinforcing the need to include it in our resource management process. The communication aspect of traditional CRM now extends to the automated aircraft itself.

Expanding the SA Envelope

To pilots, the concept of situational awareness (SA) during flight operations is not new. SA involves perceiving the temporal (time) and spatial world around us and then interpreting it in a way that allows us to react immediately or to project into the future a probable outcome. Automation has provided a tremendous benefit in expanding the SA envelope of manned aircraft flight crews from moving maps, to weather overlays, to three-dimensional presentations of terrain and objects around the aircraft.

But when pilots interpret flight displays, their frame of reference, or mental model of their environment, has been developed from an ergonomic design that has always placed the aircraft, literally or conceptually, at the center of a display. Temporal and spatial relationships and relativistic motion are easier and, more importantly, faster to derive from an aircraft-centered presentation. This is important to consider when we take into account that for the pilot of a manned aircraft, vision is the primary sensory input.

In the RPA world, however, the normal human wide-angle vision is replaced with very narrow fields of view. A simple turn of the head inside a cockpit requires a mechanical action in an RPA — either via camera or reorienting the RPA itself. Mechanical action translates to time, and time translates directly to a level of situational awareness.

As mentioned, this can be compounded by latency in the control data transmissions to and from the RPA. Further, in the RPA world, the pilot is no longer at the center of the display even though the aircraft is. The physical forces on the aircraft and its relation to its environment must be transferred via that invisible tether to the pilot and then presented in a manner that can be interpreted and acted upon. When the pilot directly can see the RPA from the ground, this is a relatively simple proposition, but when it leaves the pilot's line of sight and situational awareness becomes display-centric, the complexity increases rapidly. Situational awareness is then directly coupled with the requirement to conduct the proactive/predictive flying already described.

To accommodate this new complexity, we propose transforming the current CRM model of manned aviation into a s*ituational resource management (SRM)* model for the RPA community to better integrate the "automated crewmember" aspect of their systems into human processes and to mentally place RPA pilots in the remote reality.

InSight is a forum for expressing personal opinions about issues of importance to aviation safety and for stimulating constructive discussion, pro and con, about the expressed opinions. Send your comments to Frank Jackman, director of publications, Flight Safety Foundation, 801 N. Fairfax St., Suite 400, Alexandria VA 22314-1774 USA or jackman@flightsafety.org.

Big Sky, Many Aircraft

If we presuppose that tomorrow's airspace will look similar to today's, we quickly can foresee significant challenges. Consider what now is termed *uncontrolled airspace*, the home of much of general aviation. If we project forward to a time when the small-scale RPA become significant airspace users, this airspace segment will become a battleground for both utilization and regulation.

Business, government and private users already are clamoring for unfettered access and use of this traditionally uncontrolled regime. But the legacy rules-of-the-road protections and basic airmanship fundamentals would begin to falter in an environment where see-and-avoid is drastically diminished, situational awareness of the operator is reduced to a mere fraction, and pilot/RPA response times are delayed.

Adding to this challenge is the relative size of many of these RPA. Manned aircraft pilots understand how difficult it is to see full-size aircraft against hazy horizons, cluttered fields or urban cityscapes. When these aircraft are reduced in size by an order of magnitude, their radar-detected cross sections are shrunk proportionally, and reciprocal see-and-avoid by the RPA pilot is absent, there is a significant hazard potential in the low-altitude regimes.

Even more significant is the operation of these aircraft in the vicinity of today's urban airports such as those in Los Angeles, Chicago or San Diego, where urban sprawl extends literally to the fence lines of the airport. The RPA will be nearly invisible to pilots of manned aircraft in these dense environments and will pose a threat to the aircraft utilizing the departure and arrival corridors. The desires of the manned-aircraft general aviation community for maximum flexibility and utilization of airspace must be carefully weighed against the safety hazards that will be potentially created by the RPA proliferation in areas of population-dense or controlled-airspace interfaces.

Past is Prologue

Just as today there are many levels of manned aviation enthusiasts and professionals, tomorrow there will be the same strata in the remote aviation community. Each gradation of manned-aircraft pilots existing today will have a direct counterpart tomorrow in the remotely piloted world. Naturally, simple RPA with low-performance characteristics require fewer capabilities from their pilots than those expected for operating the sophisticated, high-performance RPA. But commonalities will remain. Basic airspace environment fundamentals and regulatory compliance, weather, aerodynamics, flight systems, navigation and maintenance knowledge persist for all of them.

Similarly, preflight planning and briefing protocols, hazard/risk assessments and contingency planning must still be conducted. Just as in manned aviation today, the key variable will be the level of complexity. If the fundamentals of piloting —learned by trial and taught through professionalism — are maintained and built into the foundation of the RPA future, there is every expectation that this transition can be accomplished safely and coherently for the benefit of us all.

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The opinions expressed here are the authors' and not necessarily those of Flight Safety Foundation.

Brave New World

BY WAYNE ROSENKRANS

Novel risks involving airline passengers' behavior with social media and/or in-flight use of portable electronic devices (PEDs) are being validated a bit at a time, say two U.S. cabin safety specialists. Early signs lead them to expect these changes to be a lasting consequence of governmental decisions to accommodate public demand for expanded in-flight use of passenger-supplied PEDs and media they produce. So they recommend that training programs specifically prepare flight attendants to be resilient in coping with the effects.

Speaking at the World Aviation Training Conference and Tradeshow (WATS 2014) in April, Larry Parrigin, manager of curriculum development, Southwest Airlines University, focused on disruptive changes that social media have brought to the cabin environment, airline classrooms and the lives of flight attendants — especially when crewmembers' decisions and on-the-job actions "go viral" within minutes on the Internet. Candace Kolander, coordinator for air safety, health and security, Association of Flight Attendants–Communications Workers

Social media pressures and expanded use of portable electronic devices disrupt conventional cabin safety.

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of America (AFA-CWA), addressed what she described as a rushed method of enabling all-phase PED use that in October 2013 resolved concerns about electromagnetic interference risks but so far overlooks some of the human factors.

Social Media Disruption

"Social media [use] is now the no. 1 activity on the web," Parrigin said. "Social media are used by our employees and passengers. How do we incorporate that and deal with that in our training environments? … It also allows our customers to air our goofs and blunders in a matter of seconds — and a lot of times before we can actually be prepared to respond. … This is the new reality that our flight attendants are currently facing."

Relevant training begins with education about the potentially harmful consequences that can arise from any aviation professional's communication through social media. Typically, formal training first covers the airline's social media policy for employees, he said.

"All of our employees have a right to free speech, but a paycheck comes with a certain level of responsibility, and I think we owe it to [flight attendants] to really educate them," Parrigin said. "But there are very few policies in place if any of our passengers utilize social media. We don't spend a lot of time training our folks on that 'ever-present watchdog' in the cabin — and I think this has taken on increased relevance, especially now that most [U.S. airlines] have gate-to-gate PED policies in place [with a] WiFi system active gate to gate. Now we say, 'Work every flight as if someone is taking a photo or video of what you're doing in the airplane — because they are.'"

The new normal is that, at the first sign of trouble in the cabin, passengers immediately retrieve smartphones to take photos and make video recordings, cabin crews report. Increasingly, the resulting digital media are uploaded to social media sites just as soon as these incidents occur, he said.

Among diverse subjects captured have been aircraft anomalies, crew responses to disruptive passengers and abnormal behavior of aircraft crewmembers. Parrigin showed that an Internet search during the conference, for example, for the phrase "flight attendant meltdown" produced tens of thousands of web page hits.

The recordings made with PEDs can result in a benefit or can do harm, or both, from the standpoint of cabin safety. "The good side is that recording on the airplane … gives us a raw, unfiltered [look] as to what is actually occurring in the cabin," Parrigin said. "This is not a flight attendant report. This is not a customer letter. This is not a re-creation scenario. It is what is actually occurring. Now on the flip side, these photos and videos rarely show the lead-up to any particular event. All of our patient interactions with difficult customers do not warrant any kind of social media update. …. So we have a very skewed perception. We get all of the drama with none of the context. Without that context, these events are very easily misinterpreted by anyone who wants to play armchair quarterback."

Flight attendants and other cabin safety specialists — as aviation professionals — have a responsibility not to draw conclusions about an event based on a single source. This includes caution about how any externally sourced videos and photos from the Internet are presented during flight attendant training, he said.

New Training Resource

"If you ask, 'Should we use social media in training?' I think we can because there's a ton of it [sometimes reflecting] exactly what's happening on the airplane," he said, acknowledging that instructors and trainees also need to apply their judgment, their "credibility filters" and "a healthy dose of skepticism" about the possibility of false information being communicated through social media. Parrigin used as an example a Southwest Airlines Boeing 737 landing accident at La Guardia Airport, which a number of passengers documented by taking photos and videos from inside and outside the airplane.

"The first images that we actually saw on the news were taken by these passengers on the airplane," he said. "Several videos were shot in the cabin — several videos of the landing, several videos of the evacuation." In the edited version of the video clip shown at WATS, a flight attendant directs passengers to bring along the smaller carry-on bags and purses already in their hands as they jump onto slides. This instruction is inconsistent with training on telling passengers to leave behind all carry-on items.

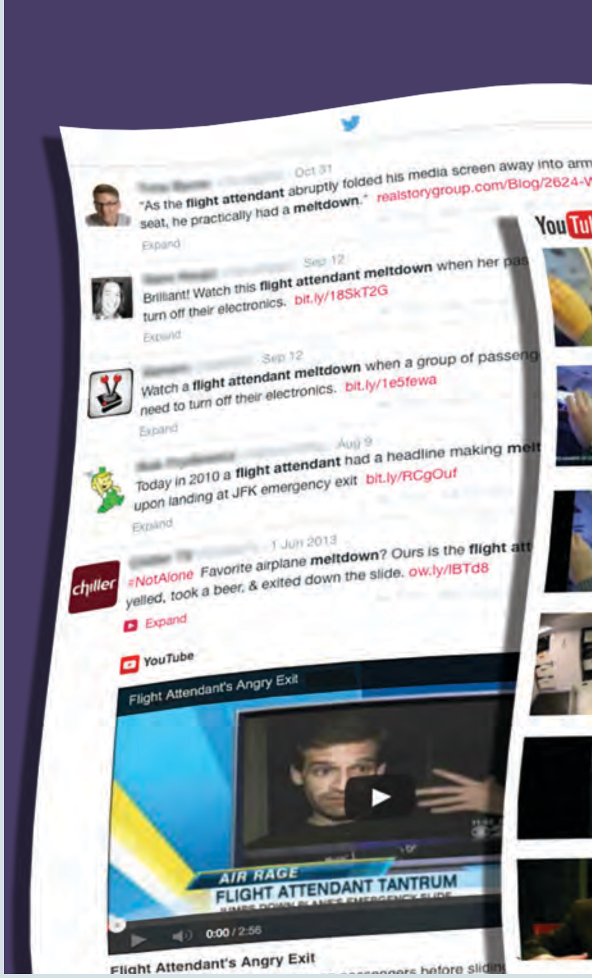
However, Parrigin said the video clip omits contextual and explanatory information. A more complete version shows that the evacuation flow already had been impeded by numerous passengers asking for exceptions to her initial "Come this way, leave everything behind!" command and that she exercised judgment per training and made a decision to override the standard command with "Just bring your small stuff — let's go!" to successfully expedite evacuation in these specific circumstances, he said.

"The biggest issue … was a huge shock for the crew coming down the escape slide [and] facing a line of passengers with their cell phones out who were photographing and filming the accident scene," Parrigin said. During the airline's debrief process, one flight attendant also recalled feeling "assaulted" by critical comments left on social media sites, especially some posted by people who identified themselves as flight attendants. "The comments questioned their actions, questioned their decisions [and] criticized the decisions without taking into account the conditions [and emotional states] that the flight attendants were actually facing, and without really knowing what was occurring on board that aircraft," Parrigin said. Particularly trivial, he said, was criticism of the flight attendant wearing an apron while conducting the evacuation.

Flight attendants assume that part of performing safety duties on any aircraft, anytime, is psychological readiness for emergency situations. But some training professionals now are expressing concerns that in the current environment — and especially among those unprepared for today's likely scenarios — crewmembers "may hesitate for fear of being judged wrong out there on the World Wide Web, and they could hesitate when critical thinking and quick decisions are called for," Parrigin said. "That hesitation could cost lives."

Assuming that passengers' in-flight use of PEDs and social media treatment of airline crews really have become the daily reality for crewmembers, Parrigin believes that shifts within training can make a difference. "We need to establish a culture that empowers our crewmembers with critical thinking skills … to make decisions and take actions without fear of being judged wrong," he said. "That assertiveness and decision-making process [are] critical in any sort of safety environment. We need to have that frank discussion of the presence and possible impact of social media … in the classroom before they encounter this on board the aircraft — especially in a critical situation."

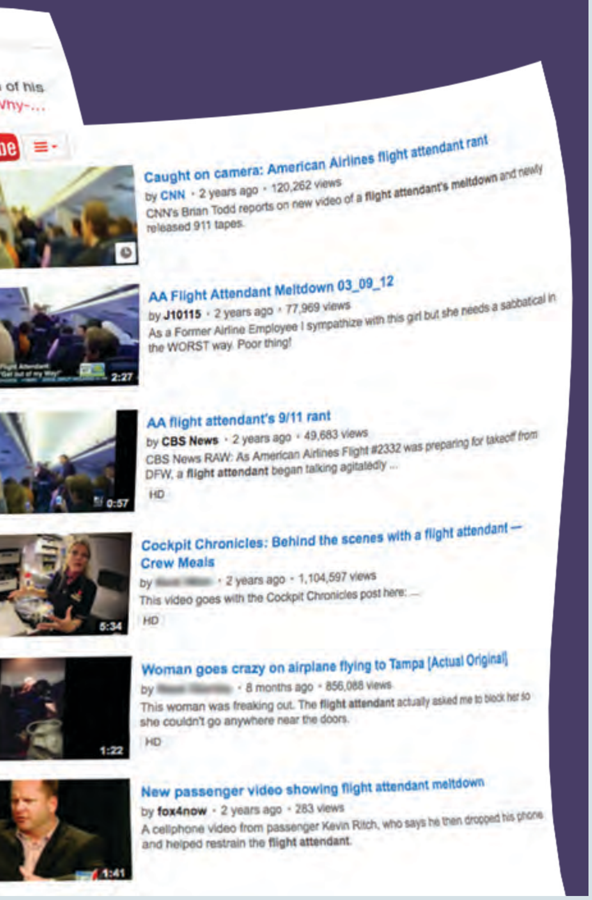
One tactic for introducing these realities during training is to incorporate PEDs into cabin event–management scenarios, especially those involving emergencies. Parrigin said that as he watched another U.S. airline's recurrent training, he saw a person playing the role of a passenger filming the emergency situation in a manner likely to induce distraction and stress. Another way to help overcome these factors is to record scenarios with mobile phones, tablet computers and other PEDs for immediate feedback to the participants



and to strengthen their resolve to disregard the presence of such devices.

"We could use our cell phones, we could use our iPads, to actually record student performance in the cabin mockups then use those videos to debrief the flight attendants and say, 'Hey, here's your door drill … . right here … you forgot to assess the conditions.' … That increases the flight attendant's comfort level with facing the camera when they're having to perform tasks."

Finally, flight attendants should be able to cope more easily with social media fallout by knowing that their airline's seasoned investigators and cabin safety professionals generally bring a sophisticated perspective from their long experience using scientific methods of interpreting human factors. "Our flight attendants have got to be reassured that their performance in any given situation — if it was proved to be necessary, reasonable and appropriate — is not going to be judged based solely on a single piece of evidence that's been posted out



there on social media," Parrigin said. A YouTube video by a passenger, for example, does need to be considered as part of the airline's or the U.S. National Transportation Safety Board's (NTSB's) investigative process but will not be the sole criterion for judging a flight attendant's decisions and actions.

In flight attendant training, Southwest Airlines nearly always uses accident-scene photos deemed to have educational value, to be reflective of a vetting process by the NTSB, and available from the NTSB's public docket. After a discussion with company flight attendants involved in the La Guardia accident, however, a decision was made not to use in training passengers' video recordings of flight attendants. "Once that [NTSB] process is complete, then we'll include the training recommendations," he said. "[We asked the accident flight attendants,] 'How comfortable are you with us addressing that accident in training?' They're not there yet, and to protect their anonymity and allow them time to process and to heal, we decided not to do that [with social media videos]."

Regarding use of social media to share cabin safety-related experiences, the company's flight attendants are covered by a generic company policy that says, in essence, that an employee posting anything that would harm the airline or harm the airline's reputation violates the policy, Parrigin said. "We have one [social media arena] specifically for cabin services, so there's a lot of activity and we do encourage that sharing — as long as it is respectful and does not cause harm," he said.

Cautions About PEDs

AFA-CWA's Kolander said that the labor union's resistance to the dismantling of restrictions on U.S. airline passengers' in-flight use of PEDs echoes the resistance expressed in documents prepared by the U.S. Federal Aviation Administration (FAA) Civil Aerospace Medical Institute (CAMI). "The new policy allows portable electronic devices to be used throughout all phases of flight," she said. "The consequence of the relaxation of the PED policy [is fewer] passengers paying attention to what we do in the cabin — the important safety message. We've gone through extensive efforts trying to figure out how [to] grab the passenger's attention. We've spent decades on it."

The union's continued issue advocacy on this subject partly stems from a trend of member flight attendants expressing frustration about setbacks in performing their safety-communication duties. "We know there are studies that say that the passengers [who listen to] exit-row briefings gain knowledge that helps them to evacuate when an aircraft is burning," Kolander said. "And yet we've just shut off that [benefit] by allowing the earbuds and the noise-canceling headsets. … With passengers now able to use PEDs during all phases of flight, including during crewmember briefings, flight attendants are concerned that important safety information is being ignored. … Eventually, this frustration will lead to our front line safety professionals throwing up their hands [as they] stop caring about safety because we have failed them."

Two FAA guidance documents that accompanied the Oct. 31, 2013, policy announcement emphasized the securing vs. stowing aspects of PED safety, she said: InFO 13010, *Expanding Use of Passenger Portable Electronic Devices (PED)*, and a supplement to InFO 13010, updated June 9, 2014, *FAA Aid to Operators for the Expanded Use of Passenger PEDS*. (The links to the principal FAA PED documents for passengers and airlines are available at <www.faa.gov/about/initiatives/ped/>.)

While the union expected tactical advice, for example, that would prepare flight attendants to direct all passengers to remove their sight/sound-blocking electronics at safety-critical times, the guidance (see "U.S. Flight Attendant Training on Expanded Use of PEDs," p. 20) instead emphasizes that it is not necessary for flight attendants to check for compliance with PED-related crewmember instructions, she said.

Since the new U.S. policy took effect, member flight attendants also have raised the following issues: performing all of their duties has become harder; they consider passenger use of headphones during takeoff and landing to be hazardous; they increasingly find PEDs in seatback pockets left with the cords of earbuds/headphones draped across an aisle, especially in exit rows; and their safety duties are complicated when improperly stowed devices become lost.

The union participated in the Portable Electronic Device Aviation Rulemaking Committee (PED ARC), formed by the FAA in January 2013. Beyond ensuring adequate aircraft protection against electromagnetic interference, the committee's key issues were impact-injury risks; size/weight limits for PED seat pocket stowage and the influence of such stowage on emergency egress; overall impact on public safety and cabin safety; management of cabin electrical receptacles to prevent impediment of egress; and the question of whether uncased, thin PEDs placed under seats would pose evacuation risks, she said.

U.S. Flight Attendant Training on Expanded Use of PEDs

In issuing new policy and guidance on how airlines can obtain approval to expand the use of passenger-supplied portable electronic devices (PEDs), the U.S. Federal Aviation Administration (FAA) said in October 2013 that "the FAA believes that sufficient risk mitigation can occur to allow for safe operation of PEDs during critical phases of flight. … The administrator will evaluate the rest of the [PED Aviation Rulemaking Committee's (ARC's)] longer-term recommendations and respond at a later date."

The FAA also explained to its aviation safety inspectors, "[The PED ARC] report contains recommendations that can be implemented in the very near term, as well as changes in policy and guidance that need additional time to be considered and implemented. … Allowing expanded use of passenger PEDs into the takeoff and landing phases of flight may change the flight attendant's (F/A) responsibilities from confronting and reporting passenger noncompliance to informing passengers of the content of PED policy. "With exceptions, flight attendants are not expected to police passenger compliance or even to know whether any passenger's PED is on, off or in airplane mode, said the guidance to operators.

One reason passenger-compliance checks are discouraged is that the overriding safety priority is to ensure flight attendants can remain in their jump seats with their seatbelts and shoulder harnesses fastened in preparation for takeoff or landing, according to the FAA.

However, the FAA's *PED Aid to Operators* notes that "on an extremely rare basis, the flight crew may require the flight attendants to coordinate and check for compliance to ensure that all devices are turned off (e.g., potentially harmful interference noted with flight instruments)."

Focus areas for revised flight attendant training include the individual airlines' revisions to flight manuals, handbooks and checklists covering procedural changes in normal, abnormal and emergency operations; revised predeparture safety briefings; and airline-specific details of PED securing and stowage.

The areas require operational knowledge that large PEDs — such as full-size laptops or other PEDs that weigh more than 2 lb (0.9 kg) or that could impede egress — must be safely stowed in an approved carry-on stowage location during takeoff and landing so as not to present a hazard in the event of severe turbulence, crash forces or emergency egress. Small handheld PEDs such as tablets, e-readers and smartphones may safely remain powered on — in airplane mode only — and be connected to a WiFi network installed in the aircraft (if allowed by the airline) and to Bluetooth accessories. Passengers' small PEDs must be secure (i.e., not loose) during surface movement, takeoff, descent, approach and landing, typically by being placed in a seat pocket or "on their person," that is, by being hand-held (although not preferable) or placed in a belt or arm holster, or placed in a pant pocket. PED cords or accessories must not impede emergency egress.

The FAA adds that flight attendant training also must "clearly address" what PEDs are approved for use aboard the specific aircraft make and model (including medical PEDs and portable oxygen concentrators); the times when approved PEDs can and cannot be used; how and when PEDs must be secured or stowed; PED modes of operation that can and cannot be used; and how and when to inform passengers of the airline's PED policies and procedures.

Other expected training content covers how and when to report suspected or confirmed electromagnetic interference events (including transient or intermittent problems); coordinating the aircraft crew's management of passenger PED use; effective teaching of passengers about the new PED policy; how and when passengers will be informed about these PED procedures; responding to passengers who use PEDs in a disruptive or unsafe way; and applying procedures for nonroutine, abnormal or emergency scenarios such as suspected or confirmed interference and the detection of smoke or fire in a PED or battery.

Moreover, to support cabin crews, the FAA's public-awareness campaign now tells all passengers: "Put down electronic devices, books and newspapers and listen to the safety briefing. In some instances of low visibility — about 1 percent of flights — some landing systems may not be proved PED-tolerant, so you may be asked to turn off your device. Always follow crew instructions and immediately turn off your device if asked. Make safety your first priority."

— WR

The committee, including FAA aviation safety inspectors (cabin), conducted lengthy discussions on safe stowage versus securing of PEDs in the cabin, and how flight attendants would need to be trained for this change. "They were very supportive, recognizing our concerns for safety … once we launched PEDs in the cabin. They realized our concerns when [we] dealt with evacuation," Kolander said. "So the issues were raised. The PED ARC did have to address some of these issues very specifically in the final report."

Holding Small PEDs

The question of whether it is acceptable for passengers to hold small PEDs in their hands during takeoff or landing needed close examination before a change in guidance and practice. "The [PED] ARC final report … defines a stowage location as 'one that is approved for stowage by the operator, and placarded with a maximum weight restriction' and refers to a secure location as a 'place that lacks formal operator approval or a maximum weight placard, but where it is considered, in the judgment of the operator, that in a survivable incident … the item is unlikely to threaten any occupant's safety,'" Kolander said.

The PED ARC's final report in September 2013 represented about three years of work by RTCA technical committees. "A lot of time [was] spent on engineering aspects. … [The PED ARC] had 29 recommendations for the FAA … basically [answering the question] 'How can we launch a program dealing with expanded PED use on aircraft?'" she said, noting that the new FAA policy was announced a few weeks later. "The FAA didn't say 'Let's [set] a timeline, let's take a break, let's say that all aircraft will be PED-tolerant in six months."

From AFA-CWA's perspective, the FAA's guidance for cabin crews has not gone far enough beyond content of a PED-related announcement to passengers prior to takeoff and landing. This announcement first seeks to gain passengers' attention to and cooperation in minimizing PED distractions during the safety briefing itself. Especially for the predeparture safety briefing, the reason for paying attention should be stressed, it says. The announcement also should instruct passengers to secure their PEDs and other loose items, and tell them the types of devices permitted, when they are permitted, and how to prevent personal injury. As noted, it also says that "an operator's flight attendants are not expected to conduct a compliance check to ensure PEDs are stowed or secured."

Another factor behind the union's concerns is flight attendant training that emphasizes that every second lost to distractions after the decision to evacuate an aircraft could mean the difference between life and death, Kolander said. The passenger-made evacuation video shown by Southwest's Parrigin, she said, showed the extra difficulty that can occur in getting people moving.

"Everyone is trying to collect some of their personal [PEDs]," she said of the video. "Now, they want to make sure that their cameras or cell phones are available and ready to start taking videos and pictures. So that even slowed the evacuation."

The memo from CAMI, which accompanied the PED ARC's final report to the FAA, said in part, "CAMI cabin safety researchers recognize the attraction of 'PED-tolerant' airplanes, including the allure of allowing these devices to operate during all phases of flight. However, in addition to … scientific data and analysis pertinent to maintaining a 'clean cabin environment,' accident data show that takeoff/initial-climb and final approach/landing are critical phases of flight for accidents and fatalities. … The research and accident statistics indicate that added distractions (e.g., usage of PEDs) during critical phases of flight would unnecessarily increase risk, discount passenger safety, and disregard the many serious efforts to rectify the shortcomings related to passenger safety awareness.

"In particular, use of PEDs should continue to respect the clean cabin environment during the pre-flight briefing and critical phases of flight, since the focused attention of passengers to PEDs creates competition for passenger mental capacity. People can selectively attend to only one thing at a time. … It seems inexplicable to promote PED usage during the very times when passengers might need to engage that safety information the most."

Overall, the human factors dynamics in the cabin, although covered in the PED ARC deliberations, did not get the level of attention that AFA-CWA expected. From the union's perspective, FAA has yet to address a number of other ramifications, such as how cabin crews will get adequate time built into their airline procedures to educate passengers about PED safety.

"Flight attendants' concerns nowadays are reflecting exactly what the [PED ARC wrote], they're saying the exact same things," Kolander said. "For any country, any company, that is looking at doing this on aircraft, [note how] we spent years looking at the technical issues … and we spent no time to decide what was going to happen to us in the cabin. … Had [the United States] done it by saying, 'OK, we mean this as a six-month period when all airlines can get PED-tolerant, and we will launch on the same day' — maybe that would have been a better way to do it."

BY ELIZABETH MATHEWS
AND ANGELA C. ALBRITTON

Language Analysis

There's more to aviation English than radio conversations between pilots and air traffic controllers.

Although the International Civil Aviation Organization's (ICAO's) campaign for proficiency in aviation English singled out radio communication between pilots and air traffic controllers, this is not the only area where those in the industry need to speak a common language.

While pilot and controller communication is the most visible, the most easily analyzed, and often the most dramatic aspect of language use in aviation, a more thorough review reveals that, speaking, listening, reading and even writing proficiency is required for a wide-ranging array of other important language tasks associated with aviation operations (see "Roles of English in Aviation", p. 25).

The English language threads its way into nearly every aspect of training, operations and maintenance.

The English language threads its way into nearly every aspect of training, operations and maintenance. Checklists and procedural manuals are most often published in English and read aloud on flight decks during normal flight, as well as in abnormal or emergency situations. Maintenance records often are compiled in English. Much *ab initio* flight training, including multi-crew pilot license (MPL) training, is based on a curriculum written and delivered in English to trainees who speak and read English as a second or additional language. Increasing use of data link communications requires reading — and some writing — proficiency for the exchange of mostly routine, coded messages but also some plain language text. Increasingly, English is the common language on multicultural flight decks.

The ICAO language proficiency requirements for pilot and controller communications were developed in the early 2000s in response to urgent evidence that inadequate English language proficiency contributed to unsafe conditions that resulted in several accidents and serious incidents. Among the most frequently cited events were the March 27, 1977, collision of two Boeing 747s on an airport runway in Tenerife, Canary Islands, that killed 583 people, and the Nov. 12, 1996, midair collision over northern India of a 747 and a Tupolev TU-154 that killed 349. Both accident reports cited the pilots' poor English language skills.

ICAO's requirements — set forth in Document 9835, *Manual on the Implementation of ICAO Language Proficiency Requirements*, first published in 2004 —were based on research into pilot-controller communications, as well as decades of practical training experience by organizations that participated in the ICAO Proficiency Requirements in Common English Study Group (PRICESG). While our awareness of the multidimensional role that English plays in this aspect of aviation safety is not new, a comprehensive understanding of language use in other aviation contexts is less mature and not well supported with hard evidence or research. In fact, implementation of ICAO language proficiency requirements came after an approximately 40-year push within the industry for greater awareness of human factors in aviation.

Communication and Human Factors

Within the field of human factors, communication is frequently referenced and widely acknowledged to be fundamental. Nearly all human factors textbooks and manuals identify communication as a critical element of safe operations, citing both first-language and second-language interactions as contributory factors to numerous accidents and incidents.

Earl Wiener and David C. Nagel, in the first edition of their pioneering *Human Factors in Aviation*, noted that the "gap between theory and practice is wider in radio communication procedures than in any other facet of aviation." Nearly 25 years later, communication gaps remain apparent, particularly if you consider a threat and error management perspective to include not only radio communications but also flight crew communications, maintenance communications, and communications during flight training. Although the importance of communication — and language — to safe and efficient operations is universally recognized in the literature on human factors in aviation, our progress in understanding language and communication issues in aviation has arguably not kept pace with industry understanding of other aspects of human factors in aviation.[1]

In their analysis of cockpit communications, Robert Helmreich and J. Bryan Sexton affirmed that "the role of language use in communication processes has been neglected."[2]

Researchers tend to approach these issues from the perspective of communication studies or psychology, or from an operational perspective, uncovering useful insights and information that have contributed to improved crew resource management (CRM), particularly regarding captain and first officer communication strategies in the English-as-a-first-language context. However, in part because the term "communication" comprises a broad set of factors and activities — from learning about communication protocol and procedures and use of the equipment and standardized phraseology, to CRM English-as-a-first-language communication, to breakdowns in communication stemming from inadequate English language proficiency or cultural factors — their research activity also has tended to occur more sporadically than systematically and has not generated follow-on work.

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As further evidence of the gap in understanding language as a human factor in aviation, ICAO Document 9683, *Human Factors Training Manual*, defines human factors as an interdisciplinary field made up of 13 academic disciplines, including psychology, engineering, medicine, education, mathematics and industrial design. The academic fields of communication and applied linguistics are not mentioned, an oversight that only highlights the pernicious tendency of language to be overlooked as either beguilingly but misleadingly simple or dauntingly complex. Michael Erard, a writer who focuses on language and life, explains that the field of linguistics is unique: "at once, too human and too social to be a hard science, too empirical and logical to belong to the humanities."[3]

So, despite the widespread awareness of the pivotal role that language plays in aviation, there has been little meaningful research into aviation communication from the perspective of applied linguistics, an academic field distinct from communication. Linguistics is the scientific study of natural human language, an area of study more complex than our usual, everyday facility with our own first — or second — language would indicate.

It would not be accurate to describe "language as a human factor" as a new field, for language and language use have long been identified as a factor in aviation safety. Just as fatigue or stress are considered part of human factors, so must language be better understood as a complex set of factors that affects human performance.

Changing Landscape

A number of aviation industry developments and factors likely will change the operational landscape in which aviation communication occurs and increase the importance of understanding language use in all aspects of aviation communication.

The first significant change comes from what is acknowledged as spectacular growth in the aviation industry in parts of Asia and also in Brazil, Russia and South Africa. Aviation operations have changed dramatically, most notably in the number of multicultural and multilingual airline flight crew rosters, not just in Asia but also across Europe and the Americas.

The aviation industry is no longer one in which English as a first language is dominant. It has shifted to a context in which aviation operations that occur in multicultural contexts are the norm and in which English-as-a-second-language predominates. English spoken as a foreign language is no longer simply a matter of pilot and controller communications; it is the medium of considerable CRM communication and flight training. Yet most aviation safety and training literature still targets an English-as-a-first language audience.

The second significant factor that increases our need to better research and understand language as a human factor in aviation stems from the ICAO standards and recommended practices that introduce English language–testing requirements. ICAO sets forth six levels of language proficiency, from "pre-elementary" Level 1 to "expert" Level 6 and specifies that pilots and air traffic controllers must demonstrate "operational" Level 4 proficiency or better if they are to conduct international flight operations. Nevertheless, the linguistic demands of threat and error management and CRM in multilingual flight crews and in multilingual flight training may very well require English proficiency above Level 4. (Understanding the level of English proficiency required for effective CRM requires formal linguistic analysis.) It is critical, too, to understand that the ICAO language standards address only speaking and listening proficiency for radiotelephony communications. They cannot be applied to reading proficiency.[4]

A third factor stems from the development of MPL training. Language use and language proficiency affect aviation communication in many, varied and profound ways. Effective teamwork cannot occur without

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Roles of English in Aviation

English is the formally required language for international radiotelephony communication, and it functions as the de facto, and unregulated, official language for other aspects of international aviation communication. For example:

- English is often the common language of the many multinational crews in international airlines, so crew resource management communication is conducted in English — increasingly in English used as a foreign language.
- Aircraft operations and emergency procedures manuals are universally published in English and often read, and read aloud during flight, by people who use English as a second or foreign language.
- Increasing use of data link communication requires that pilots and air traffic controllers be able to read and enter on a keypad routine, coded and plain language text messages.
- Maintenance manuals are similarly most often available in English and implemented in an English-as-a-foreign-language context.
- The global demand for airline pilots has created a surge of flight training conducted in English for cadets who speak and read English as a foreign language.

— EM and AA

Aviation industry developments and factors likely will … increase the importance of understanding language use.

effective communication. Effective communication rarely occurs without language, either spoken or written. Sexton and Helmreich note that "problem-solving communications are the verbal embodiment of threat and error management in the cockpit."[5] Language is the foundation upon which threat and error management is constructed.

The solution to the issue of how to adequately address what constitutes language use and language proficiency in speaking, listening, reading and writing outside of the scope for pilot-controller communication cannot be the development of yet more guidance materials. Nor should more regulations be applied without better understanding the use of language across all aviation contexts. The industry deserves a more robust understanding of what factors influence communication during flight operations and what is actually required for effective communication to take place. The complexity of the topics merits expert input from applied linguists. As noted, language use in aviation is not simple.

Until the aviation industry can call upon a more robust body of applied linguistic research in most of these areas, success in navigating the current, largely unregulated aviation English landscape will continue to be limited. Developing a more thorough understanding of the language-related factors that affect flight will help build a more robust framework. This includes developing more harmonized, valid and reliable assessment tools and protocols to ascertain if pilots have adequate language proficiency for not just operational ICAO Level 4 radiotelephony, but for effective communication in all aspects of their work.

Elizabeth Mathews, an applied linguist who led the international group that developed ICAO's English language proficiency requirements, researches the role of language as a factor in aviation communication and advocates for improving the quality of aviation English training and teacher training.

Angela C. Albritton, director of military and government relations at Embry-Riddle Aeronautical University–Worldwide, is a specialist in the field of language as a human factor. She has worked and consulted for numerous international airlines in her 20-year career in aviation.

Notes

1. Wiener, Earl L.; Nagel, David C. *Human Factors in Aviation*. San Diego: Academic Press, 1988.
2. Sexton, J. Bryan; Helmreich, Robert L. "Analyzing Cockpit Communications: The Links Between Language, Performance, Error, and Workload." *Human Performance in Extreme Environments* Volume 5 (October 2000): 63–68.
3. Erard, Michael. "What Is Language Journalism?" *Schwa Fire* Issue 1, Season 1 (May 16, 2014).
4. ICAO's criteria for Level 4 proficiency call for speakers, among other things, to possess vocabulary that is "usually sufficient to communicate effectively on common, concrete and work-related topics"; to have "usually well controlled" basic grammar and sentence patterns; and to comprehend discussions of common work-related topics.
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BY LINDA WERFELMAN

What were they thinking?

When flights go smoothly, pilots' minds tend to wander, study finds.

Although cockpit automation is intended partly to give pilots more time to think about — and plan for — upcoming portions of a flight, the pilots may not be devoting all of that time to flight-related thoughts, a new study has found.

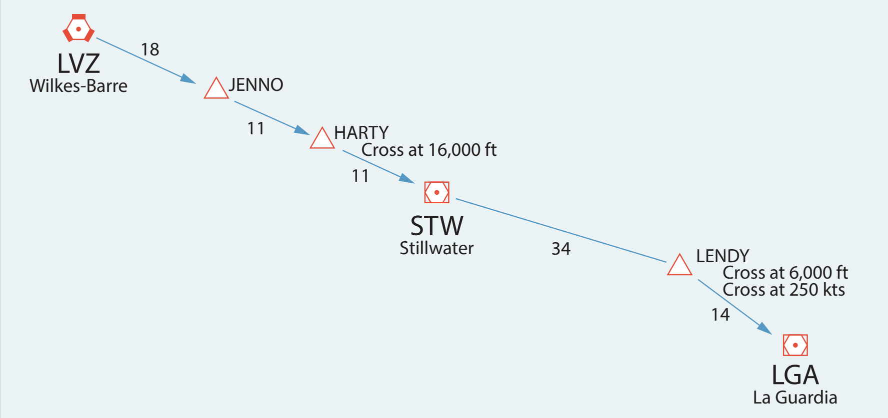
Some past studies have shown that, when pilots were queried while using automated cockpits, they sometimes were unable to answer basic questions or even to tell the questioner where they were.

Other studies showed that automation "can sometimes relieve pilots of tedious control tasks and afford them more time to think ahead," said the report on the new study, conducted by Stephen M. Casner of the U.S. National Aeronautics and Space Administration Ames Research Center and Jonathan W. Schooler of the University of California, Santa Barbara. "Paradoxically, automation has also been shown to lead to lesser awareness. These results prompt the question of what pilots think about while using automation."

To find out, Casner and Schooler designed a test, conducted in a Boeing 747-400 simulator, in which 18 experienced pilots flew an arrival procedure to New York's Kennedy International Airport (JFK). The 747-400 "practically offers the pilot two levels of automation" for an arrival procedure, and the instructions to the participating pilots were to "fly as they normally would, deciding to use the automation as they saw fit," the report said.

As the pilots flew, they were asked periodically what they were thinking — "whether their thoughts were directed at the task at hand; if they were thinking higher-order thoughts about the flight, such as planning ahead; or were thinking about something entirely unrelated to the flight."

Arrival Procedure Into JFK



Note: Diagram, adapted from official arrival procedure, does not depict JFK, located about 9 nm (14 km) south of LGA.

Source: Casner, Stephen M.; Schooler, Jonathan W. "Thoughts in Flight: Automation Use and Pilots' Task-Related and Task-Unrelated Thought." *Human Factors: The Journal of the Human Factors and Ergonomics Society* Volume 56 (May 2014): 433–442.

Figure 1

In addition, their use of automation and other aspects of their performance were recorded.

Waypoints

The arrival procedure incorporates a series of six waypoints — predetermined geographical positions defined by latitude-longtiude coordinates, in this case associated with a VHF omnidirectional radio (VOR) station — that serve as landmarks on the arrival path to JFK (Figure 1). The researchers were especially interested in how the pilots handled the two waypoints designated as crossing restrictions — HARTY, which they were required to cross at 16,000 ft, and LENDY, which required an assigned altitude of 6,000 ft and an airspeed of 250 kt. Acceptable performance, as defined by the U.S. Federal Aviation Administration was to pass within 1 nm (2 km) of the waypoints and to be at the assigned airspeed, plus or minus 10 kt.

"To achieve the two prescribed altitudes associated with the HARTY and LENDY waypoints and the assigned speed at the LENDY waypoint, the flight crew has a choice between two levels of automation," the report said. "The difference between these two levels of automation lies in how much of the work of following the route the flight crew wishes to hand over to the flight management computer and how much they would like to perform themselves."

If the participating pilots wanted the higher level of automation, they engaged the vertical navigation (VNAV) function for help in meeting altitude and speed restrictions associated with the waypoints.

"The VNAV function performs a fairly complex task," the report said. "The VNAV function must decide when to commence a descent to obey the altitudes associated with the two waypoints. In this case, if the airplane is cruising at 39,000 ft, then the airplane must descend a total of 23,000 ft. If the computer chooses a descent rate of 2,000 fpm, then the descent will take 11.5 min to complete. If the airplane is traveling at a speed of 300 kt, then it traverses 5.5 nm [10.2 km] per minute. During the 11.5 minutes needed to complete the descent, the airplane will traverse 63.25 nm

[117.14 km]. The computer concluded that the descent must be commenced 63.25 nm prior to HARTY."

The flight management computer also can determine the best way of reducing airspeed from 300 kt to the 250 kt required to cross LENDY, the report said, adding that while computer functions calculate and implement the required actions, the flight crew must monitor the airplane's progress and be prepared to intervene if they believe the airplane will not achieve the required altitudes and airspeed.

For the lower level of automation, pilots engaged the lateral navigation function for automation of navigation between waypoints, but they retained more responsibility for meeting the altitude and airspeed requirements.

"Pilots' choices about which level of automation to use are often more nuanced than it might seem," the report said, noting that to use the VNAV function, pilots need sufficient time not only to enter initial altitude and airspeed information into the flight management computer but also to reprogram the device in the event that air traffic control (ATC) instructions or weather conditions require changes.

Routine Flights

The participating pilots — nine captains and nine first officers with an average of more than 11,000 flight hours, 69 percent of which, on average, was spent in advanced cockpits — were paired up to fly the arrival procedure, and each pilot took a turn at the controls. They were told to fly as they would during any routine flight, using whatever automation functions they wanted.

A researcher seated behind them read the ATC clearance and every two minutes — while noting the automation functions in use and whether the pilot was at that moment interacting with the flight management computer by keypad or by the mode control panel — prompted the pilots to characterize the nature of their thoughts by categories. (A response of "1" meant that a pilot was thinking about a "task at hand"; a "2" meant the pilot was thinking about "something related to the flight but not something that was happening in front of them at that moment"; and a "3" meant the pilot's thoughts were "not related to the flight," the report said.) A flight data recorder noted the altitude and airspeed when the pilots crossed the HARTY and LENDY waypoints.

Thought Categories

The pilots were asked about their thoughts eight times each — a total of 144 times. Table 1 shows the thought categories and the relationship between the automation level and the pilots' thoughts.

Differences between the top row and the bottom row show what the researchers described as "a significant shift from task-at-hand thoughts (1s) to higher-level thoughts about the flight (2s) when the higher level of automation was used. … This finding supports … what is perhaps the most closely held belief about automation: that the use of a higher level of automation is associated with pilots thinking fewer task-at-hand thoughts (1s) and more higher-level thoughts about the flight (2s)."

Thoughts and Successful Piloting

Table 2 shows the relationship between what the pilots were thinking and the extent of their success in meeting the two crossing restrictions within 300 ft of the assigned altitude and 10 kt of the assigned airspeed.

"Pilots' thoughts did not drift onto other [non-flight-related] topics when a higher level of automation was used but rather when either level of automation was used successfully," the report said. "Difficulties in meeting the crossing restrictions were associated with pilots reporting more task-at-hand thoughts (1s), suggesting that automation struggles diverted pilots' attention away from higher-level thoughts about the flight (2s). However, when pilots enjoyed more success and reported fewer task-at-hand thoughts (1s), their thoughts seemed to move on to task-unrelated topics (3s)."

Table 3 shows the relationship between automation interactions and pilot thought categories. "As was the case with the success variable, interacting with the automation was not associated with fewer higher-level thoughts about the flight (2s)," the report said. "It was associated with fewer task-unrelated thoughts (3s)."

Automation Levels and Thought Categories

	Thought Category		
	1 Task-at-Hand Thoughts	2 Higher-Level (Task-Related) Thoughts	3 Task-Unrelated Thoughts
Selected (less automated)	50% (12)	29% (7)	21% (5)
Managed (more automated)	27% (32)	56% (67)	19% (21)

Source: Casner, Stephen M.; Schooler, Jonathan W. "Thoughts in Flight: Automation Use and Pilots' Task-Related and Task-Unrelated Thought." *Human Factors: The Journal of the Human Factors and Ergonomics Society* Volume 56 (May 2014): 433–442.

Table 1

Flight Success and Thought Categories

	Thought Category		
	1 Task-at-Hand Thoughts	2 Higher-Level (Task-Related) Thoughts	3 Task-Unrelated Thoughts
Missed	50% (14)	43% (12)	7% (2)
Made	26% (30)	53% (62)	21% (24)

Source: Casner, Stephen M.; Schooler, Jonathan W. "Thoughts in Flight: Automation Use and Pilots' Task-Related and Task-Unrelated Thought." *Human Factors: The Journal of the Human Factors and Ergonomics Society* Volume 56 (May 2014): 433–442. :

Table 2

Automation Interactions and Thought Categories

	Thought Category		
	1 Task-at-Hand Thoughts	2 Higher-Level (Task-Related) Thoughts	3 Task-Unrelated Thoughts
Hands on	47% (20)	51% (22)	2% (1)
Hands off	24% (24)	52% (52)	25% (25)

Source: Casner, Stephen M.; Schooler, Jonathan W. "Thoughts in Flight: Automation Use and Pilots' Task-Related and Task-Unrelated Thought." *Human Factors: The Journal of the Human Factors and Ergonomics Society* Volume 56 (May 2014): 433–442.

Table 3

Reconciling Basic Claims

The researchers said that their results "help reconcile some of the most basic and seemingly contradictory claims about the effect of automation on pilots' thinking."

On one hand, the report said, "Our data support the most closely held belief about automation — that the use of more automation allows pilots to engage in fewer task-at-hand thoughts and more higher-level thoughts about the flight."

However, the data also "were consistent with studies that demonstrate that, when more automation is used, measures of pilot awareness show that less, not more, higher-level, flight-related thinking has taken place," the report added. "When difficulties were encountered, the use of a higher level of automation may have substituted one sort of attention-demanding work for another. When all was going to plan and the task of managing the airplane was seemingly under control, pilots often opted to think about something else."

'Advantages and Disadvantages'

The report cited earlier studies that have found that people spend about 30 percent of their waking lives in task-unrelated thought — an activity that the authors said is "nuanced with advantages and disadvantages." They noted that the pilots who participated in the study were recorded as spending about the same proportion of their time in task-unrelated thought, also called mind-wandering.

The report also cited earlier studies that indicated that mind-wandering might be a critical element of human cognition with several important functions, such as providing a mental break that enables individuals to return to work with "improvements in vigilance performance" or boosting problem-solving skills. Another study says that task-unrelated though enables "autobiographical planning," the report said, adding that pilots who engage in autobiographical planning "may be thinking ahead not only to future portions of a flight but rather to future portions of their life."

Other studies demonstrated disadvantages associated with mind-wandering, including a greater tendency to commit errors, a predictable decline in reading comprehension and a "more careless response in a go/no-go decision task," the report said.

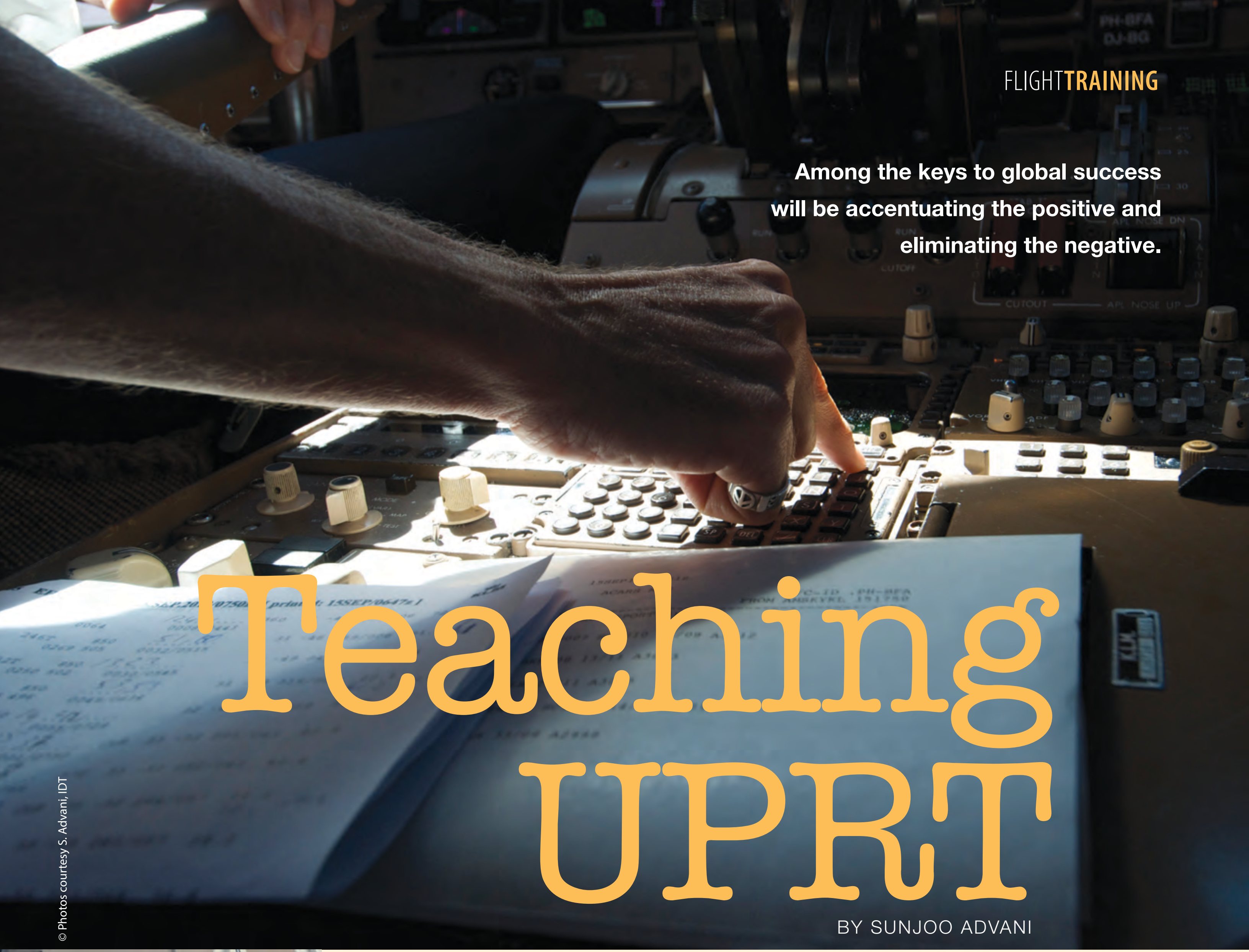
Cockpit Design

Overall, the report by Casner and Schooler said, "We must consider the possibility that the thought patterns we observe among pilots are the rational outcome of the way we have designed cockpit automation systems."

Because automation handles so much of the work, "we may have left pilots with little incentive to think beyond the steps needed to configure the automation and the aircraft behaviors that these steps produce," the report said. "And since pilots receive little procedural guidance about how to actively monitor automated systems, we may have effectively left them with the question 'What else is there to think about?' If this is the case, we might wonder if we could encourage a different use of pilots' mental free time."

The report cited earlier proposals by other researchers that called for development of specific procedures for monitoring in an automated cockpit or for the design of automated systems that require periodic action by pilots, even when the flight is running smoothly. A 2006 study by one of the authors found that "even perfunctory conversation among pilots about where they were and where they were going was enough to reverse the 'out-of-the-loop' effects seemingly caused by using advanced navigational automation," the report said.

This article is based on "Thoughts in Flight: Automation Use and Pilots' Task-Related and Task-Unrelated Thought," by Stephen M. Casner and Jonathan W. Schooler, published in Human Factors: The Journal of the Human Factors and Ergonomics Society, *Volume 56 (May 2014): 433–442.*



Among the keys to global success will be accentuating the positive and eliminating the negative.

Teaching UPRT

BY SUNJOO ADVANI

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Upset prevention and recovery training (UPRT) will take many airline pilots out of their comfort zone, exposing them to places unknown. For most of their instructors, too, these places until recently were unfamiliar territory. This article explains why that is the case, and will help newcomers to this subject quickly grasp the essentials of the paradigm shift under way.

Now that international standards and recommendations have been published (see "Starting Lineup," p. 47), one of the significant remaining challenges to UPRT implementation will be to assure a quality standard for all UPRT instructors that supports consistent and accurate training delivery.

New tools soon will be available for pilot-performance assessment by instructors in the simulator; however, instructor exposure to the threat environment, escalation and recovery also is essential. On-aircraft UPRT — recommended for different pilot groups in the new official documents — is increasingly recognized as a critical component to developing effective UPRT simulator instructors (*ASW,* 10/13, p. 40).

Sound Paradigm

For those unfamiliar with the evolution of airplane-upset terminology, *UPRT* today describes a systematic response to the steady growth in the number of accidents resulting from loss of control–in flight (LOC-I). During the past decade, LOC-I has been the no. 1 cause of worldwide commercial airline fatalities, according to the annual analyses of data published by Boeing Commercial Airplanes. The response is a comprehensive integrated approach to train pilots in awareness, recognition and avoidance, and recovery skills to mitigate LOC-I events.

In 2009, the Royal Aeronautical Society's International Committee for Aviation Training in Extended Envelopes (ICATEE) proposed the term *upset prevention and recovery training,* in which the *prevention* element was emphasized. This slight but significant adjustment to the previous term *upset recovery training* generated a broader acceptance and cooperation among the many stakeholders that the industry needed to produce training requirements that would be adopted globally.

So, what exactly is UPRT? First, an *airplane upset* is defined as unintentionally exceeding the flight parameters normally experienced in line operations or training. In other words, the airplane is not doing what the pilot intended and is approaching unsafe parameters: that is, the airplane has a pitch attitude greater than 25 degrees nose up or greater than 10 degrees nose down, or a bank angle greater than 45 degrees, or the airplane is at an airspeed inappropriate for the condition. In fact, many uncorrected upsets result from a stall if the crew fails to effectively recover from the stalled condition. Preventing, recognizing and, if necessary, recovering from an upset are now considered essential if we want to curb LOC-I.

ICATEE identified three levels of mitigation — awareness; recognition and avoidance; and recovery — the first two of which create a prevention perimeter (Table 1).

ICATEE Levels of Aircraft Upset Mitigation

Upset Mitigation Level	Learning Objective	Example
Awareness	Threat and error management related to upsets by developing an appreciation of the potential operational threats.	Appreciation of kinetic and potential energy available at varying altitudes; for example, recognizing performance limitations at higher altitudes and the possible need to trade off altitude for airspeed.
Recognition and avoidance	Early recognition of ensuing threats and unintended deviations from the normal flight path and preventing exceedance of the flight envelope.	Ability to give proportional flight control counter-response to a developing wake vortex, before the aircraft has exceeded normal attitude parameters.
Recovery	Returning the aircraft to the normal flight envelope/conditions following an upset in a timely and effective manner, without endangering the airframe.	Ability to prioritize the appropriate flight control inputs needed to safely and effectively recover from a developed stall.

Source: International Committee for Aviation Training in Extended Envelopes (ICATEE)

Table 1

If prevention fails to mitigate the upset risk, the recovery skill is the final defense against a possible LOC-I situation. It is also important to understand that, even though a stall is a form of (or precursor to) an upset, it can lead to a further exacerbation of the flight condition if recovery is not immediate. The crashes of Colgan Air Flight 3407 (*ASW,* 3/10, p. 20), Turkish Airlines Flight 1951 (*ASW,* 6/10, p. 32) and Air France Flight 447 (*ASW,* 8/12, p. 14) are all well-known, stall-related fatal accidents. Thirty-six percent of LOC-I events are stall-related. Experts have cited the following possible causal factors:

- Limited awareness of the aircraft energy state;
- Distraction caused by sudden roll-off or unexpected control behavior near the stall; and,
- Adherence to inappropriate recovery techniques, such as not reducing angle-of-attack as the primary means to eliminate a stall.

Furthermore, there was a limited emphasis during training on the additional challenges of high-altitude stalls. At high altitude, for example, a stall may require a considerably longer and sustained application of nose-down pitch (and possibly trim) to maintain a reduced angle-of-attack to prevent a secondary stall. The industry felt the urgency to carry out enhanced stall training, and one result was the *Airplane Upset Recovery Training Aid* published in August 1998, with revisions in August 2004 and November 2008. (Available at <flightsafety.org/archives-and-resources/airplane-upset-recovery-training-aid>.) Yet, further challenges have been recognized more recently. In order to explain them, additional background is useful.

The Startle Reflex

Training to prevent, recognize and recover from airplane upsets is all about developing knowledge and skill sets that make pilots aware of the threat and prompt them to initiate timely action. However, we also know that when an upset occurs in actual flight, pilots often do not respond as they were trained. In such instances, the common belief is that they were startled.

Startle is a volatile emotional response. This intense reaction can cause inappropriate or incorrect human behavior. In time-critical events, such as the escalation of an upset, an incorrect reaction may worsen the situation and make recovery (both mentally and aerodynamically) more challenging.

A pilot's startled condition is worsened when he or she is confronted with a flight condition requiring higher levels of concentration to recover from an unknown or unexpected upset event. It is worse when the person is tired, fatigued or emotionally stressed. If an event triggers the startle process, it becomes difficult to resolve the situation without tools readily available. These tools are the knowledge and the trained ability to analyze and to resolve the problem developed through recurrent practice or, better yet, real-life exposure.

Pilots need a "Been There, Done That" UPRT T-shirt. Yet, sadly, many airline pilots — including instructors — have not been in an actual stall since the single-engine flights in their early training. Compounding this, the industry has a history of erroneously emphasizing "minimum loss of altitude" over the immediate reduction of angle-of-attack (*ASW,* 4/11, p. 46).

Latest Stall Recovery

Many of today's simulators are limited in their ability to present actual type-specific characteristics of stalls. In order to mitigate and to reverse the unfortunate history of stall accidents, a number of preventive actions were introduced, including a stall-recovery template and advisory circulars recommending maneuver-based and scenario-based stall training (Figure 1).

One significant change, as noted, was the recommendation to eliminate the older stall recovery technique (i.e., apply full power and try to minimize altitude loss) and replace it with a new one, recommending immediate reduction of angle-of-attack, and trading off potential energy (altitude) to gain kinetic energy (airspeed). The pilot should, in fact, always apply the same stall recovery technique at the first indication of stall, which could be an aural warning, aerodynamic buffet or activation of the stick shaker. Test pilots have shown that, regardless of the maturity of the stall (i.e., either an approach-to-stall condition or a fully-developed stall with g-break), the recovery invariably requires use of the steps in the template.

A Surprising Study

Making this stall-recovery template a memory item was considered the "silver bullet" answer to stalls: Pilots would simply apply the procedure, and stalls would be a thing of the past. However, a study by the U.S. Federal Aviation Administration showed that there is actually no substitute for exposure to stalls in a realistic setting, and to realistic distractors caused by the nonlinear behavior of the airplane during the stall. In the 2013 study, of the 45 airline pilots involved, fewer than 25 percent applied the template satisfactorily. Despite prior familiarity with the template, a common reaction was to fight the stall and prioritize roll control instead of unloading (i.e., decreasing the load factor by reducing the angle-of-attack). The study, conducted in a Boeing 737NG full-flight simulator, raised awareness that unexpected stall scenarios should be added to today's

Stall Recovery Template

1.	Autopilot and auto-throttle	Disconnect
2.	a) Nose down pitch control	Apply until stall warning is eliminated
	b) Nose down pitch trim	As needed
3.	Bank	Wings level
4.	Thrust	As needed
5.	Speed brakes/spoilers	Retract
6.	Return to the desired flight path	

Source: International Committee for Aviation Training in Extended Envelopes

Figure 1

maneuver-based training to ingrain the proper recovery technique.

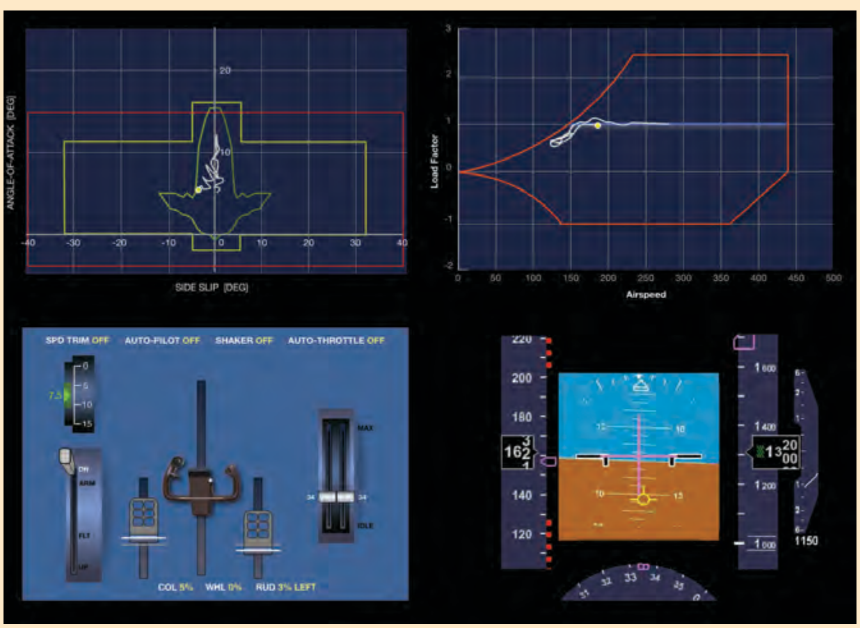
Instructor Limitations

UPRT requires that instructors have the ability to impart the correct skills to be used in times of distress. By applying aeronautical and systems knowledge, and having the tools to analyze and resolve the situation, instructors can train pilots more effectively than in the past. Yet, there are challenges to making this a reliable, repeatable and affordable process. Fortunately, there are solutions — once we understand and address the hurdles in achieving them.

The most common tool that will be used in UPRT is the full-flight simulator. However, this costly training device is only as good as the instructor operating it. The instructor needs an awareness of how to develop upset recovery skill sets and self-confidence within the pilot. Therefore, as noted, instructor exposure to the actual threat environment is considered an important ingredient to making a good UPRT simulator instructor. The argument is that without knowing one's own limitations, it is nearly impossible to teach others how to overcome them.

Clarke McNeace, a former airline captain and fighter pilot, and currently a vice president at Aviation Performance Solutions (APS) at the Breda International Airport, Netherlands, says that such experience has not been common. "A typical simulator instructor has had little to no formalized on-aircraft upset training. … Many simulator instructors have never been beyond 60 degrees of bank angle or in a deep stall in an actual aircraft themselves," he said. Furthermore, because there has been no formal guidance on simulator-based UPRT delivery for decades, most simulator instructors teach recovery techniques that they personally have decided are appropriate, without any quality assurance to prevent negative transfer of training.

UPRT Instructor Toolkit Screen



UPRT = upset prevention and recovery training

Source: International Committee for Aviation Training in Extended Envelopes

Figure 2

Simulator Limitations

Simulators are an excellent resource for training upsets, but transport aircraft behavior can deviate from simulator behavior during an upset. Therefore, empowering the instructor with appropriate information is an essential element, as is giving the instructor the ability to impart surprise scenarios during the training in order to not to rely exclusively on the rote repetition of maneuvers.

One of the unique tools that will become part of full-flight simulators adapted for UPRT is an instructor-feedback display with graphics focused on avoiding and recovering from the edges of the flight envelope. First and foremost, an instructor must be able to monitor the pilot's use of controls pertaining to the flight condition. For example, the immediate use of nose-down pressure and trim may be necessary and should be emphasized, but without the display, the inputs may not be visible to the instructor in the dark simulator cockpit. Similarly, improper use of rudder pedal inputs, such as rapid side-to-side pedal inputs that could lead to structural damage, must be detected and corrected.

The resulting aircraft responses should be within the acceptable safety margins visible on the display during the avoidance or recovery maneuver. Exceeding the structural limits must be avoided; unloading the wings by reducing the angle-of-attack — thereby allowing the aircraft to safely fly below the critical angle-of-attack — should be emphasized. Furthermore, the simulation is only valid to a certain angle-of-attack and sideslip. These are established during flight testing and, in some cases with enough confidence, through wind-tunnel testing or other engineering methods. Knowing if these limits of validity have been violated also is important because simulator accuracy of actual aircraft behavior degrades as it departs from the validated training envelope.

An example of a UPRT instructor toolkit screen is shown on a display (Figure 2). The toolkit software provides a comprehensive overview of the pilot's control inputs (lower left) and resulting aircraft responses. These are correlated with flight instrument display indications, and the aircraft loading (V-n diagram, upper right) and validated angle-of-attack versus sideslip envelope, (upper left).

When instructors are properly trained to use UPRT tools like these, their ability to teach in the simulator increases significantly. Even more importantly, emphasizing the pilot's positive performance while eliminating the negative traits during training and de-briefing can become one of the key assets to preventing LOC-I. Again, it all comes down to proper training of the pilots and the instructors.

In summary, check airmen and flight instructors who conduct training or checking in simulators must *themselves* receive training on the operation of the simulator and its limitations. Forthcoming regulatory requirements in many countries and regions will include enhanced simulator instructor training. The majority of today's instructors were trained only in simulators, with a greater emphasis on teaching procedures than on basic airmanship and flying skills.

If we want to curb LOC-I, we also will need to rethink the way we teach basic flying to pilots and instructors — from the ground up.

Sunjoo K. Advani, Ph.D., an aerospace engineer and pilot, is owner of International Development of Technology, a technology-integration consultancy firm involved in training, simulation and research for flight, driving and medical applications. He has been involved in UPRT for 10 years, including from 2009 as chairman of ICATEE. He advises aviation organizations worldwide on their aviation rulemaking initiatives and their implementation of UPRT.

Notes

1. Lambregts, A.A.; Nesemeier, G.; Wilborn, J.E.; Newman, R.L. "Airplane Upsets: Old Problems, New Issues." American Institute of Aeronautics and Astronautics Modeling and Simulation Technologies Conference and Exhibit, Aug. 18–21, 2008, Honolulu. AIAA 2008-6867.

BY WAYNE ROSENKRANS

Breaking

Advancing airline pilot training increasingly means jettisoning obsolete and discredited practices, experts say.

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On the surface, safety issues that subject matter experts explored in April during presentations to the airline pilot–track audience of the World Aviation Training Conference and Tradeshow (WATS 2014) lacked a common theme. Their proposed enhancements ranged from turning away first officer applicants who lack multi-crew flight experience to requiring flight simulator instructors to spend time in air traffic control (ATC) facilities.

Yet comparing the presentations shows that — while respectful of many past risk-reduction achievements in commercial air transport — the experts did not hesitate to call for industry stakeholders to relinquish any belief, practice or cultural norm when today's best evidence proves an increased risk or obsolescence.

Upgrading CRM

Jim Green, a captain and professor of aviation science at Utah Valley University, has observed a trend toward less airline emphasis on crew resource management (CRM) — perhaps because airline flying overall is so safe, he said — despite what he considers a critical need for a new CRM version geared to new-entrant airline pilots.

He urged airlines not to forget how difficult it was in the 1980s to gain acceptance for CRM from the airline pilot community. "CRM was considered charm school, and they resented it to an extent," he said. "It was macho not to use a checklist."

For next-generation CRM, he envisions emphasis on personal motivation; personal moral integrity; individual self-discipline in adhering to procedures; enhanced pilot monitoring to counteract automation complacency (e.g., to fully check aircraft status every 15 minutes when autoflight systems are selected); and specific mitigation of related human factors threats still being identified in the latest airline accidents. "Airlines say when hiring [pilots] that attitude is everything — you cannot affect the attitude later," Green said.

Describing approach-and-landing scenarios in which these character attributes made a safety difference when he flew as a first officer and captain, Green called for the CRM training–developer community to significantly upgrade what is being done now. "People involved in CRM should speak out now" against gradual CRM abandonment and in favor of these changes, he said.

Government and industry also must get ready, Green said, for a future in which automated assistance — possibly even a Google search–like capability — immediately will present to every flight crew the world's most relevant knowledge for safely responding to critical in-flight situations.

Admitting Shortcomings

Wally Hines, director of standards, Jetpubs, described how airlines' adoption of safety management systems (SMS) has helped to create classroom environments in which pilots are much more likely to speak up about their own errors in front of their colleagues, admit when they do not adequately

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Airlines' adoption of safety management systems (SMS) has helped to create classroom environments in which pilots are much more likely to speak up about their own errors in front of their colleagues, admit when they do not adequately understand an aircraft system and/or ask for individually "prescribed" remedial skill training.

understand an aircraft system and/or ask for individually "prescribed" remedial skill training.

"Another part of this [SMS] recipe is actually having a legitimate safety culture where people are able to come forward and say, 'Hey, I have a lot of issues with this,'" he said. "As a general rule [otherwise], we sit in recurrent [training] and, if we do have a question, people are hesitant to raise their hand and ask the question if everybody else looks like they understand [the topic]."

In light of this positive trend in professional culture, he said, specific levels of pilot knowledge of many subjects today have to be measured objectively. This enables judging the effectiveness of costly recurrent training and continual improvement of the positive atmosphere. The key now is focusing on individual needs and differences instead of one-size-fits-all classes, Hines said.

He advocated specialized training opportunities, for example, for groups of pilots with a common weakness. "Let's run a specialized recurrent class for those people, and let's be down-and-dirty," Hines said. "Let's ask questions. Let's sit across the table from one another and really tear this thing apart with the objective of them coming out with a better experience. … If the airline has the data [to identify a hydraulics expert and a novice, for example], and it's possible, let's throw those two in the sim together, and let's run a hydraulics scenario. Now we've created a situation intentionally … where [with the instructor] we've got everybody in the room. We're creating an event that really will be impactful for the novice."

Multi-Aircraft Proficiency

Thomas Walby, director, flight training, Airbus Training Center–Miami, discussed how Airbus training centers now require simulator instructors — who are well qualified but may have logged little or no recent flying in actual line operations — to spend time in ATC facilities to "get back into the swing of current procedures" and observe problem areas. The training centers also are adapting to changes/additions in the air carrier provisions of U.S. Federal Aviation Regulations (FARs) Part 121 regarding fraud and the falsification of training records, and the U.S. Federal Aviation Administration's (FAA's) jurisdiction to take certificate action and assess civil penalties; new requirements for FAA approval of a wider range of training devices such as door trainers for cabin crew; and detailed training in full flight simulators on pilot monitoring skills and progressive-intervention strategies. Also newly required for airline pilots is training in manual slow flight and manually controlled instrument arrivals and departures, he noted.

Other changes to FARs allow modifying flight crew training programs when the air carrier operates aircraft types with similar flight handling characteristics, and require pilots-in-command to receive a proficiency check on each aircraft type flown, Walby said. "Before, airlines could take credit [for pilot training] on numerous aircraft types for training events on one," he said. Others included a requirement for runway safety maneuvers and procedures training, and one for aircraft control in crosswind landings with gusts.

Reliable Pilot Monitoring

Scott Morris, first officer, Southwest Airlines Human Factors, Risk and Resources Department, discussed how to enhance the organizational culture and professional culture factors that can

and begin type-rating training without any form of transitional multi-pilot training — and the trainee will have improvised the training process and have no auditable training records. "This must stop; it must not continue," he said, given what the air transport community learned during international development and adoption of the multi-crew pilot license (MPL).

The main reason, he said, is the realization that too many pilots who begin airline careers after 1,500 hours of single-pilot operations revert to that skill set and mentality during an emergency on a two-crew flight deck.

"One of the challenges we faced in the development of the MPL has been … myths that have arisen," he said. "The first myth is that if the MPL fails — if it ceases as a regulatory process or if the airline decides to abandon the use of MPL — [the holder will believe] 'I'm left with nothing.' This is not the case. Any training organization involved with MPL and working with a partner airline to develop an MPL has committed that in the [highly unlikely] event that that circumstance exists, they will bridge [anyone affected] to a traditional pathway. … There is no example of [a case] where they were not covered in this way.

"Secondly, [the myth exists that] 'I'll be a copilot forever with an MPL.' The MPL is a first officer qualification without doubt. … However, when they meet the requirements of an airline transport pilot license [ATPL] in all its forms, they can obtain a full ATPL and become the captain of an airliner. … Thirdly, [the myth exists that] 'I can't move [among] airlines with an MPL.' … When they conclude their line-oriented experience check, the course is now complete, and they can continue with the rest of their career. If they wish to move to another airline, they complete a type-rating conversion program, and they can move to another carrier. … Finally, there's no such thing as a 'generic' MPL."

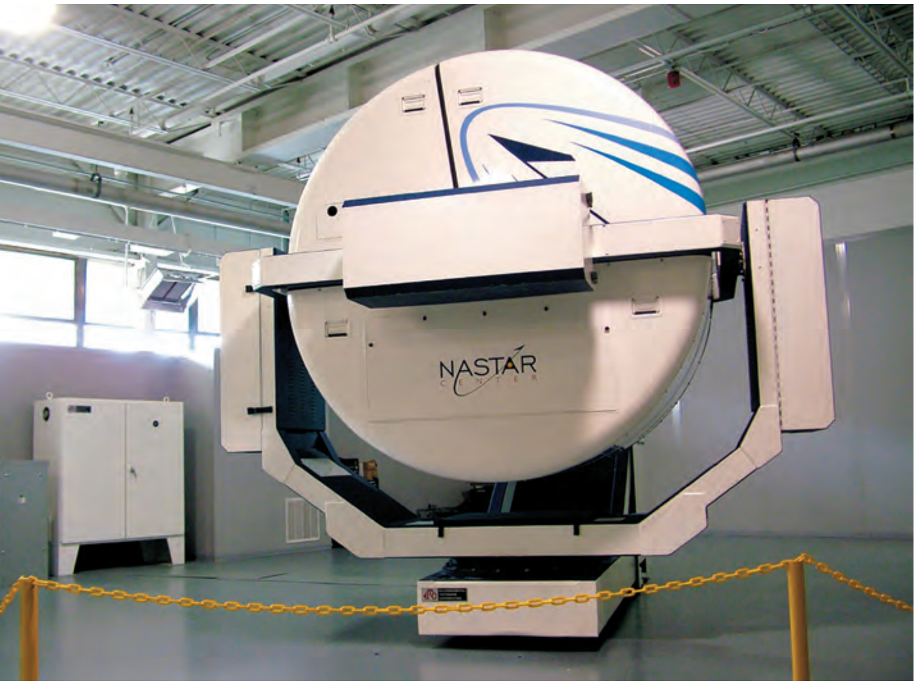
Petteford nevertheless called for new research to focus on all of today's incoming "digital native" pilots to determine objectively how well they can solve in-flight problems other than by pushing a button on the flight deck

affect the quality of pilot monitoring. Such factors come into play, for example, when the pilot monitoring actually does not even consider slips and lapses during monitoring as threats, he said. Lack of good training, being rushed and becoming distracted also have been causal factors in errors identified across many airlines studied.

"Aggregately speaking, [team members currently developing an FAA pilot-monitoring advisory circular] find that pilots do not perform cross-checking of mode control panel inputs very well," Morris said. "As well, pilots do not cross-verify the [flight management computer (FMC)] inputs very well, either — the verbalization of what they are doing and the verification from the crewmember as to FMC inputs. Pilots do not accurately or successfully verify the flight mode annunciator. On the primary flight display, when an input is made, that is their primary means to verify and to assure that what [they believe] has been selected has in fact been selected."

Single-Pilot Instincts

Anthony Petteford, executive vice president, CTC Aviation Group, told attendees that under many states' regulatory regimes, new entrants can earn a pilot license, be hired by an airline



The single-seat Gyrolab GL-2000 provides controlled, sustained g-force with its planetary axis, and provides 360-degree rotation in yaw, pitch and roll axes.

automation, and in turn, on how to develop/remediate such critical problem-solving skills.

Next Generation UPRT

Glenn King, director of the Advanced Pilot Training Program, National Aerospace Training and Research Center, presented research and technology now used in his program for airplane upset prevention and recovery training (UPRT) of airline pilots, suggesting a direction that UPRT could evolve. He described the program as essentially exceeding the recently adopted international standards and recommended practices through its use of advanced, sustained motion, g-producing training devices (Gyrolab) that "create a physiologically, psychologically and emotionally authentic upset environment."

According to King, neither the UPRT conducted for some pilot categories in all-attitude, all-envelope airplanes nor UPRT conducted in typical airlines' most advanced Level D flight simulation training devices (FSTDs) fully matches a Gyrolab's UPRT-relevant capabilities. (He did not compare stall-capable FSTDs, g-awareness devices, spin devices or spatial disorientation devices that will supplement Level D FSTDs.) In contrast, he said, a Gyrolab produces accurate sensations and recovery from worst cases like an inverted flat spin (see "Teaching UPRT," p. 31, and "Starting Lineup," p. 47).

"In-aircraft training … has its limitations," he said. "Realistically, if you look at the motion of a Level D-type simulator, it's a pretty benign flight environment. We want to be able to take pilots and put them into an environment that produces the full sensations and physiological effects of an upset event. … We can allow pilots to explore the normally dangerous envelope that they don't get a chance to practice in Level D-type sims. They also don't get to practice some of these types of maneuvers in aircraft because of limits on aircraft stress.

"In a lot of the upset-training scenarios I see, the pilots are on a low, slow and 'dirty' [flaps and landing gear extended] short final, and they get hit with a wake vortex upset. [In] the first three seconds of that encounter, they're just trying to get past the startle factor. Pilots don't have [that much] time to think what they'll do; they have to instantly get back to their training, get muscle memory going and get the proper flight control inputs. They need to do this when they're scared. … So we do want to give pilots the ability to get close to the edge and feel what it's like when they're up at 3 g or so, and they're sustaining that pullout for a recovery."

Global Professional Culture

Jacques Drappier, a captain and senior adviser, Airbus, said that given that multinational flight crews are becoming the norm — as is already happening in several world regions — the timing is right for airlines to reconsider how their long-held assumptions about the related risk implications actually measure up against the research literature.

One valuable line of inquiry into academic literature, he said, is seeking to understand the practical significance of reports that suggest that professional and organizational cultures of airline pilots actually can be changed by training. Drappier found, for example, that there is evidence that worldwide, in critical operational situations, airline pilots' professional culture typically overrides the relatively unchangeable national cultures of pilots.

U.S. National Transportation Safety Board

Testing the Limits

The NTSB calls for new tests to prove lithium-ion battery installations in aircraft can mitigate hazards tied to thermal runaway.

BY LINDA WERFELMAN

The Boeing 787's lithium-ion battery designs might not have fully accounted for the hazards of internal short circuiting, largely because of inadequate processes used to support certification of the battery, the U.S. National Transportation Safety Board (NTSB) says.

To correct these NTSB-identified shortcomings, the board issued a series of recommendations in late May to the U.S. Federal Aviation Administration (FAA), including a call for the development of a test capable of demonstrating safety performance in case of an internal short circuit in a lithium-ion battery.

The recommendations were developed as a result of the NTSB's ongoing investigation of a Jan. 7, 2013, fire in a lithium-ion battery in a Japan Airlines 787 that was parked at a gate at Logan International Airport in Boston after a flight from Narita, Japan. All passengers and crewmembers had deplaned, and the fire was discovered when cleaning personnel saw smoke in the aft cabin. About the same time, a maintenance technician opened the aft electronic equipment bay and found heavy smoke and a small flame emanating from the auxiliary power unit (APU) battery case. Aircraft rescue and fire fighting personnel extinguished

A Japan Airlines Boeing 787 on the ground in Boston after a lithium-ion battery fire in 2013. On previous page, NTSB investigator Joseph Panagiotou examines a battery cell from the airplane.

the fire, with one firefighter receiving minor injuries in the process. Cleaning and maintenance personnel were not hurt.

The NTSB expects to issue its final report on the fire later this year, but the board's preliminary reports indicate that the fire began after one of eight cells in the APU lithium-ion battery experienced "an uncontrollable increase in temperature and pressure (known as a *thermal runaway*) as a result of an internal short circuit."

The overheating of that cell spread to adjacent cells, "resulting in the cascading thermal runaway of several cells and the release of additional smoke and flammable electrolyte from the battery case," the NTSB said in a letter accompanying its safety recommendations to the FAA.

The reaction in this battery was unexpected, considering the results of tests that were performed on the APU battery system as part of the 787 certification program, the letter said.

The NTSB letter noted that the main battery in the 787 is also a lithium-ion battery — and that the 787 is the first large transport-category airplane to be equipped with permanently installed lithium-ion main and APU batteries. Lithium-ion batteries also are incorporated into the flight control electronics, emergency lighting and the recorder-independent power supply, the letter said.

In addition to the Boston fire, a blaze broke out in the main battery of an All Nippon Airways 787 during a Jan. 16, 2013, domestic flight in Japan. No one was injured in the incident, which ended with an emergency landing in Takamatsu soon after takeoff. The Japan Transport Safety Board, which is continuing its investigation of the event, characterized it as a serious incident.

Battery Development

In its letter, the NTSB traced the history of the development of the 787 battery systems to a meeting of Boeing officials and FAA aircraft certification representatives in 2004, when Boeing first indicated its intention to install lithium-ion batteries.

Because the FAA determined that the regulations that existed at the time did not address all safety-related characteristics of lithium-ion batteries, the agency issued special conditions that described additional requirements that it considered essential to provide a level of safety equal to that established in existing aircraft battery standards.

One of the nine provisions said that the lithium-ion batteries must be designed to "preclude the occurrence of self-sustaining, uncontrolled increases in temperature or pressure." During an April 2013 NTSB hearing, representatives of Boeing and the FAA testified that when the 787 was certificated, "they believed that an uncontrolled increase in temperature or pressure could only occur if a cell or a battery were overcharged." There has been no evidence that the battery in the Boston incident was overcharged, the NTSB said.

Preliminary information obtained by accident investigators indicated that Boeing "underestimated the more serious effects of an internal short circuit, that is, thermal runaway of other cells within the battery, excessive heat, flammable electrolyte release and fire," the letter said.

Limitations of Testing

The letter noted that experts in lithium-ion battery technology have said that the conditions within a battery cell that lead to an internal short circuit cannot easily be detected and managed by a battery-monitoring system. As an example, the document cited the 787 involved in the Boston fire, which experienced "no abnormal indications or maintenance messages related to issues with the incident battery" between its delivery on Dec. 20, 2012, and the fire 18 days later, on Jan. 7, 2013.

In tests conducted in March 2014, the NTSB used three different methods of simulating an internal short circuit in a single cell of a 787 lithium-ion battery to compare the energy levels of the resulting thermal runaways.

"Preliminary test results indicated that, immediately after inducing the short circuit, the maximum temperature at a common location on the cell cases ranged from about 240 degrees C to 375 degrees C (about 464 degrees F to 707 degrees F), depending on the method used, [and] the cell case temperature at various locations differed by as much as about 270 degrees C/[486] degrees F … .

"Although various other factors, such as cell age, were not evaluated during this testing, the preliminary test results were consistent with the observations of industry experts who indicated that the method used to simulate a cell internal short circuit in a thermal runaway abuse test could have a significant impact on the resulting thermal energy released. Thus the method used to initiate thermal runaway as part of an internal short circuit abuse test could also influence how the thermal runaway condition could affect other cells within a battery."

Safety Recommendations

The NTSB said that its post-accident tests were "not exhaustive." Nevertheless, the results indicated that "to fully understand the most severe effects that could occur when a single cell within a lithium-ion battery undergoes thermal runaway, various factors expected during normal operations need to be included in aircraft certification tests," the NTSB said. "In particular, it is important to ensure that installation, environmental and usage factors are fully accounted for in abuse tests intended to demonstrate the most severe effects of an internal short circuit-induced thermal runaway."

The RTCA document that is the current standard for certification of lithium-ion battery design and certification for aviation purposes includes abuse testing but "does not address all of the unique aspects of a battery's installation on an aircraft," the NTSB said.

Therefore, the board recommended that the FAA "develop abuse tests that subject a single cell within a permanently installed, rechargeable lithium-ion battery to thermal runaway and demonstrate that the battery installation mitigates all hazardous effects of propagation to other cells and the release of electrolyte, fire or explosive debris outside the battery case. The tests should replicate the battery installation on the aircraft and be conducted under conditions that produce the most severe outcome."

After the tests have been developed, the NTSB said, the FAA should require aircraft manufacturers to perform the tests as part of the certification process for new aircraft with a permanently installed, rechargeable lithium-ion battery.

In developing the tests, the NTSB recommended that the FAA work with experts in lithium-ion battery technology to "develop guidance on acceptable methods to induce thermal runaway that most reliably simulate[s] cell internal short-circuiting hazards at the cell, battery and aircraft levels."

Ongoing research could help the FAA identify accurate methods of simulating an internal short circuit in a lithium-ion battery, the NTSB said.

"An evaluation of various methods to replicate internal short circuiting … could help manufacturers determine whether they are using appropriate test methods to demonstrate the most severe effects that could result at the cell, battery and aircraft levels, given the battery's unique design and installation," the NTSB said.

Another recommendation called on the FAA to review the methods of compliance used in certifying permanently installed, rechargeable lithium-ion batteries in in-service aircraft and, if necessary, to require additional tests to ensure adequate protection against "all adverse effects of a cell thermal runaway."

Noting that technical experts outside the FAA could provide "valuable insights about best practices and test protocols for validating system and equipment safety performance during certification when new technology is incorporated," the NTSB also recommended that the FAA develop a policy of establishing independent panels of experts to provide advice on certifying the safety of new technology. These panels should be established as early as possible in the certification process "to ensure that the most current research and information related to the technology could be incorporated during the program," the NTSB said.

Ongoing research could help the FAA identify accurate methods of simulating an internal short circuit in a lithium-ion battery.

BY FRANK JACKMAN

Excursions Up, Ramp Accidents Down at EASA Airports

The number of runway excursion and ground collision accidents and serious incidents at Europe's airports increased in 2013 from the previous year, but the number of ramp-related accidents declined, according to the European Aviation Safety Agency's (EASA's) recently released *Annual Safety Review* 2013. Data in the review cover the 28 European Union member states plus Iceland, Liechtenstein, Norway and Switzerland. Airports included in the data are all open to public use, serve commercial transport, provide instrument approach or departure procedures, and have paved runways of 800 m (2,625 ft) or more or exclusively serve helicopters.

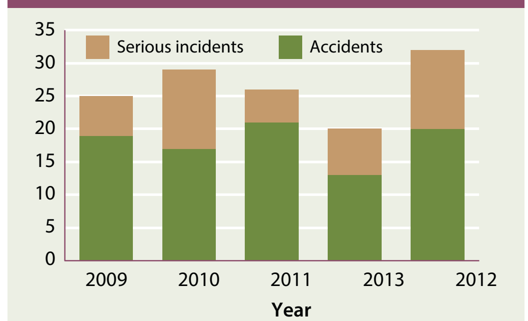
EASA airports saw 32 runway excursion accidents and serious incidents last year, which is up from 20 in 2012 and more than in any other year in the past five years (Figure 1). Of 2013's 32 excursions, 20 were accidents, as defined in International Civil Aviation Organization (ICAO) Annex 13, *Aircraft Accident and Incident Investigation*, and 12 were categorized as serious incidents, defined as incidents involving circumstances indicating that an accident nearly occurred. The annual number of runway excursion accidents and serious incidents had been on the decline since 2010, when 29 were recorded, up from 25 in 2009. The 20 reported in 2012 were the fewest in the 2009–2013 period.

In the past five years, there have been 132 runway excursion accidents and serious incidents at EASA airports, according to the *Annual Safety Review*. Of that number, 86 percent occurred during landing and 14 percent during takeoff. The European Aviation Safety Plan (EASp) identifies runway excursions as one of the key operational safety risks for commercial air transport aircraft (Figure 2).

The number of ground collision accidents and serious incidents at EASA airports increased to eight in 2013 from seven in 2012. Ground collisions, which like runway excursions, are identified in the EASp as a key operational safety risk for commercial air transport, are defined as collisions between an aircraft and another aircraft, vehicle, person or object during taxi. In the past five years, there have been 34 ground collision accidents and serious incidents at EASA airports, with 2011 being the worst year, with 10. The best year was 2009, when there were four accidents and serious incidents (Figure 3).

Ramp accidents and serious incidents at EASA airports declined for the second

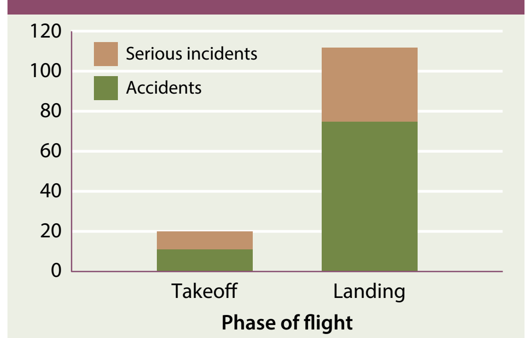
Runway Excursion Accidents and Serious Incidents at EASA Airports, 2009–2013



Source: EASA *Annual Safety Review* 2013

Figure 1

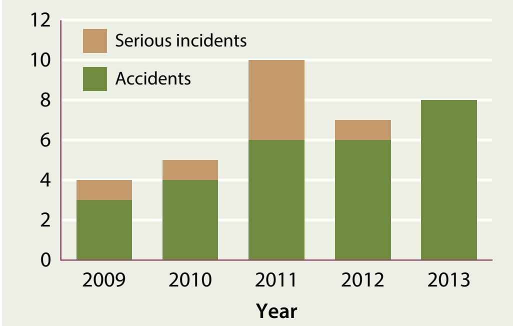
Runway Excursions at EASA Airports by Phase of Flight, 2009–2013



Source: EASA *Annual Safety Review 2013*

Figure 2

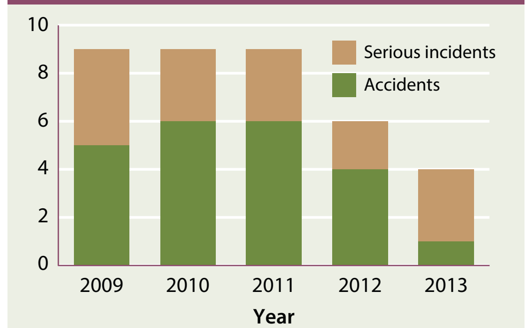
Ground Collision Accidents and Serious Incidents at EASA Airports, 2009–2013



Source: EASA *Annual Safety Review* 2013

Figure 3

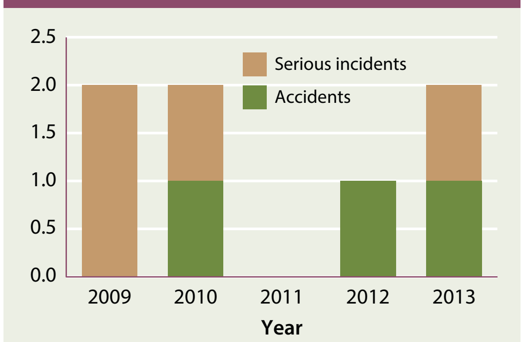
Ramp Accidents and Serious Incidents at EASA Airports, 2009–2013



Source: EASA *Annual Safety Review* 2013

Figure 4

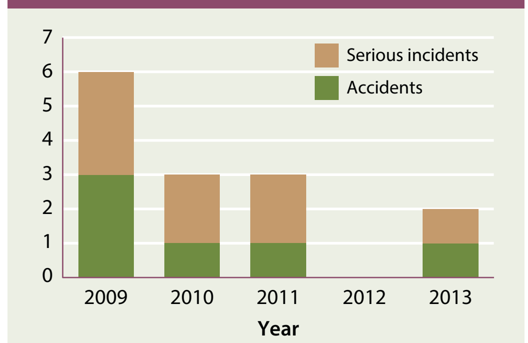
Bird Strike Accidents and Serious Incidents at or Near EASA Airports, 2009–2013



Source: EASA *Annual Safety Review* 2013

Figure 5

Accidents and Serious Incidents at EASA Airport Occurrences, 2009–2013



Source: EASA *Annual Safety Review* 2013

Figure 6

straight year, falling to four in 2013 from six in 2012 (Figure 4). Nine accidents and serious incidents per year were recorded in 2009, 2010 and 2011. Ramp events are those that occur during, or as result of, ground handling operations. Examples include loading, pushback, refueling and deicing errors, EASA said. The most common types of ramp accidents and serious incidents involve collisions with other aircraft, ground objects and with vehicle/equipment operations. Two of 2012's accidents were fatal. In one, a baggage handler was killed while loading an aircraft, and in the other, the driver of a water truck was killed when the truck collided with the wingtip of an airplane. In total, there have been 37 ramp accidents and serious incidents over the past five years: 22 accidents and 15 serious incidents.

Very few bird strike accidents or serious incidents have been reported at or near EASA airports over the past five years (Figure 5.) Two were reported in 2013, up from one in 2012 and zero in 2011, EASA data show.

Airport accidents and serious incidents, defined as those involving airport design or functionality issues associated with runways, taxiways, ramp areas, parking areas, buildings and structures, fire and rescue services, obstacles on the airport, lighting, markings, signage, procedures, policies and standards, represent another occurrence category tracked by EASA. In the past five years, there were 14 accidents or serious incidents within this category (Figure 6).

Commercial Air Transport

Airplanes of more than 2,250 kg (4,960 lb) maximum takeoff mass (MTOM) from EASA member states involved in commercial air transport (CAT) suffered 18 accidents in 2013, down 45 percent from the 33 in 2012 and down 27 percent from the 10-year (2002–2011) average of 24.6 per year, according to EASA data (Table 1, p. 46). In addition, EASA CAT operators had no fatal accidents last year, and suffered only one in 2012 when a ground operator was killed during baggage loading operations at Rome Fiumicino Airport. There has

EASA Member State Operated Commercial Air Transport Airplanes

	Total Accidents	Fatal Accidents	Onboard Fatalities	Ground Fatalities
2002-2011 (average per year)	24.6	2.3	59	0.2
2012	33	1	0	1
2013`	18	0	0	0

Source: European Aviation Safety Agency

Table 1

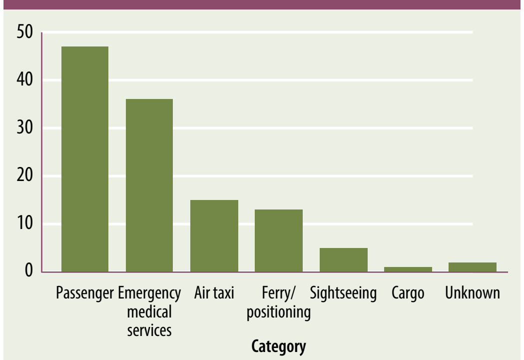
EASA Member State Operated Helicopters, All Mass Categories

	Total Accidents	Fatal Accidents	Onboard Fatalities	Ground Fatalities
2002-2011 (average per year)	12.8	3.4	14.1	0.1
2012	12	2	8	0
2013	7	3	10	1

Source: European Aviation Safety Agency

Table 2

Accidents by Operation Type of EASA-Operated CAT Helicopters, All Mass Categories, 2004–2013



CAT = commercial air transport

Source: EASA *Annual Safety Review* 2013

Figure 7

not been a year with more than one fatal accident involving an EASA member state–operated airplane since 2007. CAT operations involve the transportation of passengers, cargo and mail for remuneration or hire and ferry/positioning flights. Aircraft accidents are aggregated by the state in which aircraft operator is registered.

In the 10-year period 2004–2013, the highest number of fatal accidents (five) were assigned to the loss of control–in flight (LOC-I) occurrence category, as defined by the Commercial Aviation Safety Team–ICAO Common Taxonomy Team. LOC-I involves the momentary or total loss of control of the aircraft by the crew. During the same period, there were four fatal accidents involving fire/smoke post impact (F-POST) and three accidents involving system/component failure–powerplant (SCF-PP). The highest number of nonfatal accidents involved the abnormal runway contact occurrence category, which includes long, fast or hard landings, as well as scraping the tail or wing of the aircraft during takeoff or landing. Ground collisions and turbulence also were among the most common types of nonfatal accidents.

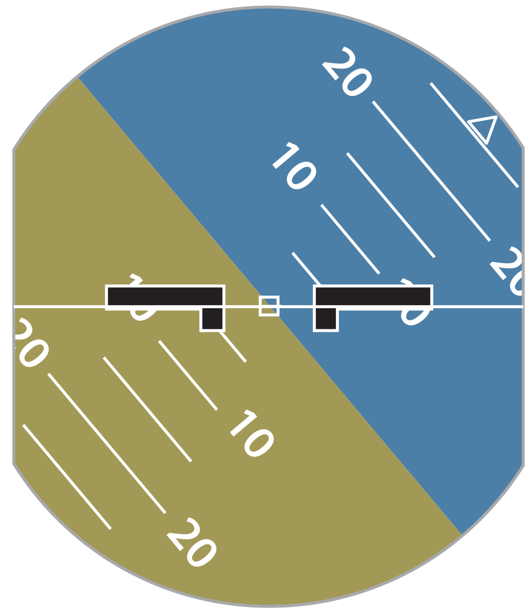
Among helicopters in all mass categories in CAT operations, there were seven accidents involving operators from EASA member states in 2013, of which three were fatal. In 2012, there were 12 helicopter accidents, but only two were fatal, EASA said. Over the 10-year (2002–2011) period, there was an average of 12.8 CAT helicopter accidents per year, of which 3.4 were fatal, resulting in 14.1 onboard fatalities (Table 2).

Passenger operations accounted for more CAT helicopter accidents during 2004–2013 than any other type of operation, followed by emergency medical services (Figure 7). During that same period, offshore operations accounted for 13 percent of fatal accidents and 23 percent of fatalities. According to EASA, offshore operations generally are carried out with large helicopters, which, when an accident occurs, could result in a larger number of casualties. Offshore operations have experienced fewer fatal accidents and fatalities, but the ratio of fatalities to fatal accidents is higher for this type of operation: 7.5 fatalities per fatal accident versus 3.8 fatalities per fatal accident for nonoffshore operations, EASA said.

Broken down by occurrence subcategories, the greatest number fatal accidents were attributed to LOC-I, followed by controlled flight into terrain, low altitude operation and F-POST. The greatest number of total accidents involved LOC-I, followed by system/component failure — non-powerplant, SCF-PP and collision with obstacle(s) during takeoff and landing. SCF-PP includes accidents related to gearbox malfunctions.

Starting Lineup

BY WAYNE ROSENKRANS



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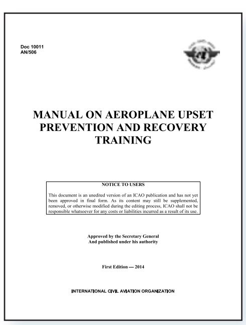
Doc 10011
AN/506

MANUAL ON AEROPLANE UPSET PREVENTION AND RECOVERY TRAINING

NOTICE TO USERS

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Approved by the Secretary General
And published under his authority

First Edition — 2014

INTERNATIONAL CIVIL AVIATION ORGANIZATION

Manual on Aeroplane Upset Prevention and Recovery Training

Doc 10011, AN/506, First Edition. International Civil Aviation Organization (ICAO). Montreal: ICAO, 2014. 94 pp. Figure, tables, appendix. Available from ICAO at <www.icao.int>.

Several *ASW* articles since mid-2009 tracked steps toward the global consensus on effective, feasible solutions for mitigating loss of control in flight (LOC-I). Recent public release of this manual sets an anchor point for aviation safety professionals regarding upset prevention and recovery training (UPRT), detailing the finalized set of international standards and recommended practices (see "Teaching UPRT," p. 30) that resulted from five years of work by experts from many organizations. They knew that, in the manual's words, "LOC-I accidents often have catastrophic results with very few, if any, survivors."

The manual also lays out its historical context: "Until recently, international licensing standards did not require training programmes to teach upset prevention and recovery, even at the theoretical level," it says. "The study of aerodynamics and its effects, and the practical lessons focusing on stall and, in some cases, spin recovery seemed to be the training benchmarks that defined the industry's efforts to mitigate the likelihood of a LOC-I occurrence. … The study of LOC-I occurrences revealed overarching training deficiencies that failed to adequately prepare the affected flight crews to recognize, avoid, and, in the worst instances, recover from an aeroplane upset condition."

Moreover, flight simulation training devices (FSTDs) typically presented "dynamic characteristics in the stall and post-stall regimes that are easier to recover from than in the actual aeroplane. … In addition, at least one event has occurred for which pilots misidentified the conditions associated with a stall, as those conditions were not portrayed in the FSTD."

ICAO begins with definition of the term *aeroplane upset* and a glossary of UPRT-related language. The manual's emphasis throughout is the need for UPRT, regardless of any airline pilot's background, type ratings or flight hours.

"Both on-aeroplane training at the commercial pilot and multi-crew pilot level and training in a flight simulation training device at the airline transport pilot and type rating level are now promulgated in Annexes 1 — *Personnel Licensing* and 6 — *Operation of Aircraft,* Part I — *International Commercial Air Transport — Aeroplanes,* as well as in the *Procedures for Air Navigation Services – Training* (*PANS-TRG,* Doc 9868), with an applicability date of 13 November 2014," the manual says. PANS-TRG revisions also include the standard for on-airplane UPRT as part of qualification for the multi-crew pilot license and the recommended practice that students preparing for the commercial pilot license–airplane receive such training.

Stall and airplane upset are now treated as closely related, and ICAO foresees comprehensive UPRT programs superseding airline programs formerly geared only to stall or airplane upset. "Although not all aeroplane upset occurrences involve an aerodynamic stall, an unintentional stall is indeed a form of upset even though it may not meet the pitch and bank attitude upset parameters," the manual says. "This is because during a stall, the aeroplane meets the upset criteria of being at an inappropriate airspeed for the conditions. In all instances of an aeroplane upset involving a stall, it is stressed in this manual that the aeroplane must first be recovered from the stall condition before any other upset recovery action can become effective."

As noted, ICAO has left no room to exempt any pilot from UPRT because recurrent training for reinforcement/refresher of perishable skills is seen as critical throughout a pilot's career.

"There are also several recorded incidents of aeroplane upsets from which there was indeed a successful recovery and many other occurrences where an impending upset was avoided," the manual says. "The determinant factor for recovery to a safe state in most of those incidents was either the flight crew's accurate analysis of the occurrence and the timely and correct application of preventive/recovery techniques, or the aeroplane's inherent stability combined with its envelope protection system that provided an added measure of time, or an autoflight system input that marginalized the seriousness of the incident."

Under this assumption of universal value, the manual tells how to assess the highly experienced airline pilots' specific needs for transitional or *bridge training*, including how the training should be delivered if pilots have not previously received any formalized UPRT. For states, airlines, approved training organizations and other entities, the instructional approach, components of UPRT design, the comprehensive integration of components and pilot-proficiency performance benchmarks also are covered.

The UPRT program blueprint divides recommended training elements into 11 subject areas with corresponding components. For example, the human factors content covers threat and error management, human information processing, crew resource management, situation awareness, decision making, problem solving, startle and stress response, and physiological factors. And knowledge of aerodynamics, flight dynamics, airplane design principles, threats and human limitations fulfills the academic/theoretical training prescribed.

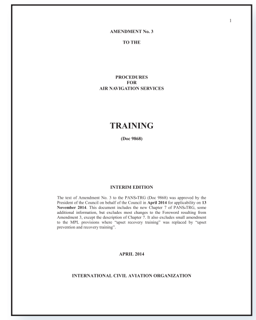
The manual also describes the continuing role for the *Airplane Upset Recovery Training Aid, Revision 2* (November 2008) — developed by Airbus, Boeing and Flight Safety Foundation — and announces an initiative led by ICAO and the airline industry to complete an update to the *Training Aid* in 2015.

On-airplane UPRT is now accepted internationally as a means to address known limitations of FTSD-based UPRT, and ICAO recommends that approved training organizations explicitly mitigate the risks to students and instructors during on-airplane training by combining a safety management system with policies and procedures of a quality assurance program.

"Limitations in FSTD motion cueing and the reduced emotional response create boundaries that prevent pilots from experiencing the full range of aeroplane attitudes, load factors and behaviour that can be present during an actual flight," the manual says. "These areas of missing experience provide gaps in pilots' understanding and proficiency when confronted with an actual upset. … FSTD capabilities permit training in operational areas that are otherwise unsafe or impractical in actual aeroplanes (such as low altitude or very high altitude upset encounters or flight during rapidly deteriorating situations involving adverse weather or icing conditions). Additionally, FSTDs can allow for practical skill development in upset prevention and recovery in a crew environment and with aeroplane-specific systems, instrument indications, control response and procedures." The manual covers appropriate use of type-specific and non-type-specific FSTDs in various contexts, including cases when type-specific FSTDs do not exist.

Amendment No. 3 to the Procedures for Air Navigation Services –Training

Doc 9868, Interim Edition, applicable Nov. 13, 2014. International Civil Aviation Organization (ICAO). Montreal: ICAO, April 2014. 8 pp.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AMENDMENT No. 3

TO THE

PROCEDURES
FOR
AIR NAVIGATION SERVICES

TRAINING

(Doc 9868)

INTERIM EDITION

The text of Amendment No. 3 to the PANS-TRG (Doc 9868) was approved by the President of the Council on behalf of the Council in **April 2014** for applicability on **13 November 2014**. This document includes the new Chapter 7 of PANS-TRG, some additional information, but excludes most changes to the Foreword resulting from Amendment 3, except the description of Chapter 7. It also excludes small amendment to the MPL provisions where "upset recovery training" was replaced by "upset prevention and recovery training".

APRIL 2014

INTERNATIONAL CIVIL AVIATION ORGANIZATION

This interim edition of the latest amendment by ICAO to *Procedures for Air Navigation Services –Training (PANS-TRG)* primarily adds an all-new Chapter 7, "Upset Prevention and Recovery Training" (UPRT) and some additional UPRT-relevant information focusing on the training needs of airplane pilots seeking to attain the required level of academic/theoretical and practical competency to mitigate the risk of loss of control–in flight (LOC-I).

"Many LOC-I accident investigations have revealed that the affected flight crew had received misleading information from well-meaning training staff or their organizations," the amendment says. "Indeed, some existing training practices were found to be not only ineffective but were also considered a contributory factor, which led to inappropriate responses by some flight crews."

This resource is closely linked to the *Manual on Aeroplane Upset Prevention and Recovery Training* (Doc 10011), and part of a comprehensive information package intended for use by civil aviation authorities, operators and approved training organizations. The training specified in the new chapter "is required for the MPL [multi-crew pilot license], the type-rating and the training of commercial air transport pilots, and is highly recommended for the CPL(A) [commercial pilot license (airplane)]," the amendment says.

"Although not obligatory, training organizations engaged in the recurrent assessment and training of flight crew engaged in the operations of large or turbojet aeroplanes in accordance with Annex 6, Part II — *International General Aviation – Aeroplanes* … should also use this information to enhance the scope of their training services being offered. A well-constructed UPRT programme will better enable individual pilots and flight crews to effectively cope with unexpected and unforeseeable situations, which regrettably is a skill set that has been found lacking in virtually every recorded LOC-I accident."

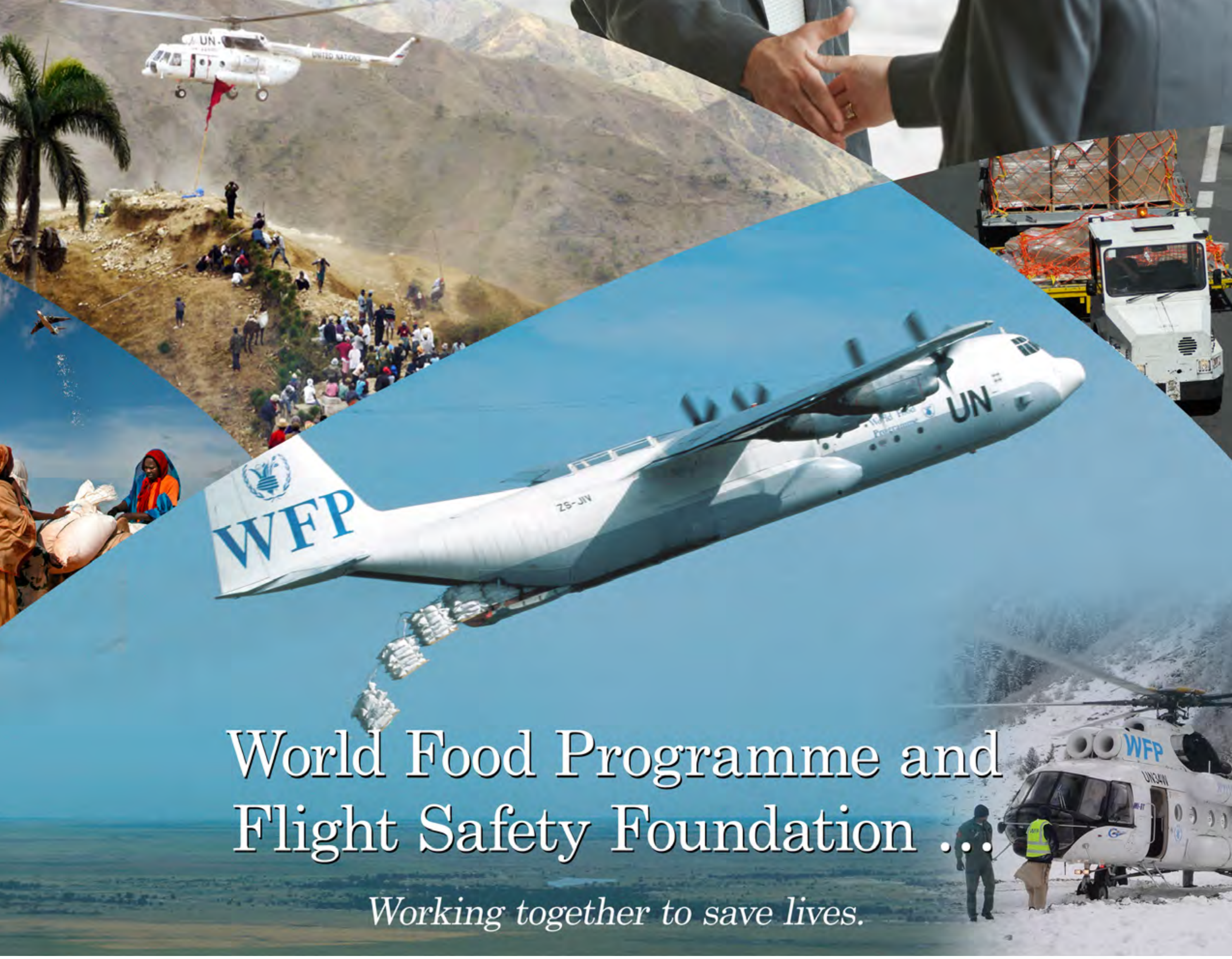
The amendment clarifies that UPRT at the CPL(A) licensing level "should be commensurate with those requirements deemed appropriate for an entry-level licence for a pilot starting employment with a commercial operator." ICAO assumes that unlike MPL holders — who begin careers as first officers operating commercial air transport airplanes — CPL(A) holders will be presumed to build upon their initial UPRT knowledge, skills and attitudes when they transition to airline-level type ratings and operator-specific initial and recurrent training stages of their airline careers.

The amendment often mirrors content of the *Manual,* especially concerning appropriate and safe use of on-airplane training; expected qualifications of instructors; quality assurance; and the oversight of approved training organizations by national authorities.

PANS-TRG and *Manual*–derived edits appear throughout other ICAO documents, as shown in two free ICAO-compiled UPRT-related lists <www.icao.int/Meetings/LOCI/Pages/Upset-Prevention-and-Recovery-Training-Provisions.aspx>.[1,2]

Notes

1. ICAO. Annex 6, *Operation of Aircraft.* "Upset prevention and recovery training–related excerpts from Part I, *International Commercial Air Transport – Aeroplanes,* Ninth Edition." Montreal: ICAO, July 2010.
2. ICAO. Annex 1, *Personnel Licensing.* "Upset prevention and recovery training–related excerpts from Annex I, *International Commercial Air Transport – Aeroplanes,* Ninth Edition." Montreal: ICAO, July 2011.



The World Food Programme (WFP) is the food aid branch of the United Nations, and the world's largest humanitarian organization. WFP provides food to about 90 million people each year, including 58 million children. From its headquarters in Rome and offices in more than 80 countries, WFP helps people who are unable to produce or obtain enough food for themselves and their families.

The Aviation Safety Unit (ASU) of WFP is responsible for the aviation safety of the humanitarian air services provided by WFP — flights to many of the highest-risk parts of the world every day for clients' needs and, often, survival.

The WFP aviation safety activities are designed to reduce the risk of accidents and to enhance safety awareness among all users and service providers. They strive to offer professional and safe air transport service through quality control.

We need you!

Your volunteer efforts, industry experience, safety expertise, and/or financial support are needed.

Flight Safety Foundation will assist the World Food Programme's efforts to further enhance the training and education needs of its Aviation Safety Unit by providing FSF products and services, instructional seminars, expertise, knowledge and lessons learned to this vital aspect of the World Food Programme.

WFP United Nations World Food Programme

For more information on how you can help, contact Susan Lausch in the FSF Development Department at development@flightsafety.org or phone +1.703.739.6700, ext. 112.

FLIGHT SAFETY FOUNDATION

Frost Triggers Stall on Takeoff

Pilot had an 'insufficient appreciation' of the risks posed by ground icing.

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

Deicing Not Available

Beech Premier 1A. Destroyed. Two fatalities, one serious injury.

The aircraft had been exposed to high humidity and to ambient temperatures at and slightly below freezing while parked outside all night at the Annemasse airport in eastern France. The resulting frost accumulation on the aircraft caused an aerodynamic stall from which the pilot was unable to recover during takeoff the morning of March 4, 2013, according to the Bureau d'Enquêtes et d'Analyses (BEA).

The aircraft was destroyed by the impact and subsequent fire. The pilot and a passenger occupying the right front seat were killed; a passenger seated in the rear of the cabin was seriously injured.

"The investigation showed that the pilot's insufficient appreciation of the risks associated with ground-ice led him to take off with contamination of the critical airframe surfaces," the BEA's report said.

The pilot, 49, was employed by an aircraft charter and management company to fly the Premier, which is certified for single-pilot operation. He had logged 1,386 of his 7,050 flight hours in the light business jet.

The pilot apparently had intended to fly his passengers to Geneva, Switzerland, the previous evening, but a landing slot (reservation) was not available there. Nor were slots available at commercial airports in close proximity to Geneva. So, he positioned the aircraft to the Annemasse airport, which was uncontrolled and had no deicing facilities.

Whether the pilot detected the frost during his preflight inspection of the aircraft is unknown. The report said that the accumulation likely was thin and would have been difficult to detect without a tactile inspection. "In any case, he was not inclined to remove the layer of ice before undertaking the flight," the report said, noting that the proper action would have been to delay the flight until the frost melted.

Those who witnessed the takeoff said that the aircraft entered a high nose-up pitch attitude after liftoff and climbed slowly while banking steeply left and right. Recorded data indicate that a stall warning sounded in the cockpit and the enhanced ground-proximity warning system (EGPWS) generated several "bank angle" warnings.

About 15 seconds after liftoff, the main landing gear struck the roof of a house to the right and about 500 m (1,641 ft) beyond the runway threshold. The aircraft then descended into a garden behind other houses. No one on the ground was hurt. The surviving passenger was thrown from the wreckage and rescued by passersby.

A data search conducted during the investigation revealed 45 other takeoff accidents between 1989 and 2012 involving aircraft with wings contaminated by frost or ice. More than two-thirds of the aircraft had not been deiced before takeoff, the report said.

Based on the findings of the investigation, the BEA issued several recommendations, including recurrent pilot training on the effects of airframe contamination, development of contamination-detection systems and installation of deicing facilities at all airports in France (*ASW*, 6/14, p.13).

Cascade of Systems Failures

Boeing 747-400. Substantial damage. No injuries.

Shortly after departing from London (England) Heathrow Airport with 340 passengers and 22 crewmembers for a flight to Malaysia the night of Aug. 17, 2012, the flight crew felt and saw indications of vibration of the no. 2 engine, followed by a loud bang and the message "ENG FAIL" on the engine indicating and crew alerting system (EICAS).

The crew shut down the no. 2 engine and received clearance from air traffic control (ATC) to hold at 19,000 ft above the North Sea to jettison fuel in preparation to return to Heathrow for a landing, said the report by the U.K. Air Accidents Investigation Branch (AAIB).

The crew decided to conduct an autoland approach to Heathrow's Runway 09R. The aircraft was established on the localizer at 3,000 ft when the master warning system activated. The three autopilots disengaged, all the cockpit displays and lights flickered, and many failure messages appeared on the EICAS. The autothrottles then disengaged as the 747 intercepted the glideslope.

"The pilots decided that, with the runway in sight, the safest course of action was to continue the approach rather than manage the failures," the report said, noting that the standby instruments continued to operate normally. "The commander continued the approach, manually flying the aircraft to a safe landing."

The engine and electrical system problems apparently were not directly related. Examination of the no. 2 engine, a Pratt & Whitney PW4056 that had accumulated 27,505 hours and 2,857 cycles since its last overhaul, revealed that spalling of the ceramic coating on the high-pressure turbine's second-stage outer air seal had caused a portion of the seal to separate and strike a turbine blade. "Subsequent damage from the liberated blade resulted in imbalance of the high-speed rotor, leading to engine vibration," the report said.

Investigators determined that the electrical system faults were triggered by a latent mechanical failure of a bus tie breaker. The failure occurred when all three autopilots were engaged for the autoland approach. The report said that the investigation prompted the aircraft manufacturer to develop procedures for detecting signs of impending failures of bus tie breakers.

Slam-Dunk Approach

Airbus A319. No damage. No injuries.

Based on the latest automatic terminal information system broadcast, the flight crew planned for an approach and landing on Runway 29 at the Tunis (Tunisia) Carthage airport the morning of March 24, 2012. The aircraft was inbound on a scheduled flight from Paris.

The descent from cruise altitude, Flight Level 350 (approximately 35,000 ft), was performed with a relatively low selected vertical speed of 1,000 fpm, said the BEA report. During the descent, an en route controller confirmed that Runway 29 was in use at Tunis.

However, as the A319 neared the 3-degree glide path for Runway 29, an approach controller told the crew that Runway 19 was active and requested that they conduct a direct approach to that runway. The crew acceded to the request and was cleared for the instrument landing system approach to Runway 19.

At the time, the aircraft was 33 nm (61 km) from the runway threshold and descending through 20,700 ft — about 10,000 ft above the 3-degree glide path to the runway — at 276 kt. The captain, the pilot flying, engaged the autoflight system's "open descent" mode (which adjusts pitch attitude to maintain the selected airspeed), selected an airspeed of 300 kt and extended the air brakes, causing the descent rate to increase to 5,000 fpm.

The A319 was 13.5 nm (25 km) from the runway and descending through 10,000 ft when the captain disengaged the autopilot and called for extension of the landing gear. About 8 nm (15 km) from the runway, the aircraft was on the localizer but about 3,400 ft above the glideslope and descending at 4,400 fpm.

The aircraft subsequently was 1,000 ft above the glideslope, descending at 4,400 fpm and 240 kt, when the copilot told the controller that they were "a little above the path" and requested a 360-degree right turn, the report said. The controller told the copilot to repeat the request.

During this time, the aircraft had descended below the glideslope. The EGPWS generated "sink rate," "pull up" and "too low, terrain" warnings. The A319 was about 398 ft above the ground when the captain initiated a go-around. The crew then flew a visual pattern and landed the aircraft without further incident.

BEA concluded that the unstabilized approach was caused by "the crew's decision to undertake and continue an approach that required a glide path interception from above in conditions that did not offer a high chance of success."

TURBOPROPS

Elevator Separates on Takeoff

Piaggio P180. Substantial damage. No injuries.

The Avanti was 23 minutes behind schedule when it departed from Camarillo, California, U.S., early the morning of July 28, 2012, for a positioning flight to San Diego. The two passengers waiting for the airplane at San Diego were upset by the delay, said the report by the U.S. National Transportation Safety Board (NTSB).

After landing in San Diego, the captain performed only a partial preflight inspection of the airplane, and the first officer did not inspect it at all before they departed for a flight to Henderson, Nevada.

"The crew reported that they had a non-eventful departure and flight from San Diego, and that the captain noticed that more back-pressure on the flight controls was required for a normal landing upon arrival at Henderson," the report said.

The pilots performed a post-flight inspection of the airplane and found that the left elevator was missing. Three days later, Camarillo Airport personnel found the elevator in the grass near the runway from which the Avanti had departed.

Examination of the airplane revealed that the self-locking nuts on the right elevator's hinges were only finger-tight. Investigators found that both elevators had been removed and reinstalled during maintenance compliance with an airworthiness directive (AD) 54 days earlier.

"It is likely that all four sets of attachment hardware for both elevators were not properly torqued during the AD maintenance," the report said. "Additionally, 26 days before the event, a phase inspection was completed, during which the elevator should have been visually inspected and functionally checked. The airplane had flown 158.9 hours with loose elevator attachment hardware before the two sets of bolts on the left elevator had completely worked their way out of the hinges and the elevator departed the airplane."

Moreover, the report said that the cockpit voice recording showed that the pilots had experienced unusual pitch control responses during all of the departures and landings the morning of the incident. "The flight crew could have identified the missing elevator during a preflight inspection at the intermediate airport, yet they decided to continue the flight despite the pitch control problems [they had] experienced."

Rudder Jams on Approach

ATR 72-212A. Minor damage. No injuries.

The aircraft was en route with 27 passengers and four crewmembers from Tampere, Finland, to Helsinki the afternoon of Aug. 19, 2012. When the flight crew reduced airspeed below 185 kt during the approach to Runway 22L at Helsinki, they received a visual warning that the rudder travel limitation unit (TLU) had malfunctioned.

The aircraft was in visual meteorological conditions (VMC) and about 6 nm (11 km) from the runway when the warning occurred. The captain continued flying the approach while the first officer consulted the quick reference handbook (QRH).

"The flight crew did not have enough time to interpret the QRH's instructions for a TLU fault [and] failed to switch on the TLU's standby system," said the English translation of the report by the Safety Investigation Authority of Finland.

The first officer was still reading the QRH when the aircraft descended below 500 ft. Although the airline required a go-around at this point because the approach technically was not stabilized, the captain decided to land the aircraft. He did not provide information about the situation to the cabin crew, and they prepared the cabin and passengers for a normal landing.

Investigators later found that the main TLU electric actuator had broken, preventing the

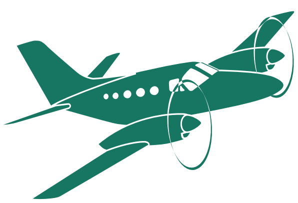
TLU system from changing from the high-speed mode to the low-speed mode when airspeed was reduced for the approach. The fault limited rudder travel to about 4 degrees.

As a result, the captain did not have sufficient rudder authority to correct a right yaw induced by asymmetric thrust as he reduced power below flight idle shortly after touchdown. (The report noted that such asymmetries are normal in the ATR 72 and are usually corrected easily by rudder aerodynamic control.)

The captain applied wheel braking, but the aircraft veered off the right side of the runway. "The captain, using nose-wheel steering, managed to steer the aircraft back onto the runway," the report said.

A belly-mounted avionics cooling fan, a landing gear fairing and a tire were damaged during the excursion. "The damage was not extensive because … the ground was sufficiently hard and level to support an aircraft of this weight class," the report said. "The serious incident did not result in any injuries to persons or damage to runway equipment."

The report concluded that the flight crew had "inadequate system awareness" and that the QRH did not provide clear instructions for using the TLU's standby system. "The haste caused by the decision to continue the approach allowed too little time for the flight crew to sufficiently explore the difficult-to-read QRH."



PISTON AIRPLANES

Fatal Search for an Airport

Piper Apache. Destroyed. Three fatalities.

The pilot departed in VMC from Sullivan, Indiana, U.S., about 0135 local time on Aug. 8, 2011, to fly a passenger to Steubenville, Ohio, so that she could be with a relative who was to undergo surgery. The pilot knew that weather conditions at the destination were forecast to deteriorate, and although instrument-rated, he conducted the flight under visual flight rules with ATC flight-following services.

A controller provided radar vectors to the airport, but the pilot was unable to locate it due to fog. He told the controller that he would divert to Columbus, Ohio, about 100 nm (185 km) southwest but then decided to fly to an airport closer to Steubenville. When informed that the runway lights there were out of service, the pilot decided to try Millersburg, Ohio, about 58 nm (107 km) northwest.

"On the approach to the third airport, the pilot was initially unable to see it because fog was in the area and the airport beacon was out of service," the NTSB report said. "Further, he was using the wrong frequency to activate the pilot-controlled runway lights."

After receiving the correct frequency from ATC, the pilot reported that he had the runway in sight. A witness heard the Apache make three passes over the airport from different directions before it struck terrain at 0455.

"It is likely that the pilot was unable to see the airport and continued to fly in the vicinity [and] search for the runway, and [he] subsequently lost situational awareness and struck trees," the report said.

Unexplained Overrun

Beech B60 Duke. Destroyed. Three fatalities.

One witness said that the engines sounded normal during the takeoff roll at Sedona, Arizona, U.S., the morning of July 26, 2012, but the airplane appeared to accelerate slowly. However, three other witnesses said that the engines "did not sound right" during the run-up and takeoff, said the NTSB report.

Density altitude was about 7,100 ft at the airport, which is at an elevation of 4,830 ft. The Duke was within weight and balance limits, and investigators calculated a takeoff roll of 2,805 ft (855 m) and an accelerate-stop distance of 4,900 ft (1,494 m).

"Directional control was maintained, and at midfield, the airplane had still not rotated," the report said. "As the airplane continued down the 5,132-ft [1,564-m] runway, it did not appear to be accelerating, and about 100 yards [91 m] from the end of the runway, it appeared that it was not going to stop."

The Duke overran the runway and traveled down a deep gully. The airplane was destroyed by the impact forces and a post-accident fire. The report said that examination of the airframe and engines revealed no signs of any malfunctions or failures that would have precluded normal operation of the airplane.

NTSB concluded that the probable causes of the accident were "the airplane's failure to rotate and the pilot's failure to reject the takeoff."

HELICOPTERS

Unmarked, Uncharted Wire

McDonnell Douglas 369E. Destroyed. Two serious injuries.

The pilot was flying the drug-enforcement observation helicopter about 500 ft above a valley floor near Jackson, Kentucky, U.S., the morning of July 29, 2013, when the main rotor head struck a utility wire.

"The pilot initiated an emergency descent, but he had limited control of the helicopter, and it collided with the valley floor," the NTSB report said.

The wire was among four that had provided electrical power to a mine. "Because the mine had been closed for a long time, no one had reported the utility wire[s] to the Federal Aviation Administration for addition on the appropriate aeronautical chart," the report said. Three of the wires had deteriorated and fallen.

Fire Traced to Instrument Panel

Eurocopter AS350B. Destroyed. No injuries.

The pilot was conducting a private, solo flight from Milton Keynes, England, to Manchester the evening of Aug. 3, 2013, when he detected an acrid odor and saw smoke and flames emanating from behind the lower left side of the instrument panel.

The pilot turned the master switch off, but smoke continued to fill the cockpit, affecting his breathing and vision. "In order to counter this, he opened the cabin door, and the smoke cleared enough for him to identify a suitable open field and carry out a successful landing," said the AAIB report.

The pilot was able to exit the helicopter before it was destroyed by fire in the field near Fenny Drayton, Leicestershire.

"Owing to the extensive fire damage, it was not possible to establish what initiated the fire," the report said. "However, given the description of the events by the pilot, it is most likely to have been related to the electrical system components or wiring behind the left side of the instrument panel."

Distraction Triggers Control Loss

Robinson R44. Substantial damage. No injuries.

Shortly after departing from Tallahassee, Florida, U.S., at 0330 the morning of July 4, 2012, for a positioning flight, the pilot saw the clutch actuator warning light illuminate. "The pilot reached for the circuit breaker box under the passenger seat to pull the clutch circuit breaker and then felt 'light in the seat,'" the NTSB report said.

The helicopter had entered a rapid descent. The pilot pulled the collective control, but the R44 continued to descend until it struck a lake. The pilot exited the helicopter and swam to shore.

Examination of the helicopter revealed nothing that would have precluded normal operation, and investigators were unable to determine why the clutch actuator light illuminated.

"It is likely that, while reaching down in an attempt to pull the clutch circuit breaker with a lack of outside visual references due to the night conditions and the helicopter's location over a lake, the pilot made an inadvertent cyclic input that resulted in the helicopter's nose-down attitude and subsequent descent," the report said.

NTSB concluded that fatigue might have been a contributing factor. The pilot had driven for six hours and had flown about 3.5 hours before launching the positioning flight.

Preliminary Reports, April–May 2014

Date	Location	Aircraft Type	Aircraft Damage	Injuries
April 4	Astoria, Oregon, U.S.	Agusta Westland 109SP	none	1 serious, 3 none
Night visual meteorological conditions (VMC) with 15-kt surface winds prevailed when the external sling cable sheared as a ship's pilot was being transferred to a container ship on the Columbia River.				
April 8	Bethel, Alaska, U.S.	Cessna 208B	destroyed	2 fatal
Recorded flight data indicate that airspeed decreased to 60 kt before the Caravan entered a steep, rapid descent and struck terrain during a training flight.				
April 9	Jayapura, Indonesia	Quest Kodiak	substantial	2 fatal, 2 serious, 5 minor
The single-turboprop airplane struck the airport perimeter fence and crashed on a road during a night takeoff.				
April 9	Albuquerque, New Mexico, U.S.	Airbus AS350-B3	substantial	3 minor
The pilot said that the tail-rotor pedals jammed in the neutral position as the medevac helicopter lifted off a rooftop helipad. The AS350 completed several left turns before coming to rest on its right side off the helipad.				
April 19	Saltillo, Mexico	British Aerospace HS125-700A	destroyed	8 fatal
Visibility was 800 m (1/2 mi) in fog when the business jet crashed in an industrial park during approach.				
April 20	Jämijärvi, Finland	Comp Air 8	destroyed	8 fatal, 3 NA
The single-turboprop airplane entered a spin at about 13,000 ft. The pilot and two skydivers exited the airplane before it struck the ground.				
April 26	Spruce Creek, Florida, U.S.	Cessna CJ3	substantial	3 none
The airplane overran the 4,000-ft (1,219-m) runway on landing and came to a stop in a pond.				
April 27	Córdoba, Argentina	Piper Chieftain	destroyed	7 NA
The flight crew diverted to Córdoba after an engine failed but was unable to reach the airport. The Chieftain veered off a road during the subsequent forced landing. No fatalities were reported.				
April 29	East Midlands, England	Boeing 737-400F	substantial	2 none
The left main landing gear collapsed as the freighter was being turned off the runway after landing.				
May 3	Santander, Colombia	Piper Chieftain	substantial	2 fatal
The crew was conducting an aerial survey when the Chieftain struck a mountain at about 14,765 ft in weather conditions described as poor.				
May 8	Kabul, Afghanistan	Boeing 737-400	substantial	130 none
Visibility was 6,000 ft (1,800 m) in rain showers when the 737 overran the 11,584-ft (3,500-m) runway on landing, struck localizer antennas and came to a stop on an airport-perimeter road. No injuries were reported.				
May 8	San Vicente del Caguán, Colombia	Douglas DC-3C	destroyed	6 fatal
The DC-3 was on a cargo flight from Villavicencio to Florencia when it encountered adverse weather conditions and crashed in mountainous terrain.				
May 10	Ganla, Niger	Fokker 100	substantial	2 NA
Radio contact was lost when the Fokker encountered a sandstorm during a ferry flight from Slovakia to Nigeria. Both pilots survived the forced landing after the aircraft's fuel supply was exhausted.				
May 17	Xieng Khouang, Laos	Antonov 74TK-300	destroyed	16 fatal, 1 serious
The An-74 was on final approach when it struck trees and crashed about 1,500 m (4,922 ft) from the runway.				
May 17	Fort Huachuca, Arizona, U.S.	Aero Commander 500S	substantial	2 serious
Witnesses heard a popping sound as the Aero Commander took off for a training flight. The airplane entered a steep turn and descended into rising terrain.				
May 27	Carmelo, Uruguay	Beech King Air B200	destroyed	5 fatal, 4 serious
The King Air crashed on a sandbar in the Río de la Plata after the pilot reported engine problems on approach.				
May 31	Bedford, Massachusetts, U.S.	Gulfstream G-IV	destroyed	7 fatal
Night VMC prevailed when the G-IV crashed in a gully about 2,000 ft (610 m) from the threshold during takeoff from Runway 11 at Bedford-Hanscom Field.				

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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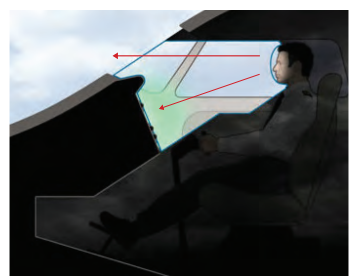

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