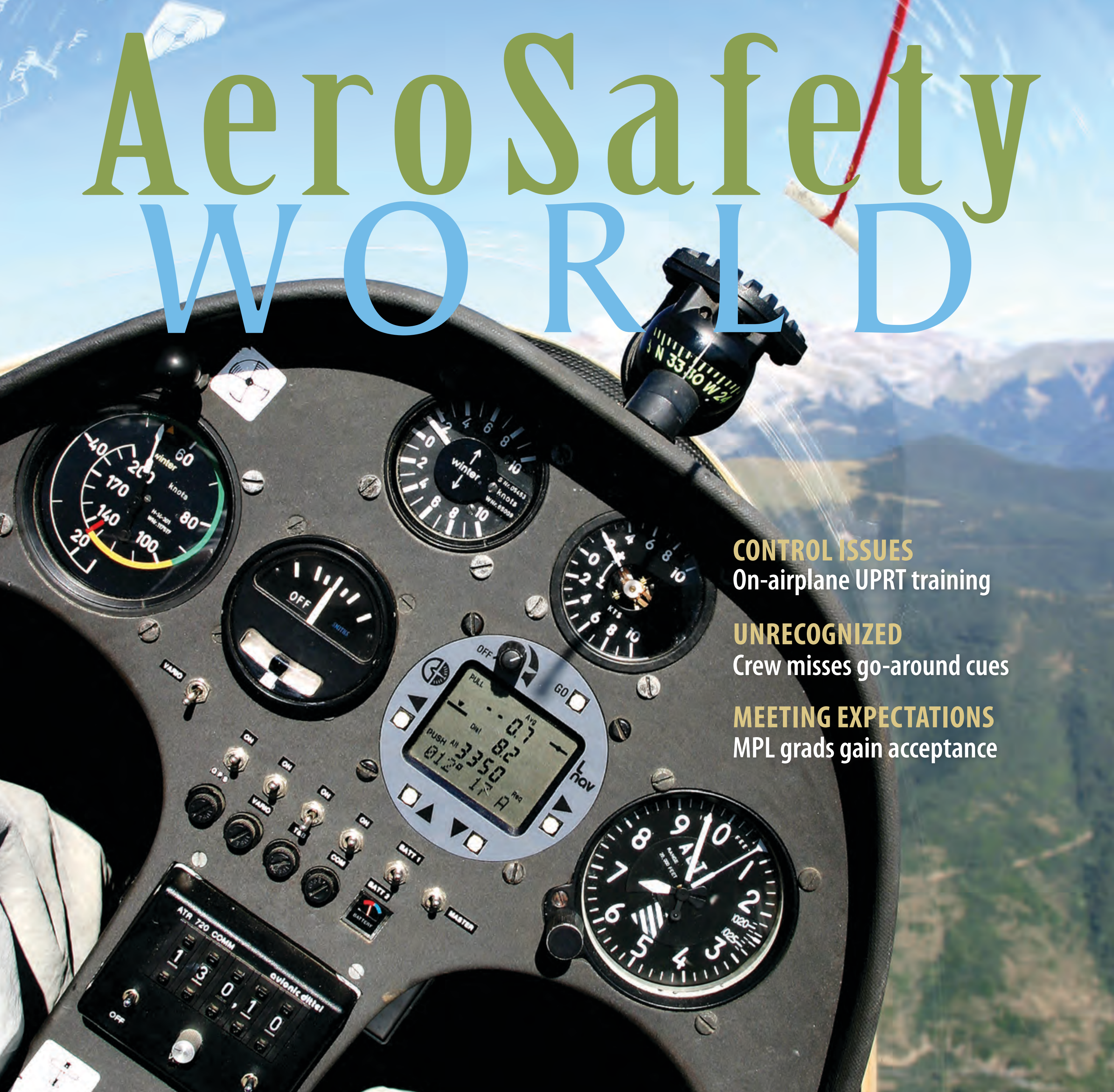
# AeroSafety WORLD



**CONTROL ISSUES**
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MPL grads gain acceptance

## SAILPLANE LESSONS
ROUTINE UPSET RECOVERY

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

MAY 2014



# THOUGHTFUL RESPONSE VS. Speculation

Once again, we have been reminded of the significance of our aviation system safety work, including the intense news media scrutiny that a single aviation event can generate. The tragic situation involving Malaysia Airlines Flight 370 (MH370), which had lasted 31 days as I wrote this, has brought our industry role into sharp focus.

You may have noticed, and perhaps wondered, why Flight Safety Foundation was not front-and-center in the media speculation on the root cause of this event. The answer lies in the word *speculation*. Quite simply, we refused to add to the mass of speculation already being disseminated.

The Foundation prides itself, and our members demand, that we be a voice of reason and calm in situations like this. That is why, after most of the wild speculation passed, we chose to call for a detailed review of technology and processes to improve aircraft location-tracking in a practical and prudent manner. We believe that this is the seminal issue that needs to be addressed.

We recognize that aircraft location-tracking is not a primary flight safety issue, such as training, reliability or compliance. But in this day and age, not being able to locate, in a timely manner, a large commercial airliner is unacceptable. More expeditious discovery of a missing airplane would not only aid in search and rescue but also allow faster understanding of the issues that caused the accident and, hopefully, bring comfort to the victims' families.

There also is a deep connection with our strategic priorities, previously introduced in this column, to better utilize data to improve investigations and safety. The aviation system is astoundingly safe, but we cannot pass on opportunities to make it ever safer. The Foundation is pleased to be working with our safety partners around the world in a leadership role to bring forward the dialogue, and ultimately to take action, to continually improve aircraft tracking, operations and safety.

Leading this charge for the Foundation will be our newly appointed president and CEO. After an exhaustive search, the Board of Governors is pleased to announce that Jon L. Beatty will assume leadership in late April. Jon brings a strong, senior aviation management background to the post. The Board is thrilled to have a person with his business and technical credentials coming aboard to guide us forward. We are confident that he will bring fresh ideas and vision to all aspects of the Foundation.

*Kenneth J. Hylander*
*President and CEO (Acting)*
*Flight Safety Foundation*

AeroSafety WORLD

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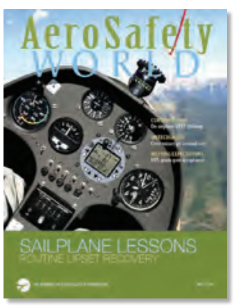


**About the Cover**
The pilot's view inside a Schempp-Hirth Duo Discus glider flying above the Pyrenees in Spain. Unusual attitudes are anything but unusual for glider pilots, says a British airline captain.

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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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**Sales Contact**

Emerald Media
Cheryl Goldsby, cheryl@emeraldmediaus.com +1 703.737.6753
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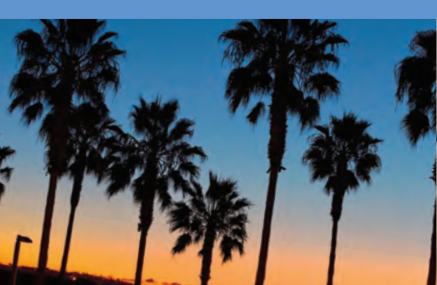

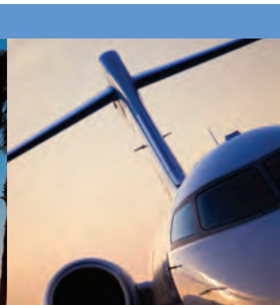

# Serving Aviation Safety Interests for More Than 65 Years

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

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Flight Safety Foundation
801 N. Fairfax St., Suite 400, Alexandria VA 22314-1774 USA
tel +1 703.739.6700 fax +1 703.739.6708 flightsafety.org

**Member enrollment** — ext. 102
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**Website** — ext. 126
**Emily McGee,** director of communications — mcgee@flightsafety.org

**Basic Aviation Risk Standard**
**Greg Marshall,** BARS managing director — marshall@flightsafety.org

BARS Program Office: Level 6, 278 Collins Street, Melbourne, Victoria 3000 Australia
tel +61 1300.557.162 fax +61 1300.557.182 bars@flightsafety.org


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**MAY 1 ➤ ISASI Mid-Atlantic Regional Chapter Spring 2014 Dinner/Meeting.** International Society of Air Safety Investigators Mid-Atlantic Regional Chapter. Herndon, Virginia, U.S. Ron Schleede, <ronschleede@aol.com>.

**MAY 5–9 ➤ Advanced Aircraft Accident Investigation Short Course.** Embry-Riddle Aeronautical University. Prescott, Arizona, U.S. Sarah Ochs, <case@erau.edu>, <erau.edu/base>, +1 386.226.6928.

**MAY 7–8 ➤ 2nd ICAO Air Transport Symposium (IATS2014).** International Civil Aviation Organization. Montreal. <icao.int>.

**MAY 8–9 ➤ 3rd Air Medical and Rescue Congress China 2014.** China Decision Makers Consultancy. Shanghai, China. <cdmc.org.cn/2014/amrcc/>.

**MAY 9 ➤ Search and Rescue Forum China 2014.** China Decision Makers Consultancy. Shanghai, China. Patrick Cool, <Patrick@pyxisconsult.com>, <cdmc.org.cn/2014/isrfc/>.

**MAY 12–14 ➤ International Humanitarian Aviation Summit.** Toledo, Spain. <wfp.org>.

**MAY 12–15 ➤ Unmanned Systems 2014 Conference.** Association for Unmanned Vehicle Systems International. Orlando, Florida, U.S. <membership@auvsi.org>, <www.auvsishow.org/auvsi2014/public/enter.aspx>, +1 703.845.9671.

**MAY 12–16 ➤ SMS Expanded Implementation Course.** The Aviation Consulting Group. Honolulu. Bob Baron, <bbaron@tacgworldwide.com>.

**MAY 13–15 ➤ RAA 39th annual Convention.** Regional Airline Association. St. Louis. David Perez-Hernandez, <www.raa.org>, +1 312.673.4838.

**MAY 14–15 ➤ National Safety Council (NSC) 2014 Aviation Safety Committee Meeting.** NSC Aviation Safety Committee. Savannah, Georgia, U.S. Tammy Washington, <tammy.washington@nsc.org>, <nsc.org.>

**MAY 18–21 ➤ 86th annual AAAE Conference and Exhibition.** American Association of Airport Executives. San Antonio, Texas, U.S. +1 703.824.0504. <aaae.org>.

**MAY 20–22 ➤ Cabin Operations Safety Conference.** International Air Transport Association. Madrid. Mike Huntington <COSCSales@worldtek.com>, <www.iata.org/events/Pages/cabin–safety.aspx>, +1 514.874.0202.

**MAY 20–22 ➤ European Business Aviation Convention and Exhibition (EBACE2014).** National Business Aviation Association. Geneva. <ebace.aero/2014/>.

**MAY 20–22 ➤ Loss of Control In–Flight Symposium.** International Civil Aviation Organization. Montreal. <icao.int>.

**MAY 20–22 ➤ Safety Management Systems Short Course.** Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, <case@erau.edu>, <daytonabeach.erau.edu/sms>.

**MAY 21–22 ➤ Asia Pacific Aviation Safety Seminar (APASS 2014).** Association of Asia Pacific Airlines. Bangkok, Thailand. C.V. Thian, <cvthian@aapa.org.my>, +603 2162 1888.

**MAY 24–25 ➤ Rotortech 2014.** Australian Helicopter Industry Association. Sunshine Coast, Queensland, Australia. <secretary@austhia.com>.

**MAY 27–28 ➤ Africa–Indian Ocean (AFI) Aviation Safety Symposium.** International Civil Aviation Organization. Dakar, Senegal. <icao.int>.

**JUNE 4–5 ➤ RTCA 2014 Global Aviation Symposium.** RTCA. Washington. <symposium@rtca.org>, +1 202.833.9339.

**JUNE 4–6 ➤ 21st annual Airfield Safety, Sign Systems and Maintenance Management Workshop.** American Association of Airport Executives and Federal Aviation Administration. Denver. Scott Boeser, +1 703.824.0500, ext. 225, <scott.boeser@aaae.org>.

**JUNE 10–11 ➤ 2014 Safety Forum: Airborne Conflict.** Flight Safety Foundation, Eurocontrol, European Regions Airline Association. Brussels, Belgium. <tzvetomir.blajev@eurocontrol.int>, <skybrary.aero>.

**JUNE 24–25 ➤ 6th annual Aviation Human Factors and SMS Seminar.** International Society of Safety Professionals. Dallas. <isspros.org>, +1 405.694.1644.

**JUNE 30–JULY 2 ➤ Safe-Runway Operations Training Course.** JAA Training Organisation. Abu Dhabi, United Arab Emirates. <jaato.com>, +31 (0) 23 56 797 90.

**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 14–20 ➤ 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>.

**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.

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

**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.

**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

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## 787 Review

A report on the review of the design, manufacture and assembly processes for the Boeing 787 has made seven recommendations for improvements in Boeing's processes and the U.S. Federal Aviation Administration's (FAA's) oversight.

The FAA said that its review team concluded that the airplane was "soundly designed, met its intended safety level and that the manufacturer and the FAA had effective processes in place to identify and correct issues that emerged before and after certification."

Nevertheless, the panel issued recommendations that included calls for Boeing to address manufacturing and "supplier-quality" issues and for the FAA to institute "improved, risk-based … oversight to account for new business models."

The team — made up of Boeing technical experts and FAA engineers and specialists who had not been closely involved in the 787 certification process — was appointed in January 2013, in the aftermath of a fire in a Japan Airlines 787 while it was parked at a gate at Boston Logan International Airport. One firefighter was injured fighting the blaze.

A preliminary report from the U.S. National Transportation Safety Board traced the origin of the fire to the lithium-ion battery in the auxiliary power unit.

The FAA said that the review team also examined service-reliability data for the 787 and found that its "reliability performance in the first 16 months of service was comparable to the reliability of other new Boeing models over the same time period."

## Global Flight Tracking

Spurred by the disappearance of a Malaysia Airlines Boeing 777, government and aviation industry experts are scheduled to meet this month to discuss how to implement worldwide flight tracking.

The planned meeting, to be convened by the International Civil Aviation Organization (ICAO), will examine "specific aircraft- and satellite-based capabilities" that would permit flight tracking on a global basis (*ASW*, 8/09, p. 24).

Malaysia Airlines Flight 370 disappeared March 8 during a flight from Kuala Lumpur to Beijing with 239 people aboard. At press time, searchers were trying to locate the source of acoustic signals that matched those emitted by flight recorders, coming from deep in the Indian Ocean.

ICAO said that its Flight Recorder Panel is reviewing suggested methods of speeding up the location of accident sites, "including deployable flight recorders and the triggered transmission of flight data."

Olumuyiwa Bernard Aliu, Council president of ICAO, added, "No matter how safe or secure we make the air transport network, these types of events remind our entire sector that no effort is ever enough, no solution ever a reason to stop seeking further improvement."

Announcement of the May 12–13 special meeting followed calls from several international aviation organizations, including Flight Safety Foundation, for such a gathering.

"Emerging technology exists to provide much more real-time data about aircraft operations and engine performance," said David McMillan, chairman of the Foundation's Board of Governors. "That data can help us unlock mysteries, leading to timely safety improvements and more focused search and rescue missions, while avoiding some of the pain and anguish felt by victims' loved ones in the wake of a tragedy."


Jennifer Moore

## New Moves to Regulate UAS

Frankhöffner/WikiMedia

The European Commission (EC) and the European Aviation Safety Agency are preparing to develop a policy framework for integrating unmanned aircraft systems (UAS) — also being called *remotely piloted aviation systems* or *drones* — into European airspace.

"Drones are already beginning to appear in our skies, but there are no clear general rules, at a national or at European level, which put in place the necessary safeguards [to] protect the safety, security and privacy of people," said Siim Kallas, EC vice president responsible for transport.

EC plans call for the integration of UAS into civil airspace "based on the principle that all operations will have an equivalent level of safety in comparison to regular manned aviation."

The European Council has said that rules should be developed for integrating UAS into civil airspace beginning in 2016.

In related action, in the United States, the Aerospace Industries Association (AIA) has urged the U.S. Federal Aviation Administration (FAA) to expedite its consideration and approval of the notice of proposed rulemaking concerning the safe use of small UAS — those with vehicles weighing less than 55 lb (25 kg).

"Only after issuance of the proposed rule can we begin a transparent dialogue between government, industry, users and other interested parties to allow the safe use of these systems by American businesses," said a letter signed by AIA President Marion Blakey and Gary Shapiro, president of the Consumer Electronics Association.

The FAA is required by law to issue a final rule on the matter by August.

## MD-11 Hard Landings

Citing 13 hard-landing accidents over the last two decades involving the global fleet of McDonnell Douglas MD-11s, the U.S. National Transportation Safety Board (NTSB) is calling for action to review the effectiveness of flare-cueing systems to determine whether they could provide useful information for MD-11 flight crews.

The U.S. Federal Aviation Administration (FAA) and Boeing should work together on the review and produce a formal report on their findings, the NTSB recommended. If they determine that the systems would "assist pilots in making timely and appropriate inputs during the landing flare," they should distribute copies of the report to U.S. operators of MD-11s and encourage the operators to install flare-cueing systems on these airplanes, the NTSB said.

Accompanying recommendations call for the FAA and Boeing to conduct a similar assessment of methods of providing "weight-on-wheels cueing" to enhance awareness of bounced landings and effective responses, with reports to operators if they determine such cueing would be useful; and to "evaluate the effect of brief power increases on simulated MD-11 landing distances," with adjusted landing distance tables, if necessary.

Another recommendation said that the FAA should reconvene the MD-10/MD-11 flight standardization board to determine whether currency requirements should be strengthened for MD-11 pilots.

"MD-11 hard landing accidents have frequently involved a pilot's late or ineffective flare and/or mismanagement of bounced landings, which can cause the airplane to porpoise," the NTSB said. "This sequence of events could be particularly hazardous in the MD-11 because overloading of the main landing gear in the vertical direction could cause the main wing spar to fracture and the airplane to subsequently roll over."

The NTSB said that a review of data showed that the MD-11 had the highest rate of hard-landing events of 27 large Western-built transport category airplanes — 5.63 per 1 million flight cycles.

Factors that might have contributed to the problem include the MD-11's high landing speed, which "increases the difficulty of a properly timed and executed flare because it must be initiated within a narrow timeframe," the NTSB said. Other factors include the location of the cockpit ahead of the center of gravity and the main landing gear, the automatic reduction of thrust during the landing flare and the MD-11's extensive use in long-range cargo flights, which offer pilots relatively few opportunities to maintain landing proficiency.

Faisal Akram/WikiMedia

## 'Extra Vigilance'

The U.S. National Transportation Safety Board (NTSB), distressed by two recent incidents in which the crews of air carrier aircraft landed at the wrong airport, has issued a safety alert urging pilots to always verify that they are landing at the correct airport.

"The consequences for pilots mistaking a nearby airport for the intended one, or landing on the wrong runway or a taxiway, can have catastrophic consequences," NTSB Chairman Deborah Hersman said.

The safety alert directed flight crews to comply with standard operating procedures, verify the airplane's position relative to the airport, and "use available cockpit instrumentation to verify that you are landing at the correct airport." The document urged "extra vigilance when identifying the destination airport at night and when landing at an airport with others in close proximity."

Other recommended precautions are to be familiar with the destination airport's layout, use the most precise navigational aids in conjunction with a visual approach and "confirm that you have correctly identified the destination airport before reporting the airport or runway is in sight," the NTSB said.

The two incidents cited by the NTSB were:

- The Jan. 12 landing of a Southwest Airlines Boeing 737 on a 3,738-ft (1,140-m) runway at M. Graham Clark Downtown Airport in Branson, Missouri, instead of on the 7,140-ft (2,178-m) runway at Branson Airport, as planned; and,
- The Nov. 21, 2013, landing of a Dreamlifter 747 on a 6,100-ft (1,860-m) runway at Colonel James Jabara Airport in Wichita, Kansas, instead of the planned destination 12 nm (22 km) away — a 12,000-ft (3,660-m) runway at McConnell Air Force Base.

Both landings were made in night visual meteorological conditions and both ended without further incident.

## New FSF President and CEO

Jon L. Beatty, a former top executive at International Aero Engines, is the new president and CEO of Flight Safety Foundation.

He officially took over at the Foundation on April 21, succeeding Kevin L. Hiatt, now senior vice president of safety and flight operations at the International Air Transport Association.

Beatty was president and CEO of International Aero Engines from 2007 through 2009 and from 2012 until his retirement earlier this year. He also held several executive positions at Pratt & Whitney, BF Goodrich and AlliedSignal Aerospace.

David McMillan, chairman of the FSF Board of Governors, said Beatty "brings an international executive perspective that will be instrumental in moving the Foundation into its next chapter as the leading voice of aviation safety around the world."


Beatty

During a two-month transition period after Hiatt's departure in February, Kenneth J. Hylander was the Foundation's acting president and CEO, and William G. Bozin was acting chief operating officer.

## In Other News …

The Transportation Safety Board of Canada has updated **regulations** governing the reporting and investigation of aviation accidents and incidents — as well as occurrences in other modes of transportation — to take full advantage of electronic information sharing and to harmonize definitions with international standards. … The U.K. Civil Aviation Authority has won a conviction in its first prosecution of an unmanned aircraft pilot for "dangerous and illegal flying." The man was found guilty in early April of flying the **unmanned aircraft system** vehicle in restricted airspace above a nuclear submarine facility. … The Australian Civil Aviation Safety Authority says it is developing a package of improvements in **airport safety standards** to clarify the intent of some rules and limit the need for exemptions. Changes will be focused on specific areas, including apron parking clearances and lighting levels, approach slope guidance for large aircraft, wind direction indicators and movement-area guidance signs.

*Compiled and edited by Linda Werfelman.*

As airline pilots pursue manual-handling practice and startle resilience, a British captain suggests glider flying.

© Neil Stuart Lawson/whiteplanes.com

# High-Alpha Culture

BY WAYNE ROSENKRANS


Upset prevention and recovery training (UPRT) at the commercial and multi-crew pilot licensing (MPL) levels — not to mention initial and recurrent training of airline pilots — has reemphasized hand-flying proficiency, recognition of potential upset situations and immediate recovery from stall indications, among other skills. A recent analysis of automation and flight path management vulnerabilities also reinforces these themes (*ASW,* 2/14, p. 12). One unsettled question, however, is whether the airline pilots who complete UPRT might gain an additional advantage from routinely hand-flying some type of general aviation aircraft on their own time.

A British airline captain favors this practice, drawing from her aeronautical engineering and safety background, involvement in implementing UPRT, and experience during more than 20 years as a glider instructor and an international competitor in racing sailplanes.[1,2] Last December, Sarah Kelman, who flies the Airbus A320 for easyJet, explained the perspective she and fellow airline-pilot members of the British Gliding Association <www.gliding.co.uk> have gained. The association was invited to brief the Royal Aeronautical Society's 8th International Flight Crew Training Conference in London on what gliding offers compared with airline training in airplane-upset avoidance.

Wayne Rosenkrans

Kelman

"The skills that I practice in my glider have a direct relevance to my day job in the Airbus A320 — both in day-to-day flying and also, particularly, in the non-normal situation," she said. "Unfortunately, it's not practical that our airlines permit their pilots several weeks a year to go and fly gliders — although it is a lot of fun. However, the core skills maintained by sport pilots do have a direct and beneficial relevance to the modern jet airline environment."

Glider training is an element of some MPL programs and military flight training, though not part of internationally accepted UPRT standards and recommended practices. The British Gliding Association does not propose using gliders in UPRT. "Any gliding training cannot be a panacea to avoid future commercial upset incidents, but those who pursue the sport are given a deep grounding in hand-flying skills, situational awareness and risk management — all of great use to a modern airline pilot — and the training should be taken seriously by commercial training organizations and operators," Kelman told *ASW* after the conference.

## Unusual Attitudes

The types of flights conducted in gliders may surprise airline pilots unfamiliar with this segment of flying. "The main feedback on the conference day was along the lines of 'I had no idea you do those sorts of things in gliders!'" she said, citing as an example one friend's recent 750-km (405-nm) flight in southeast England in a sailplane without an engine. The pilot flew, primarily in thermals, at altitudes between approximately 1,000 ft and 5,000 ft. Thermals are bubbles or columns of warm rising air.

Another friend, flying in mountain waves in Scotland and limiting his climbs to maximum altitudes of about 9,000 ft, recently flew 1,000 km (540 nm) as a double out-and-return flight. "I've personally been up to 32,000 ft in my glider in lee wave over Scotland," she added.

To accomplish such flights — whether to achieve distance, speed, altitude, navigational or other objectives — glider pilots combine in-depth knowledge of the aerodynamics with practical application of skills. "It's very much a high-alpha culture,[3] so, as such, we have a huge emphasis on handling approaching the stall, the changing handling characteristics of the aircraft, and also on appropriate actions on the post-stall departure from controlled flight," Kelman said. "If you want to achieve these flights, you need to fly by maneuvering in the 'up bits' [lift] and not in the 'down bits' [sink]."

Upset prevention, recognition and recovery issues are a critical part of training even before students are authorized to fly solo. "In gliding, there are no go-arounds from an unstable approach," Kelman said. "We have to teach our trainees energy management. And, finally, our trainees have a massive appreciation of low-level meteorology, the up and downdrafts."

The British Gliding Association's leaders and safety specialists assume that glider pilots have a high degree of exposure to unusual attitudes that, in the United Kingdom, typically begins with the winch launch. During the launch, the glider accelerates from 0 to 60 kt in two to three seconds. "The glider is then climbing at around 40 degrees to the horizontal," she said. "That's combined with the glider seating position of around 45 degrees reclined, which means that the sensation is of a near-vertical climb. The horizon is out of sight of the pilot.

"The pilot-performance margins are quite small on a winch launch. You often have a 10-kt speed window between overspeeding the glider and a high-speed stall that occurs due to the loading on the wing. Our trainees are taught that they have to fly within 2-kt to 3-kt accuracy all the way up there, even though they can't see the ground. We mention about putting the pitch attitude in the correct place even if there is a 1-degree diversion [deviation]."

Even at this early stage of glider training, Kelman finds parallels to UPRT. "That initial acceleration is very abrupt — not dissimilar to the sort of thing we're seeing in extreme upsets in the airline industry," she said. "We have to teach them to overcome the somatogravic effect.[4] At the top of a normal winch launch, the glider pilot needs to lower the nose to regain the speed."

Another parallel is the necessity of pilots overcoming any instinctive reluctance or hesitation to lower the nose to recover from a stall near the ground. "It's something that we endeavor to train out of them before they are even permitted to go on their first solo in a glider," she said. "If the cable breaks, the pilot needs to lower the nose — often to 30 degrees below the horizontal — to regain the speed. If that happens low down — below 200 ft — then they're faced with the ground rush."

The possibility of such a winch-cable break, which creates a circuit (i.e., landing-pattern) emergency situation, underscores the importance — also at the pre-solo training phase — of continual contingency planning to be ready for sudden, unexpected, rapidly changing and dynamic situations. "The pilots have to decide after a cable break whether they have the energy to land ahead or whether they have to go into some sort of low-level emergency circuit," Kelman said. "Dealing rapidly with contingency is the essence. The glider pilots must aviate, aviate and aviate to fly by attitudes and with airspeed cues, and to overcome somatogravic effect. In case of lack of a real horizon, the attitude indicator is the only safe alternative."

As in commercial airlines, glider pilots at times have failed to overcome the somatogravic effect. "People have come off the top of a failed winch launch, pushed the nose forward to recover the speed, and inappropriately interpreted the reduced g [standard gravitational acceleration] as a stall and continued to nose the glider down into an impact with the ground," she added.

## High-Alpha Culture

Operating close to the limits of the normal flight region of the aircraft's aerodynamic envelope is the key to glider pilots' capability to fly in thermals for extended periods and, in turn, makes possible cross-country flights in sailplanes. "The thermal cores are quite small, and so, to maximize the strong lift in the center, the glider needs to fly typically at a very high angle of bank and a low speed [i.e., high angle-of-attack] to make the radius of the turn as small as it can be," Kelman said. "Stall and spin awareness is paramount. We're flying right on the edges of the envelope." One of her video examples showed a pilot maintaining the desired relative position with a 70-degree bank angle in a typical gusty thermal, then demonstrating a calm, swift and correct recovery from an intentional stall and spin.

"There was no startle effect there at all," she noted in describing the maneuver. "The recovery is so familiar that he just continues to fly in the thermal. And that's where we want our trainees to be — to be able to deal with these situations safely and habitually."

This situational awareness also comes into play in hand-flying precision and understanding of aerodynamics governing the limits of high-speed flight for the specific glider. "Our pilots have to be very aware of the limits of high-speed flight, the relevance of maneuvering speed, the limits of never-exceed speed and also the appropriate control inputs at high speed, as opposed to the low-speed ends of the envelope," Kelman said.

## Airline Relevance

The systems-monitoring demands of a flight crew's duties during airline operations these days translate into less hand-flying, despite the consensus that this is a highly degradable skill. Some airlines have seen evidence of this trend, Kelman said, based on analyses from flight data monitoring programs and the performance of some MPL-trained pilots. Manual-handling deficiencies may show up as unstable approaches, exceedances of flight parameters, landings without flare, landings outside the touchdown zone and go-arounds conducted solely because of

## Characteristics of Airliner Piloting and Glider Piloting

| Airline Pilot: Normal Operations | Airline Pilot: Abnormal Operations | Glider Pilot: All Operations |
|---|---|---|
| High reliance on automation | Degradation or loss of automation | No automation |
| Mostly monitoring of autopilot | Hand flying with degraded protections | All hand flying |
| Instrument approaches | Nonprecision or visual approach | Visual approaches |
| Long periods of inactivity/boredom in cruise | High arousal | Long periods of concentration — up to 10 hours but flight durations vary widely |
| Mainly straight and level flight | Degraded protections and flight closer to limits of envelope | Always maneuvering; steep turns |
| Fly conservatively to maximize performance | | Fly to edges of envelope to maximize performance |

**Note:** A British airline captain referred to this table while outlining how glider rating–specific knowledge and skills may positively influence what airline pilots bring to their normal and abnormal operation of large commercial jets.

Source: Sarah Kelman

Table 1

flight crew reluctance to disconnect the automation and hand-fly as expected in the situation.

If workload becomes unacceptably high when pilots feel "forced" to hand-fly the airplane, situational awareness and task-completion ability can be affected. "The lack of manual flying–basis [proficiency] also leads to a lack of recognition of excursions toward the end of the flight envelope, i.e., the approaching stall; an overreliance on automation; and also a reliance on the flight management system for flight guidance rather than checking for gross errors," she said. "Skills practice in general aviation aircraft — particularly in gliders — can really help to address these issues. Hand-flying skills do offer airline pilots resilience so that when things do go wrong, we have got the capacity to deal with them, to fly the aircraft and still have enough mental capacity left to deal with the abnormal situation." Table 1 summarizes several key differences in the perspectives of airline pilots and glider pilots.

The level of hand-flying proficiency also can be a factor in decisions about serving new destinations where the approaches are not conducive to typical flight automation for reasons such as infrastructure or terrain issues, she said. Kelman noted, "As a colleague of mine said, 'When you disconnect the autopilot, it's where technology becomes art.'"

Safely interpreting energy state and maneuvering visually at low altitude after breaking out from clouds, for example, also sometimes reveal airline pilots' actual confidence in their level of proficiency, in their ability to complete this maneuver according to company policy for stabilized approach and in their judgment of when a diversion is necessary.

She offered, as another example, a situation in which flying time could be reduced by at least 10 minutes "if pilots are competent and confident enough in their handling skills" to request and fly a visual approach rather than the longer instrument approach when conditions are suitable. "As a glider pilot, this is the sort of decision we're trained to do, managing the energy all the way in," Kelman added.

A number of airlines already encourage pilots to do as much hand-flying on the line as safely feasible according to policy, such as electing visual approaches and conducting them with autopilot, flight director and autothrust disengaged to keep skills current, she said. In some companies, hand-flying during simulator sessions is required but hand-flying the airplane is not required.

## Qualities of Scale

Also surprising to many airline pilots are the handling-quality parallels between gliders and airliners. "When we're looking at the roll and yaw handling, the principal scaling factor is the wingspan," she said. "Inertia in roll is proportional to the mass but also to the fifth power of the wingspan. If we look at a typical 150-seat airliner, a Boeing 737 earlier-generation is typically around 29 m [95 ft; Figure 1]; an Airbus A320 up to around 34 m [112 ft]. A high-performance, two-seater glider wingspan is around 25 m [82 ft]. The largest-span glider flying at the moment is 33 m [108 ft]. Typical training gliders are around 18–19 m [59–62 ft]. And that means that their handling is surprisingly ponderous and the roll rates quite similar to the handling of our 150-seat airliner in manual mode with the protections disengaged.

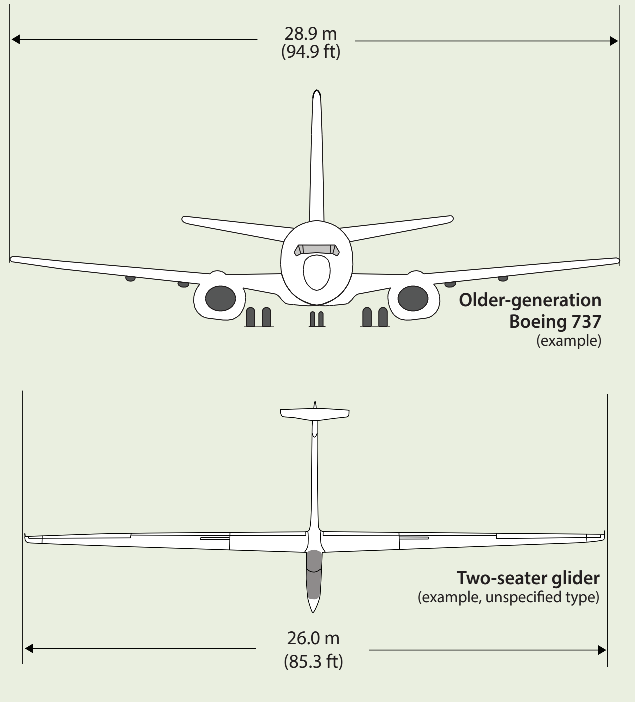
"However, unlike the airliner, the glider handling can be demonstrated in unusual attitudes to the extremes of the envelope. All gliders are utility category and at least semi-aerobatic. Gliders are very well suited to demonstrate loss of control to airline pilots because we can demonstrate the full range of the dynamic effects and the accelerations — and what it actually feels like to have the nose pointing at the sky."

Digital avionics, including moving-map displays, in the most advanced glider cockpits also have many characteristics of commercial jet simulators for purposes of manual flying practice. "The glass cockpit that I have in my glider, including the artificial horizon, is fully configurable on a laptop computer," she said. "You can set it up so it looks exactly like the PFD [primary flight display] on your airliner at home base; there is really a lot of similarity."

She also cited one relevant study of outcomes from a training exercise in which flight crews responded to a triple–inertial reference system failure. The participants who were currently involved in a large amount of general aviation flying — whether in gliders or airplanes — essentially flew the exercise much more smoothly and accurately than colleagues who only flew for their airline, Kelman said.

The final benefit to airline flight crews, in her experience, can emerge from a glider-flying airline pilot's experience in assessing dynamic weather phenomena near landing sites while flying gliders. "If adverse conditions are approaching an airfield, and I'm in my Airbus looking to make an approach, then I can bring all that gliding perspective into my threat-and-error management straightaway," she said. "I know where the lift's going to be, I know where the sink is going to be, and I know how the airplane is going to respond and whether it is safe to make an approach or whether to hold off for a later time. If you've got a light-wind day and strong thermal activity, low-drag, reduced-flap approaches to save fuel may not be appropriate because a strong thermal on short final may give the aircraft enough energy to take it outside its stable parameters. So it may be appropriate then to use a slightly increased-drag approach even though it looks like a light-wind, very pleasant day."

**Surprising Handling-Quality Parallels**




**Notes:** In aerodynamic terms, effects of inertia on the roll rate of an aircraft depend on aircraft mass and wingspan, providing a handling experience in gliders similar to that of flying a 150-seat airliner in manual mode with protections disengaged.

Source: Sarah Kelman

**Figure 1**

## Notes

1. Imperial College London. "High Flying." Focus on Alumni. *Imperial Matters.* Issue 30 (Summer 2007).
2. Although many people use the words *glider* and *sailplane* interchangeably, some consider sailplanes to be gliders capable of higher performance.
3. *High-alpha culture* refers to glider pilots' skill and comfort level using high angles-of-attack in normal operations.
4. *Somatogravic illusion* describes a pilot's acceleration-induced false perception that the aircraft is pitching nose-up.

**Whenever possible, UPRT by specially qualified instructors in all-attitude, all-envelope aircraft adds unique advantages.**

# Controlling Interest

BY RICK DARBY

Reducing the risk of loss of control–in flight (LOC-I) accidents, the leading cause of fatalities in commercial aviation between 2001 and 2011,[1] remains a priority of the International Civil Aviation Organization (ICAO) and the entire aviation community. As one of several steps to standardize and harmonize upset prevention and recovery training (UPRT), ICAO most recently has published Doc 10011, *Manual on Aeroplane Upset Prevention and Recovery Training*.[2]

Previous *ASW* articles have reported on ICAO's mid-2013 decision to update its existing standard to require *prevention* as well as *recovery* elements when UPRT is delivered for the multi-crew pilot license (MPL) and to make on-aircraft training of pilots at the commercial pilot licensing level (*ASW*, 7/13, p. 27) a recommended practice rather than a standard.

For multi-crew aircraft in air transport, however, the latest standard requires that the "applicant shall have, for the issue of an airplane category type rating, received upset prevention and recovery training." A recent *ASW* article also detailed the role that near-term advances in flight simulation are expected to have in UPRT *(ASW,* 3/14, p. 28).

To re-emphasize the on-aircraft element of UPRT last covered in *ASW* three years ago, representatives of the Upset Prevention & Recovery Training Association (UPRTA),[3] which contributed expertise during development of the *Manual,* provided *ASW* with a new report that explains and encourages voluntary adoption of the on-aircraft element of UPRT whenever possible in light of ICAO's recommended practice.

In this paper, titled "Addressing On-Airplane Upset Prevention & Recovery Training: Primary Considerations for the Safe and Effective Delivery of UPRT,"[4,5] authors Randy Brooks, Paul "BJ" Ransbury and Rich Stowell[6] assert that, ideally, UPRT must culminate in "a structured experience throughout the flight envelope and stall/spin upset red zones."

They note that the *Manual* defines an airplane upset as "an in-flight condition by which an airplane unintentionally exceeds the parameters normally experienced in normal line operations or training. An upset is generally recognized as a condition of flight during which the pitch of the airplane unintentionally exceeds either 25 degrees nose up or 10 degrees nose down; or a bank angle exceeding 45 degrees; or flight within the aforementioned parameters but at inappropriate airspeeds."

The paper stresses that there is no substitute for actual airplane handling experience during training involving bank angles beyond 45 degrees, conducted in gradual stages increasing to 180 degrees, as well as high angles-of-attack, that will lead to a full aerodynamic stall-and-spin departure from controlled flight. Such extreme bank angles and angles-of-attack are limited to specific airplane categories, to be discussed later.

Prevention of negative transfer of training to transport airplane operation requires that recovery be taught and supervised by specially qualified UPRT instructors, not typical certificated flight instructors and maybe not even traditional aerobatic instructors, because most lack the essential background in demonstration and recovery from severe upsets.

To put their perspective in context, it helps to zoom out to view the whole scope of UPRT. "UPRT resources are divided into two training tracks: academic and practical," Brooks, Ransbury and Stowell say. "Practical training is further subdivided into two parts: on-airplane and flight simulation training device (FSTD). …

"The framework of academics, on-airplane and FSTDs, coupled with consistency of language, concepts, techniques and application across all stages, will provide pilots with the strongest and most enduring learning experience possible. Cementing the training to maximize the stated goals of UPRT, however, will require pilots to have an adrenalized, on-airplane experience.

"It is the on-airplane experience where academics become reality; where techniques practiced in FSTDs can be applied under real-time constraints and with more accurate aerodynamic behavior; and where pilot stress levels can be manipulated to levels comparable to those of real-life upsets, but in a controlled environment where skill sets can be perfected, bonds to mental models for recovery strengthened and confidence gained."

Adrenaline is a hormone secreted by the adrenal glands under conditions of high stress or excitement. It boosts the body's energy level so it can act quickly and decisively, increasing blood flow to the muscles and oxygen to the lungs, the paper says. Increased physical energy *per se* is irrelevant to responding correctly to conditions where LOC-I is a real threat, but they cite scientific evidence that an "adrenalized experience" or "adrenalized training" has a tendency to enhance learning and retention.[7,8]

The retention aspect is important. "Experiences acquired during the early stages of a pilot's development shape that pilot's approach to operating airplanes, and equally important, … the lessons learned are perishable," the paper says. "The application of upset prevention and recovery skill sets, therefore, not only needs to be reinforced continually throughout a pilot's career, but also needs to be framed continually within the proper context."

Given the strong influence of adrenalized learning on the UPRT experiences of pilots that the authors have observed — and potentially on the prevention of LOC-I accidents — the paper describes three core issues concerning the value of the on-airplane phase:

- "On-airplane training considerations;
- "Airplane and equipment considerations; and,
- "Instructor considerations."

## Mind the Gaps

One ICAO document they cited states that "current FSTDs have limitations that render them incapable of providing the complete exposure to conditions synonymous with preventing or recovering from [an] LOC-I event…. These areas of missing experience provide gaps in pilots' understanding and proficiency when confronted with an actual upset."

The authors say that, "consequently, on-airplane UPRT is seen as necessary to fill the gaps. ICAO further acknowledges that on-airplane training provides experience and confidence in the psychophysiological domain of upsets that cannot be fully realized in FSTDs alone."

On-airplane UPRT pushes pilots beyond their comfort zone, they say. Human factors in a developing or actual upset can include startle factor, disorientation, overreaction, fixation and cognitive bias.

Maximizing the positive effects of adrenalized learning can be realized under five conditions, they say:

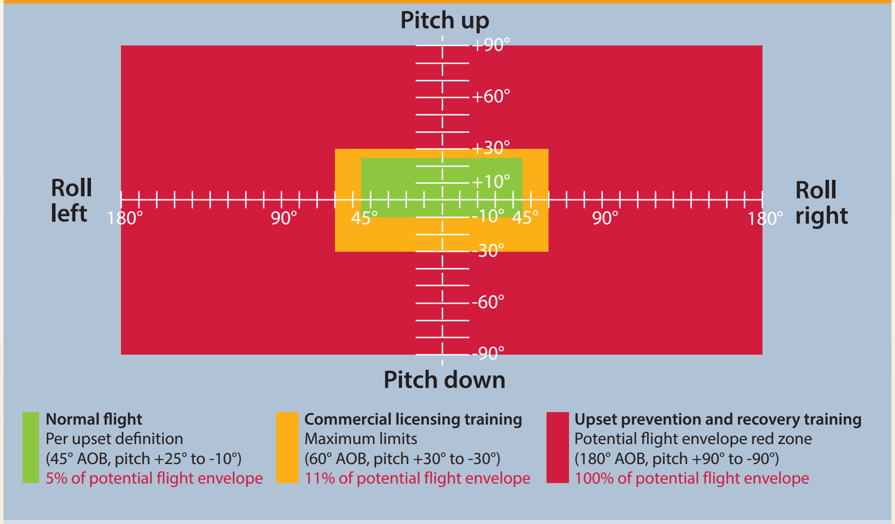
- "Training is delivered in a consistent and regimented manner across all stages;
- "Trainees are exposed to the full range of roll and angle-of-attack envelopes;
- "Trainees are confident they can learn UPRT skills quickly;
- "Trainees see that UPRT techniques work, and experience them personally; and,
- "Trainees have a positive training experience."

## Pitch and Bank Envelopes

Per the *Manual*, specific pitch and bank parameters define an airplane upset (Figure 1). In Figure 1, the green rectangle represents the normal flight envelope in which airline pilots operate. The yellow rectangle represents limits that, when exceeded, pilots are meant to cope with as part of commercial pilot training. The much larger red area shows the full dimensions of the UPRT envelope, which can involve essentially any combination of pitch and bank. Ideally, an airplane should never enter the red zone, and UPRT training is designed to prevent that from happening or, if it does, to prepare the pilot to immediately recognize the excursion and to regain control without delay.

Incomplete exposure to the red zone leaves a pilot at a disadvantage

**Operational and Training Flight Envelopes**




AOB = angle of bank; ICAO = International Civil Aviation Organization

Source: ICAO *Manual on Aeroplane Upset and Recovery Training*

**Figure 1**

should he or she ever have to recover from a severe upset, Brooks, Ransbury and Stowell say. "This does not at all suggest that pilots must only be exposed to 180 degrees of bank; escalation and recovery from the UPRT red zone can — and indeed should be — progressive," they say. "For instance, trainees might be exposed to escalating bank angles with roll recovery techniques applied at the following increments: 60 degrees, 90 degrees, 135 degrees, and ultimately, 180 degrees. This approach offers several key benefits, including:

- "Experiencing red-zone excursions coupled with appropriate mitigation strategies, initially while at lower angles of bank and reduced levels of stress;
- "Reinforcing the concept of prevention and the critical importance of bridging the gap between escalation and recovery paths with prompt, effective action (i.e., roll recovery techniques in this case); [and,]
- "Instilling the notion that intervention [action] must be taken regardless of the upset bank angle, rather than at some artificially set point on the escalation path."

*Mitigation bridges* are specific techniques appropriate to particular situations, the paper says. They help establish a mindset in which a pilot does not wait [for] a particular critical condition before beginning a recovery procedure, but instead reacts as soon as possible (Figure 2, p. 21).

The paper provides an example of how a mitigation bridge works: "As it pertains to recoveries from upset bank angles, 'push-then-roll' is an important UPRT technique … not only in terms of the sequence of the inputs, but also in terms of their magnitudes. 'Push' beneficially reduces angle-of-attack and g-load [a positive/negative multiple of the standard acceleration of gravity, experienced as weight], de-escalating from aerodynamic red zones and nominally reducing stress on the pilot. This precursor action also results in an improved 'roll' response. The magnitude of the 'push' on the elevator control, however, is generally notably smaller compared to the aileron input applied during the 'roll.'"

Common errors — such as reversing the order of the 'push-then-roll' sequence — can occur under the pressure of a roll upset, they noted.

"Many … correctable pilot errors do not manifest until beyond 90 degrees of bank and will exacerbate as bank angle approaches 180 degrees," according to the paper. "Consequently, progressively escalating into the red zone will allow the pilot to practice the 'push-then-roll' technique at lower bank angles and reduced stress levels. Training can then proceed beyond 90 degrees, where potentially debilitating effects such as startle can be worked through while simultaneously executing 'push-then-roll' actions. Thus, on-airplane exploration of bank angles from 90 degrees up to 180 degrees (the worst-case scenario) will be critical to the success of recovering from real-world upsets."

## Angle-of-Attack Threats

Another class of upsets can arise from mismanagement of angle-of-attack, when the coefficient of lift decays in connection with airspeed. Unless corrected, a stall can result. Similarly to training for recovery from the flight envelope red zone, UPRT gives pilots the experience of dealing with high angle-of-attack situations. Again, the inappropriate angle-of-attack is progressively increased so that the trainee gradually gets used to the phenomenon and its proper response, while developing confidence.

"Undesirable changes in flight characteristics and their ramifications [for] controlled flight only reveal themselves during high angle-of-attack flight," the authors say. "The aggravating effects of instinctive reactions by the pilot are revealed only as control effectiveness decays at high angle-of-attack and the airplane begins to exhibit post-stall behavior. Red-zone angles-of-attack must therefore be experienced not only to mitigate the potential merging of unfavorable aerodynamic and psycho-physiological factors, but also to maximize the beneficial effects of adrenalized learning."

As during excursions from the normal flight envelope, the internalized mitigation bridge enables rapid recovery. This training method also reinforces that recovery techniques should begin at the first sign of a dangerous angle-of-attack or yaw, not waiting for a specific upset parameter (Figure 3, p. 21).

## Inclined Planes

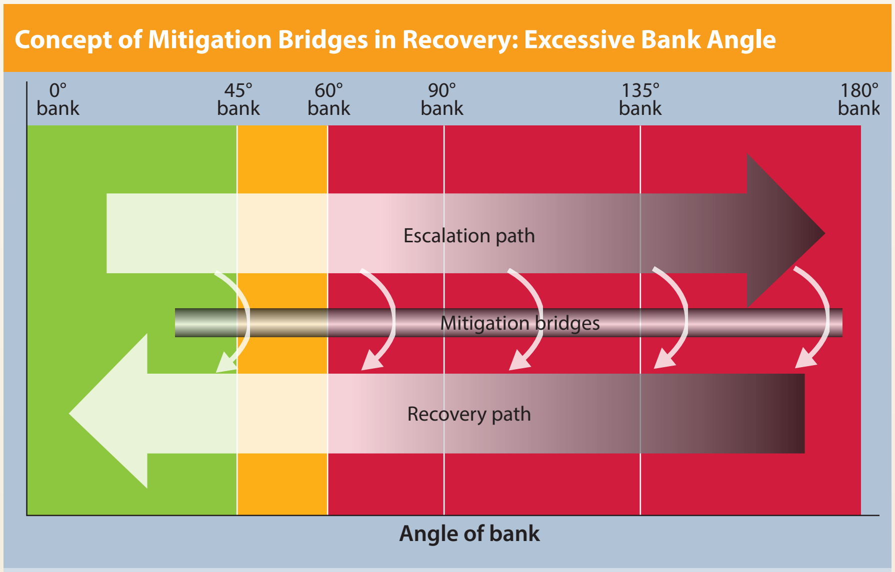
"Regardless of the airplane being used, the safe and legal delivery of UPRT requires due consideration of the training airplane's approved operating limitations, design limits, and available margins of safety," the paper says. "The success of UPRT will also depend on buy-in from both aircraft manufacturers and insurance underwriters — without their support, efforts to deliver practical UPRT will be stymied."

In the United States, for example, approved maneuvers for different categories of airplanes are described in U.S. Federal Aviation Regulations (FARs) Part 23.3:

- The *normal* category is intended for nonacrobatic operations. The authors noted, "Thus, in the normal category, operating limitations prohibit intentional maneuvers that exceed 60 degrees of bank. Intentional spins are prohibited as well."
- The *utility* category may be used in limited acrobatic operations. The authors note, "Operating limitations prohibit intentional maneuvers that exceed 90 degrees of bank. Intentional maneuvers with bank angles in excess of 60 degrees, however, will require approved parachutes to be worn by the trainee and the instructor. Whether or not intentional spins are approved in the utility category depends on the particular aircraft."
- The *acrobatic* category carries no restrictions other than those shown to be necessary in flight tests. The authors say, "Intentional maneuvers with bank angles in excess of 60 degrees, however, will still require approved parachutes to be worn by the trainee and the instructor. Intentional spins are approved in the acrobatic category (notwithstanding airworthiness directives or supplemental type certificates that may affect the spins-approved status). An accidental spin in the acrobatic category could have up to a six-turn margin of safety wherein recovery can be assured, provided proper spin-recovery actions are implemented and sufficient altitude remains in which to recover."

Considerations besides airplane category apply, however. Structural design limits also depend on flaps configuration (deployed or not) and how g-load is applied (symmetrically or asymmetrically).

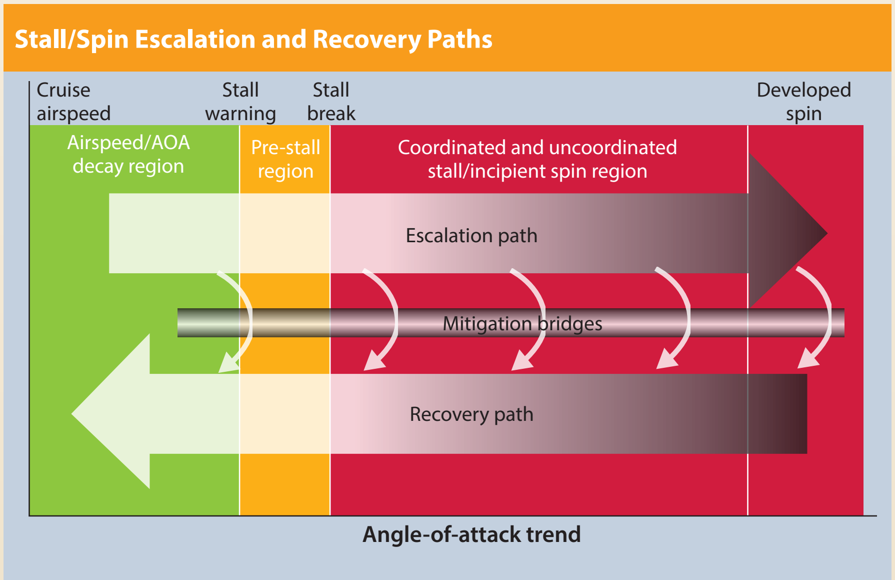
"In the acrobatic category, design limits with flaps up and symmetrical g-load are positive 6.0 g and negative 3.0 g," the paper says. "The design limit when simultaneously rolling and pulling, however, drops to positive 4.0 g. Thus the structural margin of safety




ICAO = International Civil Aviation Organization

Source: ICAO *Manual on Aeroplane Upset and Recovery Training*

Figure 2




AOA = angle-of-attack; ICAO = International Civil Aviation Organization

Source: ICAO *Manual on Aeroplane Upset and Recovery Training*

Figure 3

in the acrobatic category during an inadvertent rolling pullout would be positive 4.0 g, provided the flaps were retracted."

The possibility of airplane structural fatigue must also be monitored. "There is an exponential relationship between g-load and the fatigue life of wing structures, engine mounts, seat frames, windows and other major components. … [R]elatively small increases in g-load can result in dramatically reduced life cycles," the authors say.

"While perhaps not the deformation or catastrophic failure concern associated with design limits, structural fatigue definitely impacts the cost of, and comfort with, the delivery of UPRT. Higher g-loads can lead to increased aircraft maintenance and downtime — translating into increased [training] delivery costs — as well as increased risk to pilots flying the subject airplanes."

## Specialized Equipment

For airplanes regularly engaged in UPRT, extra equipment is either required by regulations or installed for optimal pilot safety. The authors say that among these items typically are:

- Parachutes — "With the exception of spin training, [FARs Part] 91.307 stipulates that no pilot of a civil airplane carrying any person (other than a required crewmember) may execute an intentional maneuver that exceeds 60 degrees of bank or 30 degrees of pitch relative to the horizon, unless each occupant is wearing an approved parachute that has been repacked at specified intervals."

- G-meters — "Airplanes approved for use in the acrobatic category are typically equipped with g-meters. This instrument not only allows the monitoring of the stresses imposed on training airplanes, but it also provides important context during UPRT to calibrate trainees to acceptable load factors [in relation to] design structural limitations."

- Emergency egress — "Airplanes approved for use in the acrobatic category are typically equipped with doors, canopies and windows that are capable of being jettisoned for in-flight emergency egress."

- Seat belts — "Airplanes approved for use in the acrobatic category are typically equipped with dual lap-belt systems. This redundancy provides a greater margin of safety should a lap belt attach point fail or a pilot inadvertently unlatch a lap belt during UPRT."

## To Instruct and Serve

Another critical element in on-airplane UPRT, besides the adrenalized learning and the aircraft and equipment considerations, is the flight instructor's qualifications.

"A qualified instructor is arguably the single greatest asset to UPRT, not just for the delivery of the requisite academic and practical training, but also for the mitigation of risks associated with the training itself," the paper says. "Conversely, an unqualified instructor will quickly become the greatest liability to the success of the UPRT initiative. The qualifications of on-airplane instructors, in particular, require special consideration if the benefits envisioned from UPRT are to be realized."

The certified flight instructor granted privileges by the regulator for typical flight instruction, who has not completed UPRT-instructor training, lacks the necessary background for UPRT, Brooks, Ransbury and Stowell say. Those with only the flight instructor rating generally have limited experience in beyond-normal attitudes and flight envelopes, and little or no competence in acrobatics or recovery from substantial spins; most qualified as instructors flying light general aviation aircraft in the normal category, they say.

"As the UPRT initiative expands and evolves from an unregulated to a regulated state … new concepts will be injected into the aviation lexicon and new knowledge and skills will become a core competency for all professional pilots," their paper says. "The specific competencies demanded of UPRT instructors do not exist in current instructor training and certification requirements. Even current stall and spin awareness training mandates for flight instructor applicants have proven inadequate, resulting in demonstrable — and almost universal — deficiencies in both instructor understanding of high angle-of-attack dynamics and instructor competency relative to providing adequate stall and spin instruction.[9]

"The on-airplane UPRT environment necessitates high levels of instructor competency in, and comfort with, the flight regimes well beyond normal operations, the performance and operating limitations of different training aircraft and the ability to respond appropriately to inadvertent upsets encountered in the training environment. A failure to adequately qualify UPRT instructors from the outset could have dire consequences on safety and thus on broad acceptance of the UPRT philosophy."

### Notes

1. Boeing Commercial Airplanes. *Statistical Summary of Commercial Jet Airplane Accidents, Worldwide Operations, 1959–2012.* <www.boeing.com/news/techissues/pdf/statsum.pdf>.
2. A draft of the proposed *Manual* was submitted to ICAO in December 2012 by the International Committee for Aviation Training in Extended Envelopes. The committee completed its four-year, multiphase LOC-I mitigation initiative in 2013.
3. The UPRTA website describes the association as "an international aviation organization devoted to flight training quality assurance and instructor pilot standardization." <uprta.org/uprta-mission-to-enhance-safety-of-air-travel>.
4. Available at <uprta.org/uprta-paper-addresses-icao-manual-on-aeroplane-upset-prevention-and-recovery-training>. For consistency with the *Manual*, the paper used the spelling *aeroplane*. In this article, *airplane* has been substituted.
5. The term *UPRT* was adopted by both ICAO and the U.S. Federal Aviation Administration to resolve earlier variations in terminology, including *emergency maneuver training*, *advanced maneuver training* and *upset recovery training*.
6. Randy Brooks is a master instructor, member of the Society of Aviation and Flight Educators (SAFE), UPRT instructor and vice president of training for Aviation Performance Solutions with a background in many facets of business aviation. His air show acrobatic experience includes formation team demonstrations, jet aircraft and sailplanes. He has delivered more than 3,000 hours of flight instruction and is president of UPRTA.

   Paul "BJ" Ransbury is the president of Aviation Performance Solutions, a multinational flight school that trains more than 1,000 professional jet pilots annually in integrated UPRT. He is a four-time master instructor, SAFE member, former airline pilot and military fighter pilot.

   Rich Stowell is an eight-time master instructor, SAFE member, the 2014 National FAA Safety Team Rep of the Year and the 2006 National Flight Instructor of the Year. He has been a full-time instructor specializing in spin and emergency maneuver training since 1987, and is the author of three aviation textbooks.
7. Cahill, L.; McGaugh, J. "Mechanisms of Emotional Arousal and Lasting Declarative Memory." *Trends in Neurosciences* Volume 21(7), 1988.
8. McIntyre, Christa K.; Roozendaal, Benno. "Adrenal Stress Hormones and Enhanced Memory for Emotionally Arousing Experiences," *Neural Plasticity and Memory: From Genes to Brain Imaging*, Chapter 13. Boca Raton, Florida, U.S.: CRC Press, 2007. <www.ncbi.nlm.nih.gov/books/NBK3907>.
9. Stowell, Rich. *The Light Airplane Pilot's Guide to Stall/Spin Awareness*, particularly pp. 80–87. Rich Stowell Consulting, 2007. <www.amazon.com/Light-Airplane-Pilots-Guide-Awareness/dp/1879425432>.

On the night of Oct. 16, 2012, a Bombardier CRJ700 ran off the end of a contaminated runway after touching down long with a tailwind at an airport on the coast of Brittany. None of the 57 people aboard the regional jet was hurt, but aircraft damage was assessed as severe by the Bureau d'Enquêtes et d'Analyses (BEA) of France.

# Unperceived Predicament

© Stephane Beilliard | AirTeamImages

**A tired CRJ crew did not recognize that a go-around was in order after landing long on a contaminated runway.**

BY MARK LACAGNINA

The controller advised the crew that there was a 'big squall on the field' and that visibility had decreased to 2,000 m in heavy rain.

"The investigation showed that the accident was due to the crew's failure to decide to carry out a missed approach [and their lack of awareness] of the degree to which runway conditions were contaminated or of the remaining length of runway available," said the BEA's final report.

Moreover, the report concluded that the pilots' situational awareness and decision making had been numbed by fatigue and routine, as well as the absence of clear communication about the condition of the runway. Investigators also found that an opportunity had been missed for the flight crew to review recent lessons learned and best practices for landing in adverse weather conditions.

The report said that the operator, Brit Air, "did not have a true picture of the safety performance of its operations." For example, the regional airline was not aware of data showing that one-third of the landings made by its CRJ700s on Runway 25 at the Lorient Lann Bihoué Naval Air Base, where the accident occurred, were "overshoots," or landings beyond the runway's touchdown zone.

The report also said that the operator's fatigue risk management system did not account for the effects of flying trip sequences that incorporated multiple legs.

## Fifth and Last Leg

The flight crew had completed four flight segments before departing from Paris at 2030 local time for the last leg to Lorient. Both pilots told investigators that they felt tired before beginning the flight. The captain noted that this was typical for the fifth leg of a trip sequence, especially at night.

"In general, five-leg flights are tiring," the report said. "This is felt by a majority of pilots, but few pilots, including [the captain], inform the airline of this."

The captain, 42, was the pilot flying. He had 6,910 flight hours, including 4,025 hours in type. He was hired by Brit Air as a cabin attendant in 1992 and was promoted as a flight crewmember after earning his airline transport pilot (ATP) certificate in 1999. He earned a CRJ700 type rating in 2001 and had been flying as a captain since 2007. During the three months preceding the accident, he had conducted 10 landings at the Lorient Lann Bihoué airport — seven at night and three during the day.

The copilot, 45, had 5,244 flight hours, including 3,014 hours in type, and had joined the airline in 2004. He held an ATP certificate and type ratings in the CRJ700 and CRJ1000. He had conducted eight night landings and two day landings at the airport during the previous three months.

Lorient Lann Bihoué Naval Air Base is a joint-use facility on the southern coast of Brittany that is operated by the French navy.

Around the time of the accident, showers and frequent thunderstorms had been forecast throughout Brittany. Before beginning the descent to the airport, the crew reviewed the current automatic terminal information system (ATIS) broadcast, which indicated that surface winds were from 170 degrees at 18 kt, visibility was 10 km (6 mi) and there were broken ceilings at 1,000 ft and 1,500 ft. The ATIS also said that the runway was "wet with water puddles" and that the precision approach radar (PAR) procedure to Runway 07 was being used.

A few minutes later, however, the approach controller told the crew that the surface winds were from 160 degrees at 17 kt, gusting to 26 kt, and that visibility was 3,000 m (about 2 mi). The flight crew requested and received vectors for the instrument landing system (ILS) approach to Runway 25, which had a longer available landing distance than Runway 07.

## 'Fatigue and Weariness'

The cockpit voice recording showed that both pilots expressed their "fatigue and weariness" several times during the flight, the report said. The effects of fatigue were manifested, in part, in the crew's conduct of the "Descent" checklist. The copilot called out completion of items on the checklist without waiting for confirmation from the captain; he also forgot certain callouts.

At about 2106, the controller advised the crew that there was a "big squall on the field at the moment" and that visibility had decreased to 2,000 m (1 1/4 mi) in heavy rain. The controller reiterated that the runway was "wet with some puddles" and advised that the crew of the preceding aircraft had encountered "difficulties during landing due to aquaplaning." (The crew of that aircraft, an Embraer 145, later reported that they had temporarily lost control after touching down on the slippery runway.)

"This information did not trigger any particular reaction by the crew or an additional briefing taking into account the potential threats associated with it," the report said.

The pilots were conducting the "Approach" checklist when the controller issued a new surface wind report —150 degrees at 17 kt, gusting to 25 kt — and cleared the crew to conduct the ILS approach to Runway 25.

The crew told investigators that, due to the risk of wind shear, they decided to conduct the approach with the flaps extended 30 degrees and at 140 kt, a landing reference speed ($V_{REF}$) that was appropriate for the airplane's gross weight and the selected flap configuration.

## No Change of Plan

At about 2124, "the controller again indicated the presence of heavy rain, the condition of the runway, the aquaplaning and the difficulties of the preceding aeroplane," the report said. "This information did not alert the crew and did not change their plan of action [i.e., to land with a flaps 30 configuration]."

The crew's selection of flaps 30 complied with the operator's existing instructions for an approach and landing with known or suspected wind shear. According to the report, however, the crew was not aware of another critical factor: that the runway was contaminated with standing water.

The report said that a runway is considered *contaminated*, in part, "if more than 25 percent of its surface area is covered by a film of water more than 3 mm [0.125 in] deep." Although no measurements had been taken by airport personnel at the time, the BEA determined that the runway was indeed contaminated by standing water.

However, the repeated reports that the runway was "wet with water puddles" — phraseology that was not proper for pilot-controller communications — had led the crew to believe that the runway was wet, rather than contaminated with standing water, which reduces braking performance and typically results in a longer landing distance.

The report indicated that a flaps 45 configuration would have been more appropriate for the conditions because it would have provided for a shorter landing distance.

Runway 25 was 2,230 m (7,316 ft) long and surfaced with ungrooved concrete. The runway was known to have water-retention problems. Following two landing excursions by military

### Bombardier CRJ700



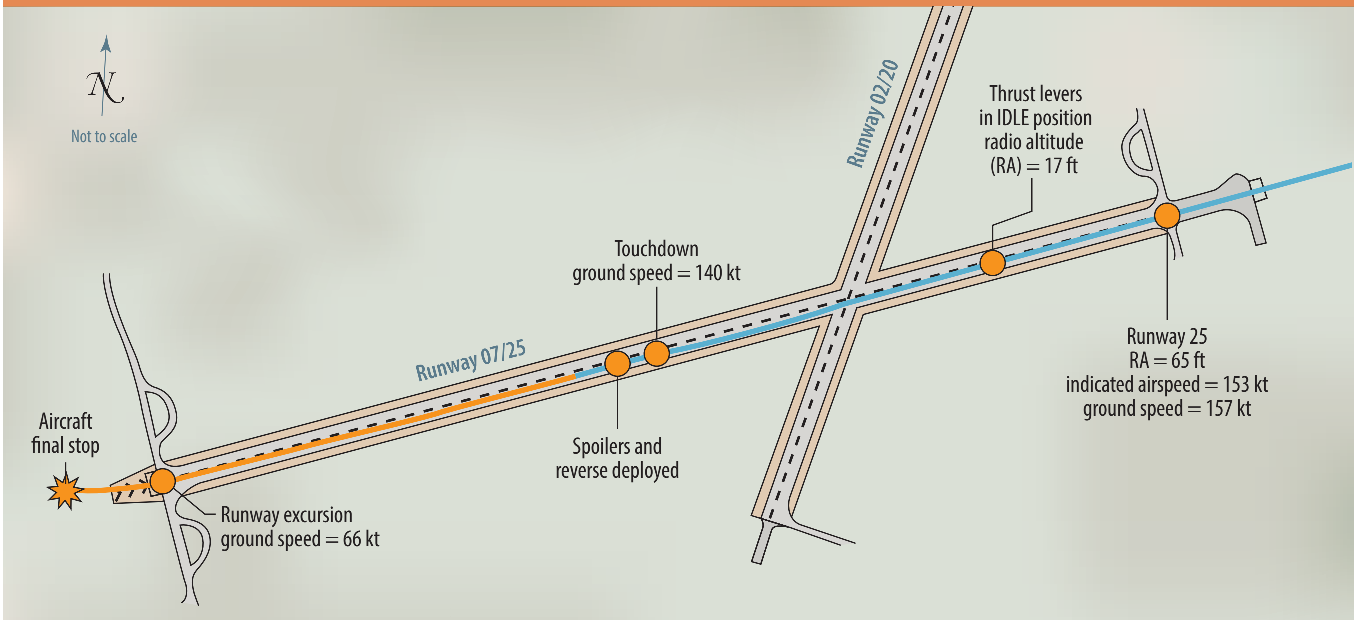

Bombardier's Canadair Group began design studies in 1987 for a medium-haul regional jet based on the Challenger 600 business jet, which had entered service seven years earlier. Sharing the Challenger's engineering designation CL600-2B19, the 50-seat CRJ100 entered service in 1992. The CRJ200 followed three years later with more powerful General Electric CF34 engines.

The CRJ700 model entered service in 2001 with a stretched cabin that seats 66 to 78 passengers and a new wing with leading-edge slats. The airplane's CF34-8C1 engines each produce 12,670 lb (56.3 kN) thrust. Maximum weights are 72,750 lb (32,999 kg) for takeoff and 67,000 lb (30,391 kg) for landing. Maximum cruise speed is 0.85 Mach, and normal cruise speed is 0.78 Mach at the 41,000-ft service ceiling. Maximum range is 1,218 nm (2,256 km).

The accident airplane, F-GRZE, entered service in 2002. To date, more than 1,600 CRJs have been delivered worldwide. Currently in production are the CRJ700, 900 and 1000 "NextGen" models.

Sources: BEA, Bombardier Aerospace, *Jane's All the World's Aircraft* and *The Encyclopedia of Civil Aircraft*

CRJ700 Flight Path




Susan Reed; Source: Bureau d'Enquêtes et d'Analyses

aircraft, the navy in 2010 had approved a recommendation for runway reconditioning, including grooving the concrete to improve water drainage. However, "as of the date of the accident, no reconditioning had yet been undertaken," the report said.

Investigators calculated that the CRJ's landing distance on the contaminated runway was 2,117 m (6,946 ft). It is important to note that this calculation assumed that the aircraft would pass 50 ft over the approach threshold at the reference landing speed.

## 'Stable, Continue Approach'

As the aircraft descended through a radar height of 1,000 ft, the captain called out "stable, continue approach." Recorded flight data confirmed that the approach was stabilized at that point but also that the latter portion of the approach was conducted with increasing airspeed and with a tailwind component of about 4 kt.

The crew saw the runway approach lights at about 800 ft. The captain disengaged the autopilot and told the copilot to set the windshield wipers at maximum speed. Both pilots recalled that it was raining heavily.

"For about 10 seconds, the airspeed increased above 150 kt, with a maximum of 155 kt," the report said. "The aeroplane went through 500 ft radio altimeter height at a speed of 154 kt."

Numerous roll-control inputs were recorded before the CRJ crossed the runway threshold at 56 ft. Indicated airspeed was 153 kt (13 kt higher than $V_{REF}$), and, due to the tailwind, groundspeed was about 157 kt. The faster speed and the tailwind increased the calculated landing distance on the contaminated runway from 2,117 m to about 2,500 m (8,202 ft), according to the report.

Just before touchdown, the copilot remarked that visibility was "bad" and told the captain that the aircraft was left of the runway centerline. The captain later told investigators that he had difficulty estimating height and aligning the CRJ with the centerline due to the aircraft's inefficient landing lights and the deficient runway marking and lighting. The runway did not have centerline lights.

## Long Landing

The captain told investigators that he perceived that the flare was initiated too high and that the aircraft floated, but he did not know how far from the approach threshold the aircraft actually touched down.

The report said that groundspeed was 140 kt when the CRJ touched down about 1,130 m (3,707 ft) from the approach end of the runway at 2122. "The crew did not realise that the runway was contaminated and that the landing was long. At no time did they envisage a go-around."

The touchdown occurred with 1,100 m (3,609 ft) of runway remaining. "This length was sufficient for a complete stop of the aeroplane on a dry or wet runway," the report said. "It was inadequate on a contaminated runway."

The spoilers extended after touchdown, and the crew deployed the thrust reversers and applied maximum reverse thrust and wheel braking. A few seconds after touchdown, the captain told the copilot that he could not brake the aircraft. The report said that white tire tracks found on the runway after the accident indicated that aquaplaning likely had occurred.

The aircraft turned right just before it overran the runway at 66 kt. The CRJ came to a stop in a grassy area about 200 m (656 ft) from the end of the runway after the left wing struck localizer antennas.

The captain ordered an emergency evacuation, and the 53 passengers exited through the left front door and the overwing exits. The report said that the CRJ incurred major structural damage; the landing gear required replacement and the engines had to be removed for repair.

## Unrecognized Threats

The report said that the pilots had accounted for the possibility of wind shear and a wet runway in their planning, but they had not identified the threats of a contaminated runway and an overshoot, even after receiving information about the previous crew's difficulties in landing.

The airline recently had incorporated principles of threat and error management (TEM) in recurrent ground school sessions. However, "this was not put into effect during simulator sessions," the report said. "In addition, by the date of the accident, only the captain had been given awareness training. The crew therefore was not predisposed to apply it."

Moreover, the report noted that the airline's training had not incorporated the "lessons learned and best practices" for landing in adverse weather conditions that had been covered in a symposium hosted in 2010 by the Direction Générale de l'Aviation Civile (DGAC), the civil aviation authority in France. "This symposium specifically addressed the risk of runway excursions," the report said.

Investigators also found discrepancies in the information provided by the airline and by the aircraft manufacturer regarding flap selection. Bombardier had recommended using the minimum flap setting appropriate for the available runway length when landing with suspected or confirmed wind shear. Based on this information, Brit Air's operations manual specified a flaps 30 configuration in this situation. However, the operations manual was not revised after the manufacturer in 2010 removed the instruction to use the minimum flap setting in wind shear.

"Bombardier stated to the BEA that this instruction had been removed because [the CRJ700 was] certified only for the standard flaps 45 configuration," the report said, noting that among several changes made by Brit Air after the accident was an instruction to use a flaps 45 configuration for all landings.

The BEA issued several recommendations based on the findings of the accident investigation. The recommendations included improvement of drainage and elimination of known areas of water retention on Lorient's Runway 07/25; extension of civil airport certification and safety management requirements to all military airports where civil aircraft operations also take place; integration of TEM in recurrent training and checks by commercial aircraft operators; and implementation of effective and thorough fatigue risk management systems. The BEA also called on the DGAC to ensure improvement by Brit Air of its processes for checking and updating its documentation.

*This article is based on the English translation of the BEA report "Accident on 16 October 2012 at Lorient Lann Bihoué (56) Aerodrome to the Bombardier CRJ-700 Registered FGRZE, Operated by Brit Air." The report is available at <www.bea.aero/index.php>.*

**'The crew did not realise that the runway was contaminated and that the landing was long.'**

# What Goes Around

**Study urges improved training to help flight crews to better cope with go-arounds.**

BY LINDA WERFELMAN

Most air transport pilots lack adequate training in how to perform the most common go-arounds — those with both engines operating in the high-pressure environment of a missed approach, according to a study by the French Bureau d'Enquêtes et d'Analyses (BEA).

Although a go-around is considered a normal procedure, it nevertheless is challenging because of its "rarity … and complexity in terms of workload," said the study, begun after fatal accidents in 2009 and 2010 that were associated with "aeroplane state awareness during go-around (ASAGA)," which the agency characterized as "loss of control of the flight path during or at the end of a go-around maneuver."[1]

The *Study on Aeroplane State Awareness During Go-Around* added, "A go-around does not often occur during operations … and is one of the manoeuvres … poorly represented by simulators, in particular due to the absence of a realistic ATC [air traffic control] environment."

The study's findings indicated that pilot training typically does not take into account actual go-around accidents and incidents. Accompanying recommendations to the International Civil Aviation Organization (ICAO) and the European Aviation Safety Agency (EASA) included several calling for the development of more realistic training scenarios involving go-arounds with all engines operating.

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Emergency response personnel watch as the tail of an Armavia Airbus A320 is lifted by a crane after a 2006 crash in Sochi, Russia. All 113 people in the airplane were killed in the crash, which occurred during a nighttime missed approach.

Susan Reed ; Source: Bahrain Accident Investigation Board

The multi-phase study began with a statistical examination of go-around accidents and serious incidents, and an in-depth look at selected events.

Researchers searched the ICAO and BEA databases for "ASAGA-type" accidents and serious incidents, ultimately identifying 25 such events, including 15 fatal accidents that were responsible for 954 deaths, and singling out 10 events for further discussion (Table 1, p. 30).

Among them was the crash of a Gulf Air Airbus A320 into the Arabian Gulf during an attempted go-around in night visual meteorological conditions (VMC) on Aug. 23, 2000. The crash destroyed the airplane and killed all 143 people aboard (*Accident Prevention*, December 2002). The Bahrain Accident Investigation Board cited several contributing factors, including the captain's nonadherence to standard operating procedures, the first officer's failure to draw the captain's attention to aircraft deviations from standard flight parameters, the flight crew's "spatial disorientation and information overload," and their "non-effective response" to ground proximity warnings.

Another example cited was the May 3, 2006,[2] crash of an Armavia Airlines A320 during a missed approach to the Sochi (Russia) airport at night with weather conditions that, while VMC, were only slightly better than the airport's minimums. The accident killed all 113 passengers and crew, and destroyed the airplane (*ASW*, 10/07, p. 44).

The BEA study said the report by the Russian Air Accident Investigation Commission "suggests that it is possible to hypothesize that the nose-down inputs [by the captain, the pilot flying (PF)] may have been due to somatogravic illusions and/or … the speed approaching $V_{FE}$ [maximum speed with flaps extended]."

The Russian report also "referred to the pilots' loss of situational awareness in pitch and roll, and inadequate — or even non-existent — CRM [crew resource management] during the go-around phase and until the end of the flight," the BEA study said. "It also concluded that the captain had engaged the aircraft in an abnormal situation and that, with the exception of his responses to requests, the copilot did not perform his monitoring role adequately. It also highlighted the lack of an appropriate reaction from the flight crew to the GPWS [ground-proximity warning system] warning."

## Shared Themes

The study identified a number of shared themes. For example, all of the events but one involved a twin-engine airplane — relatively light at the end of a flight, with more thrust available than is required for a go-around maneuver. The exception to the twin-engine theme was one event involving a four–engine airplane. In all but one of the events, all engines were operative.

All but two events involved "significant speed and pitch attitude excursions" and, as a result, "excursions in climb speed and altitude," the report said. In addition, all events involved "a disruption … soon after a higher level of thrust was ordered and generated potentially hazardous maneuvers." The disruptions often came as a surprise to the crew.

CRM failures "were mentioned" in all of the events, the report said.

Six events occurred during the day in conditions with no apparent visibility problems. Visibility was not specified in one event, and instrument meteorological conditions, "which probably aggravated the situation," prevailed in nine events, the report said.

In 11 events, the pilot monitoring (PM) performed the tasks specified for beginning a go-around, such as retracting the landing gear and flaps. In four of these 11 events, these actions helped regain control of the airplane; in six others, there was no effect; and in one event, the

## Go-Around Events Described in Study

| Date | Location | Aircraft Type | Injuries | Aircraft Damage |
|---|---|---|---|---|
| Nov. 12, 1998 | Surat-Thani, Thailand | Airbus A310 | 101 fatal | destroyed |
| Aug. 23, 2000 | Bahrain | Airbus A320 | 143 fatal | destroyed |
| May 3, 2006 | Sochi, Russia | Airbus A320 | 113 fatal | destroyed |
| September 2006[1] | Naples, Italy | Airbus A320 | NA | serious incident |
| March 30, 2007[1] | Abidjan, Ivory Coast | Airbus A330 | NA | serious incident |
| July 21, 2007 | Melbourne, Australia | Airbus A320 | NA | serious incident |
| Sept. 23, 2007 | Bournemouth, England | Boeing 737 | NA | serious incident |
| Nov. 27, 2008 | Perpignan, France | Airbus A320 | 7 fatal | destroyed |
| Sept. 23, 2009 | Roissy, France | Airbus A319 | NA | serious incident |
| Oct. 11, 2010[2] | New York | Airbus A380 | NA | incident |

NA = not applicable

**Notes**:

1. Information about this event was obtained by BEA from internal airline documents.
2. Information about this event was obtained by BEA during the course of the study.

Source: French Bureau d'Enquêtes et d'Analyses (BEA), Aviation Safety Network

**Table 1**

actions had a negative effect. After these initial actions, insufficient monitoring by the PM was mentioned in reports on nine of the events, the BEA report said.

In 10 events, the airplane's "strong and quick-acting nose-up pitching moment generated by the engines at low speed placed the pilot in a situation that necessitated a high level of vigilance," the report said, adding that although causes of the disruptions were "extremely diverse," they often were made worse by automatic systems.

The most frequently cited "aggravating factor" was the "unexpected or overlooked operation" of the autopilot or the automatic horizontal stabilizer trim or both, the report said. Somatogravic illusions were cited as aggravating factors four times and suspected in two additional events, the report said.

The "intervention of ATC" was cited in six events, and related changes were mentioned in two others.

### Pilot Survey

The study's analysis of 831 survey responses from pilots with 11 French and British airlines showed that 54 percent had performed fewer than nine actual go-arounds at that point in their airline flying careers.

Their answers indicated that the go-arounds were performed for three primary reasons: meteorological conditions, an unstabilized approach or "ATC involvement." In addition, 30 percent of pilots said they had performed at least one go-around while flying below minimums.

Sixty percent indicated that they had go-around "difficulties" — most often involving vertical flight path management (capturing the go-around altitude) or autoflight system management. Of that 60 percent, half said that they also had difficulties during go-around simulator sessions. When instructors provided responses to the survey, they said those areas were not the only go-around–related problems observed during simulator sessions; in addition, they cited "getting and maintaining pitch angle," "visual scan management" and decision making.

"The pilots surveyed indicated that, overall, they were sufficiently well trained in [go-arounds] with one engine out (85 percent of the pilots)," the study said. "However, almost half of the pilots indicated that they were not sufficiently well trained in [go-arounds] with all engines in operation. This figure was even higher for the pilots who indicated that they had encountered difficulties in flight."

### Stress and Startle

The study's human factors analysis of pilot behavior during a go-around concluded that the go-around "introduces a discontinuity in the tasks to be performed and a disruption to their rhythm of execution.

"The diverse nature of the tasks and the speed at which they must be performed generate stress, notably when the startle effect is also included. … Since stress reduces our ability to cope with complex actions, performance levels drop during go-arounds. The sudden onset of new tasks, the need to perform vital, rapid and varied manoeuvres and the rapid changes in the numerous parameters to be managed (controlled) in a limited period of time combine to make it difficult for a crew to perform a go-around that is not controlled right from the start."

The human factors analysis said that the first challenges associated with a go-around are adapting to a new situation, controlling related stress and managing layers of tasks. The PM is forced to cope with an overload, which often prevents him or her from monitoring the PF, the analysis said.

## Suggested Improvements

The study said that the pilots participating in the survey suggested several ways of improving go-around training, including changes in ATC procedures, such as increasing the initial go-around altitudes, which sometimes are too low; limiting pilot-controller communication during portions of a go-around that require crew concentration; and simplifying flight paths.

One pilot elaborated, "Ideally, if there is no terrain restriction, the flight path should go straight ahead in line with the runway and climbing to a height of more than 3,000 ft. The flight paths are all too often complicated, with banks early on in the manoeuvre, and altitudes that are too low."

Other suggestions called for simplifying operators' go-around procedures to "indicate the pitch attitude to avoid a CFIT [controlled flight into terrain accident]" and "indicate the thrust needed to move away from the ground and climb steadily." Procedures also should describe the method of checking automatic systems, clearly state when landing gear and flaps should be retracted and describe the flight path for returning to land, pilots said.

## Simulator Sessions

In 11 simulator sessions (six in an A330 simulator and five in a Boeing 777 simulator) designed to bolster other study data, 11 flight crews each flew three go-arounds and participated in post-session interviews. Although all 33 go-arounds were studied, one subset of 11 was the subject of an in-depth analysis that found that at least one pilot in 10 of the 11 participating flight crews reported having difficulty with the go-around session.

Typically, that crewmember was the PM, the study said, noting that within seconds of the start of the go-around, PMs were forced to deal with "multiple and diverse" tasks involving callouts, readbacks of ATC instructions, verification of the pitch attitude, monitoring the PF's flight control and verification of flight mode annunciator (FMA) modes.

"The crews that experienced difficulties made adaptations to the procedure," the study said. "Some adaptations had positive effects (approach to interception altitude); others led to deviations from the expected result (flight path, for example)."

The researchers accompanied their evaluation of the simulator sessions with a discussion of simulator fidelity issues, including the inability of a typical full flight simulator to accurately represent a somatogravic illusion — the "powerful perceptual illusion of a nose-up attitude" — that typically occurs during an actual go-around. Although some airlines have suggested training pilots only on fixed-base simulators, "this would appear to be inappropriate for this flight phase," the study said.

## Causal Factors

ASAGA events have always occurred with all engines operating, the study said, noting that, in a typical ASAGA event, the crew begins a go-around with nose-up pitch and the application of full thrust.

"The acceleration due to this rapid and significant increase in thrust can create the feeling of a too-high nose-up pitch," the study said. "In the absence of external visual references and visual monitoring of instruments, a somatogravic illusion can cause the PF to reduce the aeroplane pitch towards inappropriate values. In practice, these somatogravic illusions are little known to crews, and existing simulators do not make it possible to recreate them so as to train pilots to recognize them."

Automatic systems add to the problems because their "initial engagement modes [are] different from those expected for the go-around … [and] when they are neither called out nor checked, [this] leads the aeroplane to follow an unwanted flight path," the study said. "Thus, in addition to reading the FMA, the monitoring of primary parameters — pitch and thrust — is a guarantee for the crew to ensure that the automatic systems put the aeroplane on a climbing flight path during the go-around."

The study emphasized that ASAGA events result in a "sudden, high workload" for the PM, "higher than that of PF," with tasks that are difficult to manage. Deficiencies in the performance of the PM's monitoring tasks "can have catastrophic results," the study added.

The document also noted that accident reports often mention the absence of CRM while crews cope with an

ASAGA event. Nevertheless, the study found that CRM often is in place before the event and again after the crew has regained control of the flight path.

"This 'lack of CRM' now seems to be a normal consequence where there is a situation involving startle effect, cognitive overload, time pressure and high stress," the report said.

The primary challenges in conducting a successful go-around are identifying "ways of giving the crew time to carry it out and also to simplify their actions," the study said.

## Recommendations

The BEA focused its nearly three dozen safety recommendations on flight crew training, calling on EASA — in coordination with airplane manufacturers, operators and non-European civil aviation authorities — to "ensure that go-around training integrates instruction explaining the methodology for monitoring primary flight parameters, in particular pitch, thrust, then speed."

Related recommendations to EASA and national civil aviation authorities, within Europe and internationally, say these regulators should ensure that recurrent training places greater emphasis on pilots' monitoring skills.

Because of the difficulties of maintaining CRM during a go-around, EASA should study methods of mitigating CRM's shortcomings in situations involving heavy workload or other unusual conditions, the BEA said. "Current CRM alone cannot constitute a reliable safety barrier in the case of disruptive elements," the study added.

Because full-thrust go-arounds can contribute to excessive climb speed, complicate the crew's efforts to accomplish all actions required by the go-around procedure and contribute to somatogravic illusion, the BEA said manufacturers should install devices to limit thrust during a go-around and "re-evaluate the possibilities of errors linked to the engagement of go-around modes."

Other recommendations included calls for:

- Manufacturers and operators to study pilots' visual scans as a prelude to improving procedures, especially for go-arounds;
- National civil aviation authorities, manufacturers and operators to identify methods of countering the "channelized attention phenomena" in which pilots become so focused on some of their go-around tasks that they neglect others;
- EASA and non-European certification authorities to ensure that go-around procedures are evaluated "in a realistic operational environment";
- EASA, national civil aviation authorities and manufacturers to ensure that pilots are familiar with actions required during a go-around "at low speed with pitch trim in an unusual nose-up position";
- ICAO to indicate that, when a missed approach procedure is being designed, a straight-ahead flight path should be given preference, when possible, and the first vertical constraint should be as high as possible; and,
- ICAO to define practices so that ATC does not instruct pilots to follow missed approach procedures that contradict published procedures and so that radio transmissions are not made to crews during a missed approach.

In addition, noting the helpful role of cockpit video recordings during the go-around simulator sessions, the BEA recommended that ICAO require image recorders in all full-flight simulators used in training public transport pilots.

"During the study, the use of video was essential to carry out a proper analysis of simulator sessions," the study said. "The video recordings made it possible to have access to all the information presented to the crew. … Installed in a simulator, it [a video recording system] would be a source of additional information of use during crew debriefing."

*This article is based on the BEA's "Study on Aeroplane State Awareness During Go-Around," originally published in French in August 2013 and subsequently translated into English. The report is available in both languages at <www.bea.aero>.*

### Notes

1. The accidents were:
   - The June 30, 2009, crash of a Yemenia Airways A310 about 6 km (3 nm) off the coast of Comoros during an approach to Moroni–Prince Said Ibrahim International Airport. The crash killed 152 of the 153 people aboard. The Aviation Safety Network said that the final report by the Comoros L'Agence Nationale de l'Aviation Civile et de la Météorologie cited as the probable cause of the accident inappropriate actions of the flight crew on the flight controls, which resulted in an unrecoverable stall.
   - The April 13, 2010, crash of an AeroUnion A300 B4 near Monterrey, Mexico, that killed all five people in the freighter and two people on the ground. A final report has not been issued.
   - The May 12, 2010, crash of an Afriqiyah Airways A330-200 that killed 103 of the 104 people aboard. The final report by the Libyan Civil Aviation Authority cited the crew's inappropriate flight control inputs during a go-around as one factor in the accident.
2. The BEA report, which provides the coordinated universal time (UTC) instead of local time, says the accident occurred May 2, 2006.

**Different countries use vastly different criteria in setting the pass-fail threshold for pilots' color vision tests.**

# Color Vision GAP

BY LINDA WERFELMAN

Photo Illustration: Jennifer Moore
Face: © sskfoto/istockphoto; Globe: © alessandroiryna/istockphoto

A lack of uniformity in assessing pilots with color vision deficiency (CVD) is encouraging "aeromedical tourism," with pilots seeking out aeromedical examiners in countries most likely to accept their particular deficiencies and issue medical certificates, according to a new study.[1]

The study was conducted by Dougal B. Watson, principal medical officer of the New Zealand Civil Aviation Authority, and a report on its findings was published in the February issue of *Aviation, Space, and Environmental Medicine.* The report concluded that "the medical assessment of CVD applicants is not performed consistently across the world. Factors that favor uniformity have been inadequate to encourage countries toward consistent medical assessment outcomes."

This inconsistency does not conform to "the highest practicable degree of uniformity in medical assessment outcomes," the report said.

## Setting Standards

CVD is an inability to see some shades of color — or, in some severe cases, an inability to see colors at all — that are seen by people with normal color vision (see "Explaining Color Vision Deficiency," p. 36). Noting that, in aviation, color has an important role in cockpit instruments and displays, on charts "and throughout the external airborne and terrestrial environment," the report added, "The ubiquity of color-coded information … has [led] to the importance of pilots and air traffic controllers being able to rapidly and accurately differentiate and identify colors."

The report traced aviation standards for color vision to World War I, when the British Royal Flying Corps tested applicants' color vision. "Great emphasis was laid upon perfect color vision because of the importance of picking out the color or markings of hostile machines, recognizing signal lights and judging the nature of landing grounds," the report said, quoting from a history of aviation medicine in the Royal Air Force.[2]

## Similar Requirements

Today, color vision standards set by the International Civil Aviation Organization (ICAO) specify that pilots must have "the ability to perceive readily those colors the perception of which is necessary for the safe performance of duties."[3]

However, the report said that the wording of the ICAO standard, as well as the flexibility given to ICAO member states in determining exactly how they will evaluate pilots' color vision and how they will interpret the results, leads to "wide scope for variation in the examination and the assessment of applicants' [color vision]."

The report added, "Wherever there is variation between countries in the interpretation and implementation of medical standards, there is also the potential for aeromedical tourism. Aeromedical tourism occurs when an applicant, faced with an unattractive medical assessment from one regulatory authority, seeks a more accommodating medical assessment from a different regulatory authority."

The study examined information about 78 countries — all but one of them ICAO member states — representing 92 percent of world aviation activity and found that their national medical standards contained similar color vision requirements.

For example, in Canada, India, Pakistan, Singapore and South Africa, the requirement is for professional pilots to "perceive readily those colors the perception of which is necessary for the safe performance of duties," while in New Zealand, pilots must "have no deficit of colour vision to an extent that is of aeromedical significance." European Joint Aviation Requirements call for pilots to "have normal perception of colours or be colour safe," and U.S. Federal Aviation Regulations specify that pilots must "perceive those colors necessary for the safe performance of airman duties."

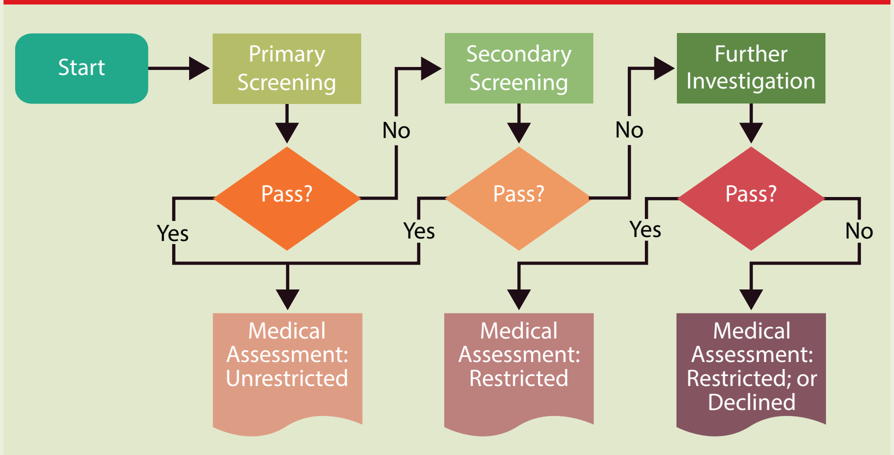
## Different Methods

The study found that, in all jurisdictions, the color vision assessment process begins with a primary screening, and pilots who pass are not subject to further color vision assessment (Figure 1).

Those who fail the primary screening, however, follow different paths, depending on the requirements of the civil aviation authority in the country where they are seeking medical certification. In some countries, they are denied medical certification at that point, but in others, they undergo a secondary screening before completing the medical assessment process.

The secondary screening practices end in similarly divergent paths — those applicants who pass are issued a medical certificate, and those who fail are either denied certification, granted

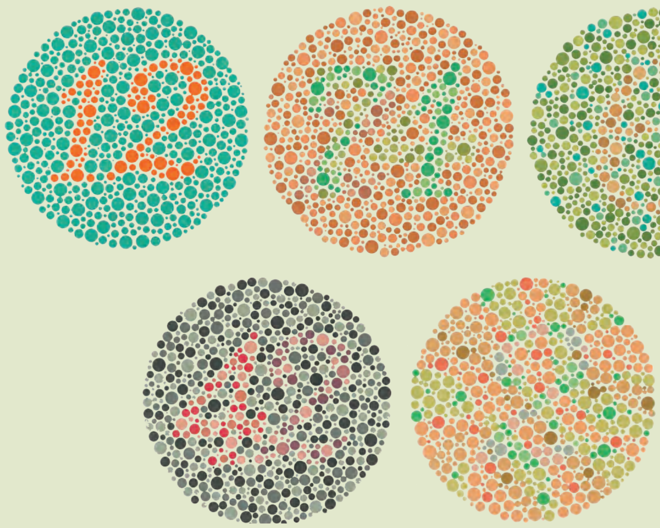
**Aeromedical Decision-Making Model**




Source: Watson, Dougal B. "Lack of International Uniformity in Assessing Color Vision Deficiency in Professional Pilots." *Aviation, Space, and Environmental Medicine* Volume 85 (February 2014): 150.

**Figure 1**

**Sample Ishihara Plates From a Color Vision Test**



**Notes**: People with normal vision should see, in the top line from the left, 12, 74 and 6, and in the bottom line, on the left, 42, and on the right, nothing. However, people with red-green color vision deficiency, instead of seeing nothing in the final plate, see the number 2.

Source: Wikipedia

**Figure 2**

certification with specific conditions such as no night flight, or subjected to further investigation in the continuing assessment process.

Applicants who pass during the further-investigation phase are issued medical certification with conditions. Those who fail either receive a medical certification with more restrictive conditions or their certification is denied.

The examination of the assessment processes found that, for pilots seeking a Class 1 medical certificate, all states began with a primary color vision screening. In 66 of the 78 member states, the primary screening consists of a single test; the remainder use two tests or more.

The report said that all but one of the states include at least one type of Ishihara pseudoisochromatic plate test (Figure 2) in their primary screenings; for 88 percent, an Ishihara test was the only one in use.

The most commonly used Ishihara test involves the use of a set of 24 plates designed to assess color vision. The study found that, in 65 of the 75 states using that set, a single error on the first 15 plates results in failure.

Overall, in 74 of the 78 states, applicants who fail the primary screening are permitted to move on to a secondary screening or further investigation, the report said. In the other four states, failure on a primary screening results in denial of a medical certificate. (In one of these four states, however, the denial applies only to first-time applicants.)

The secondary screenings typically involve the use of optical lanterns and other devices designed to test color vision by asking applicants to identify the colors, but they may also involve flight tests. Sixty of the 74 states allow only one level of secondary screening, but 14 provide two or more levels, so that applicants who fail on their first attempt may undergo alternative tests.

The "further investigation" phase is used in two states, and in both, applicants who pass are restricted to daytime flights while those who fail are denied medical certification, the report said.

## Failure and Inconsistency

In five of the 78 states surveyed, applicants who fail all phases of tests offered still are granted medical certification with restrictions, usually in the form of prohibitions on airline flying or night operations, the report said.

"In one state, an applicant who fails all of the testing offered may be issued a Class 1 medical assessment that allows all professional aviation operations except left-seat (captain) airline operations," the report said. "In this state, a profoundly CVD applicant is able to operate as an airline copilot."

Among the inconsistencies noted in the report were that some states did not comply with their own published assessment processes, either using a more liberal pass-fail threshold or applying different requirements for new applicants versus experienced pilots. Some states evaluated color vision only as part of the first application for medical certification, some tested annually, and others conducted the test every few years.

In addition, the report said, "some also accepted the [color vision] assessment of another state in lieu of their own, even when that other state's CVD assessment protocols and outcomes were different to their own requirements."

## 'Conceptually Sound'

The report said that, although the ICAO standard is "conceptually sound and relatively concise … [it] is not readily interpreted for practical use. It does not indicate which colors need to be perceived readily for safe aviation, or what degrees of measurable CVD [fail] to comply."

The document noted that ICAO has acknowledged the difficulties of clarifying the international color vision standard and of providing more specific criteria for assessing CVD, stating in its *Manual of Civil Aviation Medicine*, "The question is where to draw the line."[4]

While a single-step assessment would be easier to administer and less expensive, the report said, a two-step process with a second assessment for those who fail the first step would help reduce the number of false-positives. In this way, the report said, the structure of the CVD assessment system influences the outcome of assessments.

Earlier research found that it is not unusual for people with normal color vision to misread some plates in the 24-plate Ishihara test, the most common tool for assessing color vision. Nevertheless, errors on three or more plates almost always indicate that the person being tested has CVD.

Instructions accompanying the 1985 version of the 24-plate CVD test say that the first 15 plates are used to determine whether color vision is either normal or defective, and, if 13 of the 15 plates are read correctly, color vision should be considered normal.

The report said that the states that set a higher threshold for passing (those requiring a perfect reading of all plates, or allowing only one error) were allowing more false-positive results — in which people with normal vision are identified as having CVD.

These states may hold "fundamentally different views of the purpose of … testing," the report said.

The same conclusion applies to states with a lower threshold for errors (six or more incorrectly read plates), the report said, noting that their goal presumably is to ensure that no one with normal vision is incorrectly identified as having CVD.

"An argument that the different systems produce similar outcomes cannot be reasonably embraced," the report said. "Two regulatory systems will not have remotely similar medical assessment outcomes when one declines an applicant who makes one error … and another allows unrestricted commercial and limited airline pilot privileges to an applicant unable to pass any CV test."

ICAO provides no specific guidance on how member states should determine the pass-fail threshold, the report said.

## Explaining Color Vision Deficiency

People can see colors because the cones — photoreceptors — in the eye's retina contain light-sensitive pigments that enable the detection of wavelengths associated with red, green or blue light. That information is sent through the optic nerve to the brain, which distinguishes among many shades of color.[1]

Color vision deficiencies (CVD) occur when one or more light-sensitive pigments are missing from the cones. People with CVD typically have difficulty differentiating among the associated colors.

The most common deficiency is a red-green deficiency. Blue-yellow deficiency is rarer and often indicates more severe CVD; in most cases, people with a blue-yellow deficiency also have a red-green deficiency. People with both types of deficiency often see gray areas instead of color.

Although the term "color blind" often is used to refer to CVD, very few people are actually "blind" to color. Those who are truly color blind are those with a condition called achromatopsia; they see all colors as black, white or gray.

CVD usually is an inherited condition, but it also can result from diabetes, macular degeneration or other diseases, or some medications. Advancing age also can contribute to a deterioration of color vision.

— LW

### Note

1. American Optometric Association. *Color Vision Deficiency*. <www.aoa.org>.

### Notes


1. Watson, Dougal B. "Lack of International Uniformity in Assessing Color Vision Deficiency in Professional Pilots." *Aviation, Space, and Environmental Medicine* Volume 85 (February 2014): 148–159.

2. Watson, citing Gibson, T.M.; Harrison, M.H. *Into Thin Air: A History of Aviation Medicine in the RAF*. London, U.K.: Robert Halt Ltd. 1984.

3. ICAO. *Annex 1 to the Convention on International Civil Aviation: International Standards and Recommended Practices — Personnel Licensing*, 11th edition. Montreal, Canada, 2011.

4. ICAO. Document 8984, *Manual of Civil Aviation Medicine*. Part III, "Medical Assessment," Section 11.8, "Color Vision." Third edition, 2012.


### Further Reading From FSF Publications


"Color Vision Recommendations." *AeroSafety World* Volume 4 (July 2009): 9.

Werfelman, Linda. "Color Deficient?" *AeroSafety World* Volume 3 (December 2008): 38–41.

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# Bright Prospects

BY WAYNE ROSENKRANS

As graduates of multi-crew pilot licensing (MPL) programs gain admission to the right seats of flight decks in several world regions, the substantial data now being collected about their performance show high rates of completing courses and fulfilling airline expectations, say officials of the International Civil Aviation Organization (ICAO). Moreover, comments by captains surveyed at MPL-participant airlines typically show acceptance of MPL graduates and sometimes a preference for them versus traditionally trained first officers.

The status of MPL programs and graduates, including early thinking about desirable improvements, was the focus of the ICAO Multi-Crew Pilot License Symposium in December. Many presenters compared today's outcomes with the safety-centered philosophy on which the MPL was developed, and some pioneers predicted that this training will predominate as early as 2018.

"In October 2000, ICAO convened an industry meeting in Madrid [Spain] to review future flight crew licensing and training," said Vincent Galotti, deputy director, safety standardization and infrastructure, ICAO Air Navigation Bureau. "The industry meeting concluded that the emphasis placed by Annex 1, *Personnel Licensing*, on experience hours as the means to qualify


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for a professional pilot license was an obstacle to implementing best practices in *ab initio*–level training. From there on, work began to develop a safer and more efficient training regime for the next generation of commercial airline pilots with a focus on multi-crew operations."

When ICAO approved the provisions that launched the MPL in 2006 — the first new ICAO license in 50 years — safety was at the forefront of its lofty objectives, he said. The first was to produce a higher level of quality in graduates so they would contribute to improved safety. "Second, it provides for a closer linkage between licensing standards and training standards — and it's built on competencies, not on prescription of hours," he said. "Third, it uses high-quality flight simulation training devices to train in a multi-crew environment from the beginning, and introduces a framework of collaborative relationships between the [approved] training organization [ATO] and the airlines, allowing the airline environment to permeate the training."

Despite ICAO's confidence in concepts tested earlier, the need for a full-scale operational proof of concept — evaluating whether MPL actually would provide an equivalent level of safety to airline pilots trained under the traditional approach — was not possible without first adopting and applying the standards, Galotti said. The first results of this step, a preliminary analysis of de-identified data from states and ATOs, provided the first insights. This analysis is ongoing and will generate further reports about MPL program results.

Günther Matschnigg, then senior vice president of safety and operations for the International Air Transport Association (IATA), reminded the symposium in a video message that the IATA Training Qualification Initiative during this period has worked to implement new competence-based concepts, including MPL, and evidence-based training as part of modernizing and harmonizing airline pilot training to improve safety and attract younger generations of people to the industry.

"MPL is the first airline-dedicated professional pilot's license," he said. "MPL training is tailored to guide students seamlessly from *ab initio* training to airliner type rating using simulation designed for multi-crew training. … MPL training addresses the increasingly important issue of loss of control in airline operations through required upset prevention and recovery training (UPRT) and seeks to reduce the continuing dominance of multi-crew human factors in accidents through embedded threat and error management and crew resource management training. … Indisputable results [from about 30 airlines] prove that MPL [is] the better solution, and the outcomes mean that MPL is the way to go."

IATA's information at the end of 2013 showed more than 2,400 students enrolled in MPL programs and 800 MPL graduates worldwide. "Despite the small sample size, operators report average/all-around graduates' performance as good as or better than students from traditional training," Matschnigg said. "IATA and its members, through the Operations Committee, will push to see MPL implemented worldwide."

## Painstaking Evolution

Decisions about designing the MPL in the early 2000s grew out of an ICAO Air Navigation Commission meeting with industry in 1997, said Jim Dow, alternate representative of Canada on the Council of ICAO and a member of the commission. "It was a very deliberate, collaborative, transparent process — a very evolutionary process," he said, citing relevant concepts discussed at least since the 1970s and 1980s. "What you see as you circle backward is a constant effort to look at pilot training questions … because these questions always have to be asked."

The standards for the MPL found in Annex 1 explain the license training scheme, competency units, guidelines for program implementation, training objectives and threat and error management. Other ICAO documents provide guidance to states' establishment and management of a personnel licensing system, including MPL as the most comprehensive training system aligned with safety management systems.

Outside the MPL, ICAO provisions still emphasize hours of experience for the commercial

**Multi-crew pilot licensing programs fulfill ICAO's proof-of-concept expectations at this early stage of development.**

pilot license as the basis of training a first officer. "This is not a performance-based standard. It's a prescriptive standard that prescribes inputs rather than focusing on outcomes, and it lacks resilience. It's slow to respond [to change, and among regulators, it] invites tinkering with arbitrary numbers. … If 200 hours is safe, 250 must be safer," Dow said.

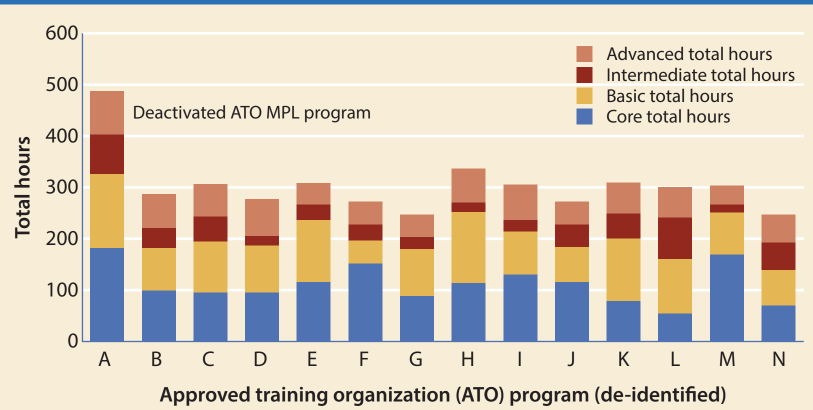
## Proof-of-Concept Results

"[Our December report] is an analysis of the data that we received as a result of replies to state letters," said Mitchell Fox, chief, ICAO Flight Operations Section. "It is not the only part of this proof-of-concept exercise." ATOs were instructed to furnish the state licensing authority with de-identified information concerning each of four phases of their MPL training program — core, basic, intermediate, advanced (type-rating) — for each student during and following the program, including any corrective actions that were necessary.

This first-time analysis on the ICAO website <icao.int> covered how programs are structured and planned, data from each graduating class to date, and individual student performance. "First off, we wanted to see [if] states actually were implementing regulations in conformity with the ICAO standards for the MPL," Fox said. "Having graduated from an ATO in collaboration with an airline, how did they actually perform in their initial operating experience or line experience? … We've analyzed 15 MPL programs to date." All of these involved their sponsoring airline in the student-preselection process, and every ATO implemented qualification requirements for evaluators as recommended by ICAO.

"These [factors have] figured prominently in the success of this particular license," he said. "For the final phase of training — the type rating — the evaluators and the instructors were very well-qualified. In the programs that we analyzed, nine had airline transport pilot license–qualified evaluators, and two did not. … All of the evaluators in the final phase of training were type-qualified, and the majority were currently qualified on type."

**Allocation of Total Hours in Surveyed MPL Programs, 2013**




MPL = multi-crew pilot license

**Notes:** The International Civil Aviation Organization continues to analyze a new trove of de-identified, proof-of-concept data that help to compare MPL programs and their results.

Source: International Civil Aviation Organization

**Figure 1**

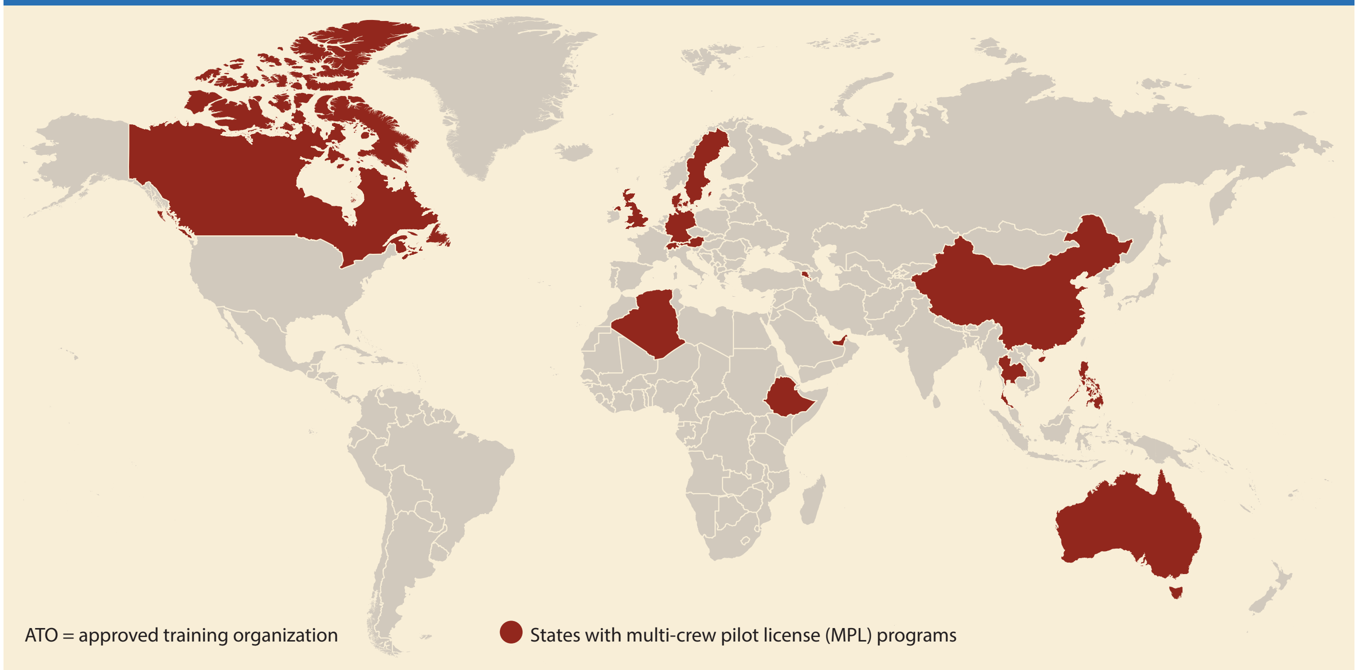
Graphs of these data showed that states introducing the MPL typically have enabled its use by incorporating it into their national regulations. The ATOs thus have state approval. States that have not implemented MPL-enabling regulations tend to conduct this training only for pilots who will work in other states.

"This is a graphic representation [Figure 1] of the training hours by ATO that we analyzed," Fox said. "What we find is that the amount of training hours is fairly consistent. [With the exception of one discontinued program,] the programs pretty well averaged out to about 300 hours, with a minimum training time of about 240 hours and a maximum training time of around 330 hours."

In the final phase of training, actual takeoffs and landings are required in the aircraft type in which the applicant would be type-rated. ICAO's *PANS-TRG (Procedures for Air Navigation Services–Training)* specifies 12 takeoffs and landings. "That can be reduced by the state authority once the proof of concept has been proven," he said. "The vast majority of the ATOs conducting MPL training have a programmed takeoff and landing [requirement] of about 12 takeoffs and landings. A couple of the ATOs have been authorized by their authorities to conduct [fewer] takeoffs and landings."

Graphs of other data showed that typical airplanes used for most core-phase training comprise Cessna, Diamond and Piper models. The responding ATOs also indicated that some use flight simulation training devices in this phase. Data also show that many ATOs use aerobatic aircraft "in the core flying phase of the MPL … based on [the anticipated] requirement for UPRT [although this] is not an absolute requirement. In the MPL, we do strongly recommend training in inverted flight but we have found through the

Twenty States Have Approved MPL Programs Provided by an ATO, 2013




Source: International Civil Aviation Organization;Base map: San Jose/Wikimedia CC-SA 2.0

research that we've done, and the further development that we've done on upset prevention training, that it may not be something that's necessary — and many states do not do that, or they do not have access to aerobatic airplanes."

The first set of data from states and ATOs also showed that the "vast majority" of the airlines and ATOs have been training students for the right seat of the Airbus A320. "The average class sizes so far have been about 13 trainees, a minimum of two … and a maximum of 27," Fox said. "The MPL [students' high final-check] pass rate is quite exciting, [but] I do have to put a little bit of a proviso in this. We do not have data, nor did we collect the data, on how many people wash out of training programs [i.e., fail and disenroll]. In retrospect, that probably would have been a good number to collect, but we just don't have that data."

All but one of the reporting ATOs had a 100-percent pass rate; the other had a 98-percent pass rate. "'Train for success' [in a competency-based system] makes a big difference," he said. "We had 586 datasets, meaning trainees. … In actual hours for completion, the average was about 286 hours actual flight time and flight simulation training device time. …The deviation from the planned/programmed amount of hours … was certainly within an acceptable tolerance. … In terms of the total flight time average — including solo or pilot-in-command time, sole-[control]-manipulator time and dual — the average amount of actual flight time on type was approximately 85 hours. Remember, the only actual time on type is that which is required for the takeoffs and landings." Fox acknowledged the incongruence of programming specific amounts of hours in performance/competency–based training, and he called it a temporarily needed concession to achieve stakeholder consensus at the time.

"The actual takeoffs and landings required to train to competency was [about 14,] actually a little bit above the 12 takeoffs and landings," he said. "But we did see deviations. In one case, we saw [a] maximum of 36 takeoffs and landings required in type. Three of the ATOs that we analyzed actually required at-or-above 24 takeoffs and landings to reach full competency."

Students' scores on airline transport pilot license–level theory testing were typically 80 percent to 90 percent correct answers. Another area reviewed was the ICAO English language proficiency level. "Most ATOs require that the entrants enter with ICAO proficiency Level 3 … but they have to graduate at the full operational Level 4."

Other graphs from the data analyzed in time for the symposium showed the nature of graduates' deficiencies during their initial line training/line check, also called initial operating experience, at their airline. ATOs furnished data on trainees who failed a check (but subsequently passed the check and the full course) or had to be debriefed for skill-enhancement purposes following a particular maneuver.

"Of [586 dataset] files that we received, we had about 21 incidents where graduates of the MPL program had some challenges in the execution of a maneuver in actual line training," Fox said. "That's not a high percentage but it is notable. The next [highest-reported] area was related to workload management. … The vast majority of these were performance that didn't quite meet the full-line requirements and required a debrief; of the debriefs, only about 1 percent per airline actually resulted in failure on that particular maneuver. That doesn't mean to say that the [airline] trainees didn't go on to succeed in their line training, but they failed that maneuver on one occasion.

"What we found surprising is that the graduates [also] had some challenges associated with monitoring the flight progress in cruise. … The next area where the graduates were most challenged had to do with precision approaches and normal landings. … These are either a failure, which represents about 1 percent of the numbers, or a debrief, which is the vast majority of those numbers."

Comments on the new first officers' post-line evaluations showed that a few of the graduates had pilot–air traffic control communications problems — possibly related to English language proficiency.

These MPL graduates also varied somewhat in the number of sectors they flew before attaining the airline's full qualification to line-performance standards. The average was 105 sectors, with a minimum of 70 to 72 sectors and a maximum of 281 sectors. The average sector length was about 1.5 hours, with the line trainee performing about half the pilot-flying duties.

"What we show so far is the MPL works," Fox said. "It's sound. One of the factors that we attribute that success to is [the airline-involved student] preselection. We feel that has been a marked factor in the success of the MPL. The failure rate is low [because they train until they achieve] the individual's competency … the individual's need. The goal is train to success. … Really, the mark of MPL success is 'Do the graduates go on to an airline career as a professional pilot?' The vast majority of [these] graduates went on to the sponsoring airlines. … It's not really surprising."

Some captains were apprehensive about flying with graduates of the MPL program, he said. "They found, however, that they preferred to fly with them, as opposed to graduates of conventional training programs. I think that's also a mark of success." He noted that ICAO so far has no data on the number of MPL graduates that have upgraded to captain, or their performance in command.

## UPRT in Core Phase

Harmut Fabisch, a captain representing IATA as a consultant on UPRT and on loss of control issues in MPL programs, told the symposium that although ICAO standards and guidance do not specify the phase where this subject is to be covered, there are several reasons for including this training early, at the core flying-skills phase.

"I'm quite proud about the fact that we already had thought about UPRT in 2001 during the design phase of the MPL," he said. "At that time, loss of control–in flight was not yet on everyone's lips but we had the feeling that this was of essential importance and that we should include [what was then called *upset recovery training*] in the course. … MPL is the only course under ICAO Annex 1 which mandates UPRT."

The primary reason for providing this in the core flying-skill phase is because this phase, in great measure, deals with human factors and pilots' career-long foundation of confidence in their own capability.

"UPRT worldwide varies from very professional, all-attitude recovery training [to] misunderstandings like [teaching] aerobatics or spin training [or] classic unusual-attitude maneuvering in normal-category aircraft with regular flight instructors who never received any specific qualification in this field," Fabisch said.

The MPL course uniquely embraces all recommended areas of UPRT — from generic on-aircraft and simulator training at the core and basic phases to UPRT in type-rating training.

"[UPRT elements] that exclusively can be trained in the real aircraft are mainly related to the psychophysiological effects — such as the handling of surprise and startle, maintaining the ability to act during reduced and increased g loads [multiples of the standard acceleration of gravity] and enabling pilots to perform counterintuitive actions such as applying forward elevator in nose-low or even in inverted attitudes," he said.

"The special value of on-aircraft UPRT lies primarily in the human factor … to build confidence in a pilot, trust in [her/his] own ability to determine the situation correctly and recover any aircraft from any attitude or any energy state as long as this is possible … [and] there is no way around using an aerobatic-certified aircraft for this type of training. Developing handling skills to recover from upsets is also very important, but this can all be trained in the simulators. … Most experts among us consider a certain maturing process and psychological aspects as most important [in the core phase]. … This means that UPRT and the core phase are closely connected because they share the same fundamental value. *Core-flying confidence phase* would be a better name."

BY FRANK JACKMAN

# Commercial Aviation Fatalities Down Sharply in 2013

Commercial aviation, including both jet and turboprop operations, suffered 16 fatal accidents in 2013 that resulted in 210 fatalities, according to worldwide data released in early April by the International Air Transport Association (IATA). While there was one more fatal accident last year than there was in 2012, the number of fatalities in 2013 fell sharply from 2012's total of 414, IATA said. In addition, last year marked the third consecutive year in which fatalities declined from the previous year, and 2013's fatality total was less than half of the annual average over the five-year — 2009–2013 — period (Figure 1).

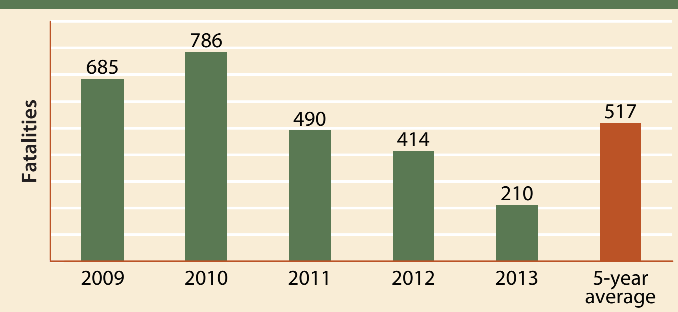
Overall, there were 81 commercial aviation accidents involving Eastern- and Western-built aircraft last year, up from 75 in 2012, but still fewer than in any of the previous three years (Figure 2). Of the 81 accidents, 78 percent involved passenger operations, 18 percent cargo operations and 4 percent ferry flights. Just over half of the accidents, 53 percent, involved turboprops. Twenty-one percent of last year's accidents involved a runway excursion, 17 percent a gear-up landing or gear collapse, and 15 percent involved ground damage.

IATA defines an accident as an event in which persons have boarded an aircraft with the intention of flight; the intention of the flight is limited to normal commercial aviation activities, specifically scheduled or charter passenger or cargo service; the aircraft is turbine-powered and has a certificated maximum takeoff weight of at least 5,700 kg (12,500 lb); and the aircraft has sustained major structural damage exceeding $1 million or 10 percent of the aircraft's hull reserve value, whichever is lower, or it has been declared a hull loss.

Over the past five years, there have been 432 commercial aviation accidents, or an average of 86.4 per year. During that period, there were 94 fatal commercial aircraft accidents. Sixty-five percent involved passenger operations, 31 percent cargo operations and 4 percent ferry flights, according to IATA.

Runway excursions were the most common type of accident during the 2009–2013 period, accounting for 23 percent of all the accidents, IATA said (Figure 3). Those accidents, however, accounted for only 8 percent of 2,585 fatalities during the period.

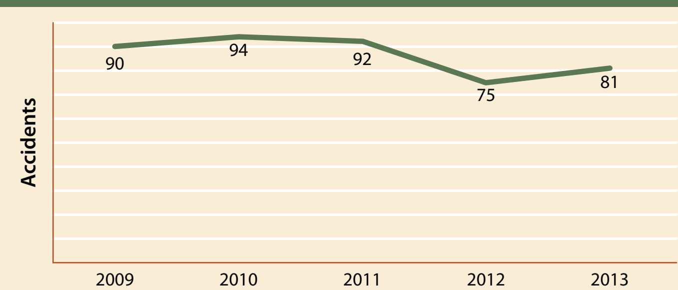
Commercial Aviation Fatalities, 2009–2013 vs. Five-Year Average




Source: International Air Transport Association (IATA)

Figure 1

Commercial Aviation Accidents, 2009–2013




Source: International Air Transport Association

Figure 2

"Improving runway safety is a key focus of the industry's strategy to reduce operation risk," IATA said. "Information sharing, risk analysis, training and analysis of the taxonomy of runway safety are all part of the industry's comprehensive approach to improvement in this area." From 2009 to 2013, 58 percent of all accidents occurred in the runway environment, IATA said.

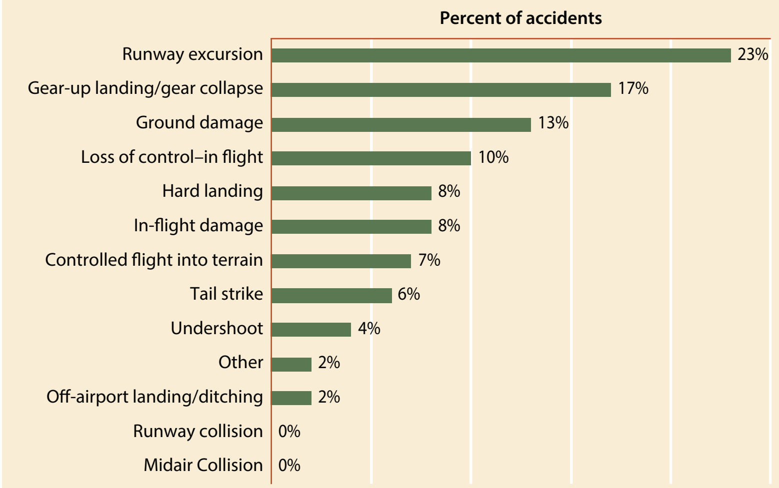
Approximately 10 percent of all the commercial aviation accidents over the past five years have been categorized as loss of control–in flight (LOC-I), according to IATA. "While few in number, LOC-I accidents almost always are catastrophic," IATA said. Ninety-five percent of the LOC-I accidents during the five-year period involved fatalities to passengers or crew. Of the 2,585 fatalities suffered in commercial aviation in 2009–2013, 1,546, or 59.8 percent, were as a result of LOC-I accidents. Last year, there were eight LOC–I accidents, and all of them involved fatalities.

There were six controlled-flight-into-terrain (CFIT) accidents in 2013, and 7 percent of all accidents in 2009–2013, or 31, were CFIT, according to IATA data. The association said that most CFIT accidents occur in the approach and landing phase of flight and are often associated with nonprecision approaches. Over the past five years, 52 percent of CFIT accidents were known to involve the lack of a precision approach. "There is a very strong correlation between the lack of instrument landing systems or state-of-the-art approach procedures, such as performance-based navigation (PBN), and CFIT accidents," IATA said, adding that it has established a campaign for states to expedite the implementation of PBN approach procedures for runways lacking precision approaches.

IATA calculated the Western-built jet hull loss rate for 2013 at 0.41 per million flights, or the equivalent of one per every 2.4 million flights, which is nearly double 2012's rate of 0.21 hull losses per million flights (Figure 4). There were 12 hull loss accidents involving Western-built jets last year, compared to six in 2012. Last year's hull loss rate of 0.41 per million, however, still is lower than the five-year (2009–2013) average of 0.48 hull losses per million flights. A hull loss is defined as an accident in which the aircraft is destroyed or substantially damaged and not subsequently repaired for whatever reason, including a financial decision by the owner.

With the release of its most recent statistics, IATA introduced a new measure for accidents, the *modern jet hull loss rate*. This includes aircraft approved for production after 1985 and equipped with a glass cockpit and flight management system at initial certification. Aircraft using older technologies are considered "classic." IATA said this definition "reflects the harmonizing of aircraft manufacturing and certification standards and the global manufacturing of aircraft components." The modern jet hull loss

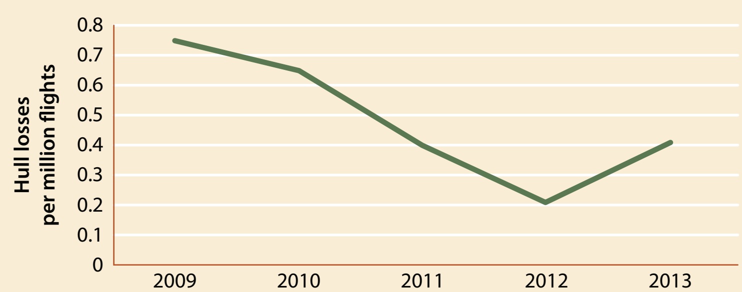
**Commercial Aircraft Accidents by Category, 2009–2013**




Source: International Air Transport Association

Figure 3

**Western-Built Jet Hull Loss Rate, 2009–2013**




Source: International Air Transport Association

Figure 4

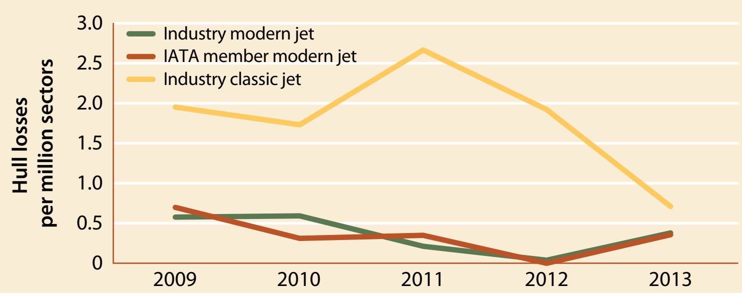
rate is calculated as the number of accidents per million flights or sectors. IATA also calculated the modern jet hull loss rate for the industry as a whole and separately for IATA member carriers.

According to IATA, the classic jet hull loss rate last year was 0.71 per million sectors, while the overall industry rate was 0.38 per million and the IATA member carrier rate was 0.36 per million (Figure 5).

The most comprehensive of the rates calculated by IATA is the *all accident rate,* which includes substantial damage and hull loss accidents for jets and turboprops. The industry all accident rate last year was 2.23 accidents per million fights, which represents a slight increase from 2012 (Figure 6). The IATA member carrier all accident rate was 1.57 per million flights in 2013, up from 0.74 the previous year and also greater than the five-year average rate of 1.49. The accident rate last year for operators that are IATA Operational Safety Audit (IOSA)–registered was 1.46 accidents per million flights, and the rate for non-IOSA-registered operators was 3.6 per million. The five-year average rate for IOSA operators is 1.57 per million, while the five-year average rate for non-IOSA-registered operators is 4.24 per million. IOSA is an industry standard for airline operational safety auditing that assesses airline operational management and control systems and, as of March 2009, is a condition of IATA membership.

The Commonwealth of Independent States had the worst performance of any region in terms of the Western-built hull loss rate in 2013 (Figure 7), followed by Africa. North Asia, Europe and North America had the lowest rates, all well below the industry average of 0.41 hull losses per million flights. IATA member carriers as a group also fell below the industry average. Over the past five years, Africa had the highest average hull loss rate, followed at a distance by the Middle East and North Africa. North Asia and North America had the lowest rates.

**Modern Jet Hull Loss Rate, 2009–2013**

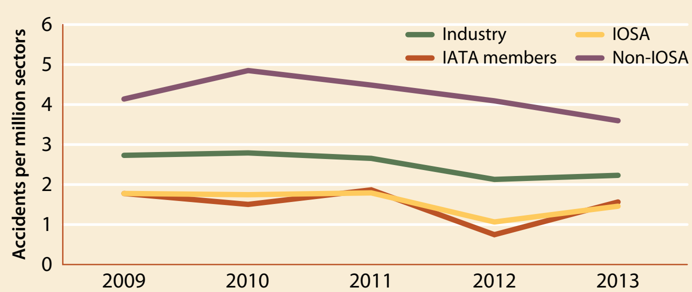



IATA = International Air Transport Association

Source: International Air Transport Association

**Figure 5**

**All Accident Rate, 2009–2013**

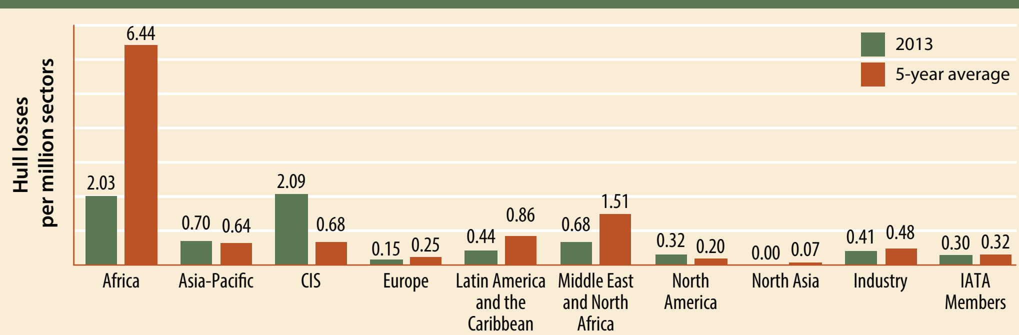



IATA = International Air Transport Association; IOSA = IATA Operational Safety Audit

Source: International Air Transport Association

**Figure 6**

**Hull Loss Rate by Region**




CIS = Commonwealth of Independent States; IATA = International Air Transport Association

Source: International Air Transport Association

**Figure 7**

# Risk Roundup

BY LINDA WERFELMAN


## BOOKS

### Managing Risk: Best Practices for Pilots

Wilson, Dale; Binnema, Gerald. Newcastle, Washington, U.S.: Aviation Supplies & Academics, 2014. 231 pp. Figures, resources, index.

This book — written, the authors say, to help pilot-readers "learn from the mistakes of others [because] you will not live long enough to make them all yourself" — is a compendium of the risks faced by anyone who flies, from new private pilots to seasoned veterans.

The authors — a professor of aviation at Central Washington University in the United States and an aviation safety consultant in British Columbia, Canada — say the book's title "captures its essence. It documents and describes most of the significant risks associated with flight."

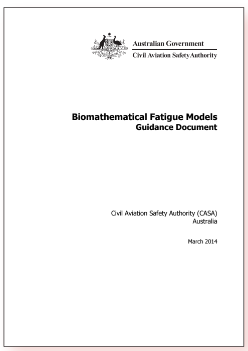
Discussions of those risks include descriptions of related accidents involving aircraft as diverse as a Cessna 172, an Embraer EMB-120 Brasilia and a Boeing 747, and specific risk-mitigation recommendations.

The 10 chapters cover runway incursions; midair collisions; icing, wind shear, inadvertent flight into instrument meteorological conditions and other weather-related issues; hypoxia; the limitations of night vision; visual illusions and spatial disorientation; and controlled flight into terrain.

Each chapter examines the nature of the hazard, as well as the conditions under which it is most likely to occur, "the human aspects that make pilots particularly vulnerable" to a particular hazard and the strategies that a pilot could use to mitigate the risk. In addition, each chapter includes a list of resources providing additional information on the subject.

Over the years, most of these risks have been "managed down to remarkably low levels," the authors say. "Rather than deny the existence of these risks … the key is to acquire a thorough knowledge of them and the strategies necessary to identify, eliminate and/or reduce them to acceptable levels. Because 'pilot error' is responsible for the majority of aircraft accidents, and because you can't treat an illness without first knowing its cause, this book is as much about identifying the internal human limitations of pilot performance as it is about identifying the nature of the external threats to safe flight."

## REPORTS


Australian Government
Civil Aviation Safety Authority

Biomathematical Fatigue Models
Guidance Document

Civil Aviation Safety Authority (CASA)
Australia

March 2014

### Biomathematical Fatigue Models Guidance Document

Civil Aviation Safety Authority (CASA) of Australia. March 2014. 73 pp. Figures, glossary, references, tables. Available from CASA at <www.casa.gov.au>.

This document, an update of CASA guidance published in 2010, discusses the application of biomathematical fatigue models as components of fatigue risk management systems (FRMS).

"The science and application of fatigue modelling continues to evolve, and … this report includes a survey of the capabilities of currently available biomathematical fatigue models and discusses important considerations regarding the incorporation of such models into an FRMS," the report says.

Biomathematical models can be used to predict crewmember fatigue levels, taking into account "a scientific understanding of the factors that contribute to fatigue," the report says. Nevertheless, biomathematical models have limitations, and these limitations must be understood to ensure that they are used appropriately.

The review begins with background information on how the guidance material was developed, including references to the regulatory context for biomathematical models, and explains the science involved in biomathematical modelling and the limitations of the models.

"Biomathematical models of fatigue essentially make the tacit assumption that changes in levels of fatigue will be paralleled by similar changes in risk, but the available evidence suggests that this may not always be the case," the report says. "It is obviously true that if an individual's level of fatigue is such that they fall asleep, the risk of failing to respond appropriately when required will be high. … However, most accidents seem to occur while the worker is awake and are linked with slow or inappropriate responses rather than a total failure to respond."

A primary limitation of biomathematical fatigue models, the report says, is that they typically are based on averages and on measures obtained from a limited number of people, and "individuals clearly differ from one another on an enormously wide range of factors, many of which may impact on their fatigue and safety performance levels."

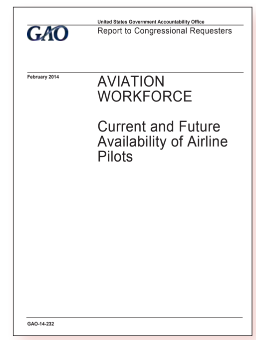
Another section of the report describes seven primary applications for biomathematical fatigue models — forward scheduling, non-scheduled/irregular operations, work/rest cycles in augmented crew, evaluation of countermeasures, individual fatigue prediction, training and safety investigation.

The document also includes a directory of the seven biomathematical models and explains their various elements "in terms of their internal structures and formulae (components), the variables that can be entered into the models (inputs) and the prediction methods or outcomes that are produced (outputs)." These elements are used in comparing the seven biomathematical models to help potential users select one model that is most suitable for them.

In addition to the report, related information is available on the fatigue page of CASA's website at <casa.gov.au/scripts/nc.dll?WCMS:STANDARD::pc=PC_90315>.

## Aviation Workforce: Current and Future Availability of Airline Pilots

GAO-14-232. U.S. General Accounting Office (GAO). Feb. 28, 2014. 61 pp. Appendixes, figures, tables. Available from GAO at <www.gao.gov/products/GAO-14-232>.


United States Government Accountability Office
GAO
Report to Congressional Requesters
February 2014
AVIATION WORKFORCE
Current and Future Availability of Airline Pilots
GAO-14-232

This report, requested by members of the U.S. Congress because of concerns that the United States might lack a sufficient supply of available and qualified pilots, said that researchers had found "mixed evidence" of any shortage.

The report cited forecasts by the aviation industry and the U.S. Bureau of Labor Statistics that indicated that between 1,900 and 4,500 new pilots will be needed each year over the next decade. Those numbers are consistent with the airlines' hiring expectations, the report said.

The report also cited, as an indication of an adequate pilot supply, earlier studies that have concluded that there are a large number of U.S. pilots working in other countries, in the military or in other occupations.

"However, whether these pilots choose to seek employment with U.S. airlines depends on the extent to which pilot job opportunities arise and on the wages and benefits airlines offer," the report said. "Another study concludes that future supply will be insufficient, absent any actions taken, largely resulting from accelerating costs of pilot education and training. Such costs deter individuals from pursuing a pilot career."

Researchers found that pilot schools had fewer students entering their programs and attributed the lower enrollment to concerns about the high cost of training and low entry-level pay at regional airlines. The report said that the regional airlines complained of difficulty finding qualified entry-level first officers, in part because of a new law that raised hiring requirements for these pilots. Mainline airlines, which hire experienced pilots, have not reported similar problems.

The report concluded, "The supply pipeline is changing as fewer students enter and complete collegiate pilot-training programs and fewer military pilots are available than in the past." The document added that new pressure on pilot availability will result from "the projected number of mandatory age-related pilot retirements at mainline airlines over the next decade and beyond, the increasing demand for regional airlines to address attrition needs and the reported lower number of potentially qualified pilots in the applicant pool for filling regional airlines' first officer jobs."

If predictions of rising demand come to pass, airlines might be forced to make "considerable operational adjustments" to compensate for the pilot shortage, the report said.

Those adjustments might include "employment pathway partnerships" with pilot schools and financial and career support for new pilots as they accumulate flight time, the report said.

"With the mandate to increase pilot qualifications for airline pilots having only recently gone into effect, opportunities exist to develop new training methods and pathways for students to gain experience relevant to an airline environment," the report said. "It is unclear at this point what adjustments could occur within the pilot-training system that would help to respond to … stakeholders' concerns about the current regulations or if government action may be necessary to enable certain changes. Therefore, we encourage FAA [the U.S. Federal Aviation Administration] to continue its efforts in working with the airline and pilot training industries in considering additional ways for pilots to build quality flight time that contributes directly to working in airline operations."

# ‘Conflict of Plans’

**The captain was focused on landing the 777 and was slow to react when a caution message required a go-around.**

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

### CAT III Approach

Boeing 777-200. No damage. No injuries.

Inadequate crew coordination and monitoring of flight parameters were key factors in a serious incident that brought the 777 close to the ground during a go-around at Paris Charles de Gaulle Airport the morning of Nov. 16, 2011, according to the English translation of a report released in January by the French Bureau d’Enquêtes et d’Analyses (BEA).

At the onset of the incident, the captain had the airport in sight and was concentrating on completing a Category III (CAT III) autoland approach to a landing when a master caution activated, requiring a go-around in accordance with standard operating procedure. This resulted in a “conflict of plans of action between respecting the operator’s instruction and continuing the landing,” the report said.

The 777 was inbound to Paris from Caracas, Venezuela, and had been airborne for 10 hours. “After a long flight that arrived at 1100 in the morning (local time), this may have led to a certain loss of vigilance,” the report said. “However, the crew [later told investigators that they] did not feel tired.”

The English translation of the BEA report noted that the flight crew comprised the captain (the pilot flying), a copilot and a relief pilot but did not indicate whether there were passengers or cabin crew aboard the aircraft.

Low visibility procedures, which included increased spacing between arriving aircraft, had been in effect for several hours at de Gaulle. As the 777 neared the airport, the reported runway visual range for Runway 08R was 400 m (1/4 mi) in fog. Due to the low visibility, the captain decided to conduct an autoland approach. Accordingly, the crew requested and received radar vectors from air traffic control (ATC) for a CAT III approach to the runway.

The aircraft was on the glidepath and descending through a radio altitude of 320 ft when the master caution alarm sounded and an amber warning, “NO LAND 3,” was displayed on the engine indicating and crew alerting system. In addition, the green “LAND 3” indications on the primary flight displays changed to “LAND 2.”

The report explained that this indicated change to the aircraft's autoland system performance would not, by itself, have prevented the crew from continuing the approach to CAT II minimums, typically a 50-ft decision height rather than the 20-ft decision height of a CAT III approach. During the investigation, the aircraft manufacturer determined that under the existing conditions, the landing could have been conducted safely. However, the aircraft operator required that a go-around be conducted if any alarm or mode change occurred below 1,000 ft during a CAT III approach.

The relief pilot, who was occupying the central observer's seat, told investigators that neither the captain nor the copilot immediately reacted to the warnings, so he called out "warning." The copilot subsequently called out "go around."

By this time, however, the captain had acquired visual contact with the airport. "Having visual references and knowing that the landing was possible, his plan of action was to land," the report said. "The 'NO LAND 3' warning, making mandatory a go-around, led to confusion and to a change in his plan of action."

The captain initiated a go-around, but the procedure was only partially executed, with inadequate management of the autoflight systems, the report said. The captain inadvertently pressed the autothrottle-disconnect switch instead of the takeoff/go-around (TOGA) switch, which would have prompted an increase in thrust sufficient for a 2,000-fpm climb as well as the selection of the autopilot go-around pitch and roll modes. He then manually moved the thrust levers forward and pulled the control column back, but the control input was not sufficient to disconnect the autopilot, which was still in approach mode. The aircraft continued to descend on the glideslope.

The copilot told investigators that he was concentrating on changing the flap configuration and was not monitoring the flight parameters. The relief pilot called out "pitch attitude" twice before control inputs sufficient for a go-around were made. By this time, the captain also had disconnected the autopilot and moved the thrust levers full forward.

The 777 reached a radio height of 63 ft before beginning to climb. The crew retracted the landing gear and climbed straight out to 4,000 ft, as instructed by ATC. They subsequently set up for another CAT III approach and landed the aircraft on Runway 08R without further incident.

"This serious incident was due to the inadequate monitoring of flight parameters by the flight crew," the report concluded. "After the incident, prevention information relating to go-arounds with no TOGA selection was distributed among 777 sector pilots."

### 'Sorry About That'

Airbus A319-112, Transall C-160. No damage. No injuries.

Visual meteorological conditions (VMC) with light winds prevailed at Zweibrücken Airport in Germany the afternoon of May 14, 2008, when the A319 flight crew requested clearance to taxi from the gate. A controller who was handling ground, departure and arrival operations told the crew to taxi to Runway 03 and to line up and wait on the runway, said a report published in January by the German Federal Bureau of Aircraft Accident Investigation.

While the Airbus was taxiing out, the crew of a Transall C-160, a twin-turboprop military transport, called for taxi clearance. The crew was conducting a series of parachute drops and was using Runway 21 for takeoff because the runway was much closer to its parking area. The controller told the crew to "taxi holding point runway … correction, taxi holding point Alpha, Runway 21."

The report said that this instruction was not in strict accordance with proper ATC phraseology, but the C-160 crew correctly read back "taxi runway holding point Runway 21 via Alpha."

The Airbus was lined up and waiting on the runway about one minute later when the controller said, "A319, wind variable 1 knot, Runway 03, cleared for takeoff."

The report noted that the elevation of the 2,950-m (9,679-ft) runway is higher at the mid-point than at the thresholds; consequently, the crew of an aircraft positioned at one end of the runway has little, or no, ability to see the other end of the runway. Moreover, the tower controllers do not have an unobstructed view of the approach end of Runway 03.

As the A319 crew began the takeoff run, the controller realized that the C-160 crew was not holding on Taxiway Alpha, as instructed, but had taxied onto the runway. The controller told the C-160 crew to "hold position" and the A319 crew to "break up."

Noting that "break up" is not a phrase used in ATC communications, the report said that the controller likely meant to tell the A319 crew to "stop immediately" — that is, to reject their takeoff. The crew did not understand the "break up" instruction and asked the controller to "say again."

However, by this time, the Airbus had accelerated through $V_1$, the maximum speed at which the crew could take action to safely reject the takeoff. The crew continued the takeoff, and the A319 passed 400 ft above the C-160. There were 137 people aboard the Airbus; the C-160 had a crew of four and an unspecified number of passengers.

After seeing the Airbus pass overhead, the C-160 crew told the controller that they had been instructed to line up and wait on the runway. The controller said, "You were cleared to holding point Alpha." The crew replied, "OK, sorry about that."

## TURBOPROPS

### Ditching Follows Fuel Exhaustion

Beech King Air C90GTX. Substantial damage. No injuries.

The pilot-in-command (PIC), who had logged 2,600 of his 11,500 flight hours in 90-series King Airs, had been contracted by an air taxi operator to ferry the newly purchased airplane from Wichita, Kansas, U.S., to Willemstad, Curaçao, in the Netherlands Antilles. He was accompanied by an employee of the operator, a 3,650-hour pilot who had recently completed initial training in the airplane.

The first stop was planned for Fort Lauderdale, Florida, but strong headwinds prompted a landing in Marianna, Florida, where the King Air was refueled, said the report by the U.S. National Transportation Safety Board (NTSB).

After continuing the flight to Fort Lauderdale, the pilot requested that the nacelle fuel tanks be topped off. The PIC told investigators that he monitored the refueling, but surveillance cameras showed that the line service agent was alone when the nacelle tanks were filled.

The pilots stayed overnight in Fort Lauderdale and returned to the airport early in the morning of April 3, 2012. The PIC reviewed the fueling ticket and concluded that 134 gal (507 L) had been pumped into the nacelle tanks, bringing the total fuel load to 366 gal (1,385 L).

However, investigators found that only 25 gal (95 L) of fuel had been required to top off the nacelle tanks. The number "134" on the fueling ticket was the line service agent's employee number.

"Utilizing the information contained on the fuel ticket, it was determined that the airplane had departed with only 261 gallons [988 L] of fuel on board," the report said. "Review of performance data in the [airplane flight manual] revealed that, in order to complete the flight, the airplane would have needed to depart with 328 gallons [1,241 L] on board."

The King Air was cruising over Haiti at 27,000 ft about two hours after departure when the PIC noticed that the indicated fuel quantity was lower than expected. "However, the pilot decided to continue despite his proximity to airports on Hispaniola that were suitable for diversion," the report said. "By the time he began to be concerned about a possible fuel leak or indication failure, he was once again over open water."

The airplane was about 90 nm (49 km) from Willemstad when the PIC decided to divert to Oranjestad, Aruba, because of "very low indications" on the fuel gauges. Both engines flamed out due to fuel exhaustion shortly after the descent was begun.

Realizing that he could not reach Oranjestad, the PIC ditched the airplane in the Caribbean Sea. The pilots boarded a life raft and were rescued about 20 minutes later by the crew of a Royal Netherlands helicopter. The King Air subsequently sank.

### Pyrotechnic Paper Clip

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

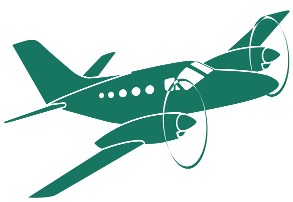
Shortly after the aircraft reached cruise altitude, 25,000 ft, during a flight from Vaasa, Finland, to Tallinn, Estonia, the morning of Nov. 28, 2011, dark blue smoke began to emerge from the aircraft communications addressing and reporting system thermal printer. The flight crew saw a red glow inside the printer.

"The pilots donned their oxygen masks, started an immediate descent and made the decision to land at Pori Airport," said the English translation of the report on the serious incident by the Safety Investigation Authority of Finland. The crew declared an emergency, reported a cockpit fire and requested and received radar vectors to Pori.

The pilots initially had difficulty donning and using their oxygen masks. "The oxygen masks hampered communication between the pilots and between the captain and the cabin crew," the report said.

The captain instructed the cabin crew to prepare the cabin and passengers for an emergency landing. The smoke was thick at first but dissipated during the approach to Pori, leaving a strong odor in the cockpit and in the front of the cabin. No portable fire extinguishers or passenger oxygen masks were used during the approach. The pilots landed the aircraft without further incident, and the seven passengers deplaned normally.

"A paper clip which showed signs of having been heated was found inside the printer," the report said. "The paper clip caused a short circuit in the printer. The smoke generation ended when the printer's circuit breaker tripped. There was no actual fire inside the printer. … Immediately after the occurrence, [the operator] banned the use of paper clips on its entire fleet."



## PISTON AIRPLANES

### Fire Erupts Near Oil Gauges

Beech 58 Baron. Destroyed. Four fatalities.

The Baron was cruising at 9,000 ft in VMC about 30 minutes after departing from Atlanta for a charter flight to Hazard, Kentucky, the afternoon of May 25, 2011, when the pilot told ATC, "We gotta declare an emergency. Got a fire."

The controller asked him to state his intentions, but there were no further radio transmissions from the pilot. The airplane rapidly descended below radar contact. "The time interval between the pilot's declaration of an emergency and the last radar return from the airplane was a little less than one minute, suggesting that the fire grew quickly, without much of an incipient stage," the NTSB report said. "These characteristics are consistent with a fuel-fed fire."

A witness saw a two-engine airplane flying about 1,500 ft above mountainous terrain before it abruptly banked right and pitched nose-down. The witness then heard an explosion.

The Baron had crashed in a wooded area near Murphy, North Carolina, killing the pilot and the three passengers. "The cockpit, cabin, instrument panel, nose compartment, empennage and inboard sections of both wings were nearly consumed by the post-crash fire," the report said.

Investigators determined that the fire most likely began underneath the instrument panel, near the direct-read oil gauges. Because of the extensive fire damage, however, NTSB was unable to form a conclusion about what caused the fire.

### Crossed Communications

Piper Navajo C. No damage. No injuries.

The Navajo pilot used the common traffic advisory frequency (CTAF) to broadcast his intention to taxi to Runway 32 for takeoff from Port Hedland Airport in Western Australia the afternoon of May 27, 2013.

About five minutes later, the crew of an aviation rescue and fire fighting (ARFF) vehicle used a portable radio to announce on the CTAF frequency that they were crossing the runway to return to the fire station.

The ARFF vehicle then entered the 2,500-m (8,203-ft) runway from a taxiway about halfway down the runway, said the report by the Australian Transport Safety Bureau.

The Navajo pilot told investigators that he made the required CTAF broadcasts as he taxied onto the approach end of the runway and began the takeoff. "The crew of the fire vehicle had not heard any CTAF broadcasts [from the Navajo pilot], nor did they see the aircraft when they scanned the runway prior to crossing, possibly due to heat haze," the report said.

The pilot had not heard the CTAF broadcasts from the ARFF vehicle. During the investigation, "Airservices Australia determined that the transmission power of the portable radios was lower than the radios mounted in the vehicle," which had not been programmed with the CTAF frequency, the report said. "The investigation also noted that a radio dead zone — an area within the range of a radio transmitter in which the signal is not received — may exist in the vicinity of the Runway 32 threshold."

After the Navajo lifted off, the pilot saw the ARFF vehicle crossing the runway. "As the aircraft was airborne, the pilot assessed the safest action was to continue the takeoff," the report said. "By the time [the aircraft] crossed the intersection [at 300 to 400 ft], the fire vehicle was clear of the runway."

## HELICOPTERS

### Helipad Known as Flight Hazard

Bell 206-L4. Substantial damage. One fatality.

The pilot was attempting to land the JetRanger on an oil-drilling platform in the Gulf of Mexico to pick up a passenger the afternoon of May 28, 2012, when the main rotor blades struck the corner of an oil derrick that was partially positioned over the helipad. The tail boom separated as the helicopter spun into the water.

The pilot — who was wearing a seat belt, shoulder harness and life vest — sustained multiple blunt-force injuries on impact and drowned when the JetRanger sank rapidly. The NTSB report said that the helicopter's emergency external floats had not inflated.

At the time, the fixed oil-drilling platform was mated to a jack-up rig, a mobile platform used for maintenance and exploratory drilling. Although a notice to airmen (NOTAM) had not been issued and there were no markings on the fixed platform's helipad, the pilot knew that this helipad was closed due to the proximity of the jack-up rig's derrick and that aviation operations were being conducted on the larger and unobstructed helipad on the jack-up rig.

"There was also nothing in the operator's flight operations manual that would have restricted the pilot from landing under an obstruction," the report said. "Other company pilots were aware that [the fixed platform] helipad was a flight hazard due to the encroachment of the [jack-up rig's] oil derrick, but it was never reported to management or via the company's internal safety notification system."

Company records showed that the pilot had flown to the platform several times and had landed on the jack-up rig two days before the accident. "It could not be determined why the pilot decided to land on the smaller and obstructed helipad rather than the jack-up rig's larger helipad," the report said, noting that several workers had tried to signal the pilot not to attempt the landing on the fixed platform.

### Rotor Snags a Power Line

Robinson R44. Destroyed. Two fatalities.

A search was begun when the R44 did not return at the expected time from an aerial tour launched from Wheatland, Missouri, U.S., the afternoon of May 24, 2013. The wreckage of the helicopter was found the next day in a densely wooded area near Cross Timbers, Missouri. The pilot and his passenger had been killed.

"A power line was found wrapped around the main rotor driveshaft, and a section of the power line was found resting on the ground leading from the power line pole to the main wreckage," the NTSB report said.

Investigators determined that the power line had been suspended about 65 ft (20 m) above the ground and was perpendicular to the helicopter's flight path. After striking the power line, the R44 had descended into trees. The helicopter was destroyed by the impact and subsequent fire.

## Preliminary Reports, February 2014

| Date | Location | Aircraft Type | Aircraft Damage | Injuries |
|---|---|---|---|---|
| Feb. 1 | Surabaya, Indonesia | Boeing 737-900 | substantial | none |
| The rear fuselage and landing gear were substantially damaged when the 737 touched down hard and bounced several times on landing. | | | | |
| Feb. 2 | Fort Lauderdale, Florida, U.S. | Learjet 35A | none | 1 serious, 2 none |
| A line service agent was seriously injured when the Learjet inadvertently moved forward while he was disconnecting a ground power unit. | | | | |
| Feb. 3 | Gauteng, South Africa | Beech King Air 90 | destroyed | 3 fatal |
| The King Air overran the runway and traveled down an embankment while landing in heavy rain. | | | | |
| Feb. 3 | Elk City, Oklahoma, U.S. | Cessna 525 CitationJet | substantial | 7 none |
| The ceiling was broken at 200 ft and visibility was 1 3/4 mi (2,800 m) in light freezing rain when the CitationJet struck an electric utility pole, damaging the fuselage and horizontal stabilizer, about 2 nm (4 km) north of the airport during a night instrument approach to Runway 17. The pilot conducted a go-around and landed without further incident in Oklahoma City. | | | | |
| Feb. 3 | Bellevue, Tennessee, U.S. | Gulfstream 690C | destroyed | 4 fatal |
| The pilot was conducting a second global positioning system (GPS) approach when the Commander veered left and descended into trees. Visibility was 5 mi (8 km), and the ceiling was overcast at 800 ft. | | | | |
| Feb. 8 | Panacea, Florida, U.S. | Robinson R44 | substantial | 2 fatal, 1 serious |
| Night visual meteorological conditions (VMC) prevailed when the R44 struck trees on takeoff and descended into a marsh. | | | | |
| Feb. 11 | Aïn Kercha, Algeria | Lockheed C-130H | destroyed | 76 fatal, 1 serious |
| The C-130 was transporting families of Algerian military personnel to Constantine when it struck a mountain about 30 km (16 nm) south of the airport. | | | | |
| Feb. 12 | Moscow | Hawker 700B | substantial | 2 none |
| The flight crew landed the Hawker on a foamed runway after they were unable to extend the right main landing gear. | | | | |
| Feb. 15 | Bragança, Brazil | Robinson R44 | destroyed | 2 fatal |
| Rain was reported in the area when the R44 crashed in a forest during a night flight. | | | | |
| Feb. 16 | Sandhikharka, Nepal | de Havilland Canada DHC-6-300 | destroyed | 18 fatal |
| Freezing rain was reported in the area where the Twin Otter struck terrain at 7,000 ft during a scheduled flight from Pokhara to Jumla. | | | | |
| Feb. 17 | Funchal, Portugal | Boeing 737-800 | substantial | 182 none |
| A tail strike occurred when the 737 encountered wind shear during approach, touched down hard and bounced. | | | | |
| Feb. 17 | Rubkona, South Sudan | British Aerospace 748 | destroyed | 1 fatal, 3 serious |
| The aircraft was conducting a United Nations humanitarian fight when it veered off the runway on landing and struck vehicles. | | | | |
| Feb. 17 | Billings, Montana, U.S. | Boeing 737-700 | minor | 2 serious, 9 minor, 108 none |
| The 737 encountered severe clear air turbulence at 34,000 ft during a flight to Billings from Denver. | | | | |
| Feb. 18 | Rio de Janeiro, Brazil | Robinson R22 | destroyed | 2 fatal |
| The helicopter crashed in water during a local training flight. | | | | |
| Feb. 19 | Pearland, Texas, U.S. | Beech King Air B100 | destroyed | 1 fatal |
| Visibility was 5 mi (8 km) in mist and the ceiling was overcast at 300 ft when the King Air struck terrain during a go-around from a circling GPS approach. | | | | |
| Feb. 21 | Grombalia, Tunisia | Antonov 26 | destroyed | 11 fatal |
| The aircraft struck terrain about 33 km (18 nm) from the airport after the pilot reported engine problems during a night medevac flight to Tunis. | | | | |
| Feb. 25 | Lukapa, Angola | Embraer Brasilia | substantial | 3 minor, 14 none |
| The flight crew diverted to Lukapa after encountering engine problems during a charter flight from Luanda to Dundo. The Brasilia veered off the runway during a single-engine landing. | | | | |
| Feb. 26 | Lanai City, Hawaii, U.S. | Piper Chieftain | substantial | 3 fatal, 3 serious |
| Night VMC prevailed when the Chieftain struck terrain shortly after departing on a charter flight. | | | | |

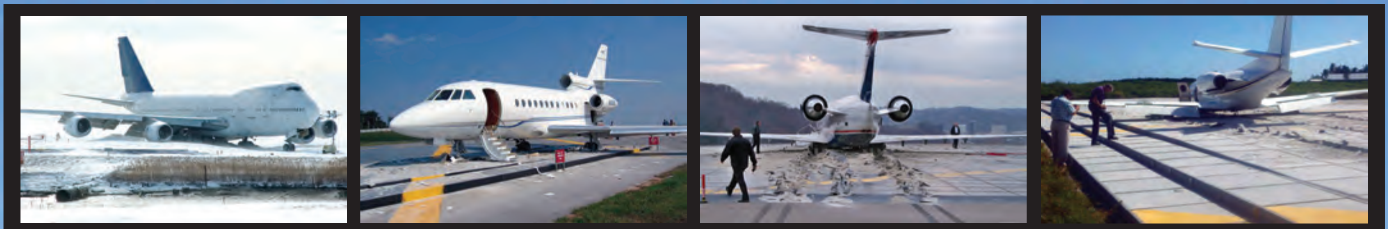
This information, gathered from various government and media sources, is subject to change as the investigations of the accidents and incidents are completed.

# No RESA? No Problem, with EMASMAX®

Maximizing Runway Safety

## According to ICAO's updated Annex 14 Aerodromes standard:

- EMAS/arresting systems, such as EMASMAX, are now officially accepted as an Alternative Means of Compliance to a RESA
- EMAS/arresting systems are permitted to be installed within the runway strip, a critical factor when RESAs are non-existent or severely constrained



B-747, 2005 JFK, NY | Falcon 900, 2006 Greenville, SC | CRJ 200, 2010 Charleston, WV | Citation 550, 2011 Key West, FL

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

## EMASMAX Provides Safety at Over 80 Airport Runways Worldwide.

- Proven reliability • Predictable performance • Safe and effective • 9 saves in 9 attempts

2239 High Hill Road, Logan Township, NJ 08085 ▪ Tel: 856-241-8620 ▪ Email: emasmax@zodiacaerospace.com ▪ www.emasmax.com

Background photo: Kjevik Airport, Kristiansand, Norway, courtesy of AVINOR



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