FLIGHT SAFETY FOUNDATION

AeroSafety WORLD

FACING THE ISSUES
BARS Audits Pinpoint Weaknesses

ADVANCING AWARENESS
Updating AOA Displays

GOING ROGUE
The Intentional Crash Phenomenon

UNHEEDED WARNINGS
ICE-INDUCED STALL DOWNS PHENOM

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

SEPTEMBER 2016

Coming Soon

Later this fall, we will be launching a new Flight Safety Foundation website <flightsafety.org> that incorporates the best of *AeroSafety World* in a redesigned format for internet-only distribution to each reader's preferred digital device. This will better serve our members and more effectively disseminate aviation safety news and knowledge around the world.

Months of work involving just about everyone here at the Foundation, as well as several outside partners, have gone into the planning and development of this new initiative. The work was not entered into lightly; to keep pace with an ever-changing industry, we carefully planned how best to create a more flexible, user-friendly and responsive digital communication platform with which to support our members and the aviation industry.

Research has shown that media content like ours increasingly is being consumed on mobile devices, such as tablets and smartphones. In fact, because of this preference, mobile-device traffic in 2016 accounts for at least half of all internet traffic. Our new website will enable webpages, including *ASW* articles, to display correctly and optimally regardless of the type and size of the device used to access our website.

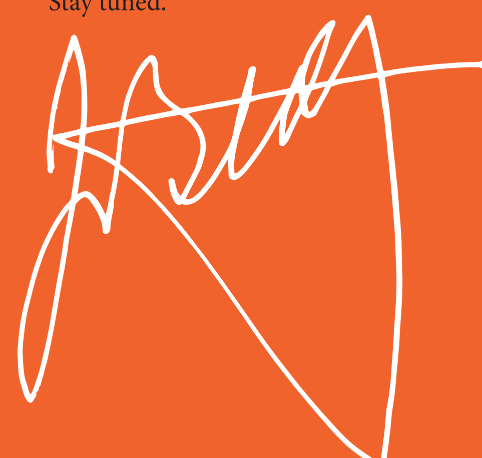
We understand that time is critical in today's fast-paced operating environment, and that safety professionals don't want to be scouring the internet for useable news and information. With that in mind, our new website also will feature a federated search engine that will enable users to simultaneously find and retrieve their query results from the latest content, digital archives of the Foundation, our Basic Aviation Risk Standard program and our Global Safety Information Project website <fsfgsip.org> — as well from Eurocontrol's SKYbrary website <skybrary.aero> and from the Aviation Safety Network website <aviation-safety.net>. Our editors and technical staff also will be curating relevant safety content from around the world on a daily basis and delivering it to you in the new site's Industry Updates section.

AeroSafety World will have its own dedicated pages, as noted, for content in the new design, and will offer easy access to all past *ASW* issues and legacy publications in Adobe PDF format, as always. In addition, we are planning late in the year to roll out an *ASW* app that runs on today's most popular devices, which will make it easier for aircraft crewmembers and other readers who are not always connected to the internet to download issues of the magazine and to read them whenever it's safe and convenient.

The website also will be linked to our new membership database. A single sign-on will get FSF members immediate access to all of our latest content and member-focused communication, plus tools to renew their membership and to more easily register for our industry-leading safety summits and seminars.

There is not enough space in this brief message to go into detail on all of the new website features or to explain the thinking behind all the decisions made during development. Our purpose, however, is simple and unchanged: to provide impartial, independent, expert safety guidance and resources for the aviation and aerospace industry.

Stay tuned.



Jon L. Beatty
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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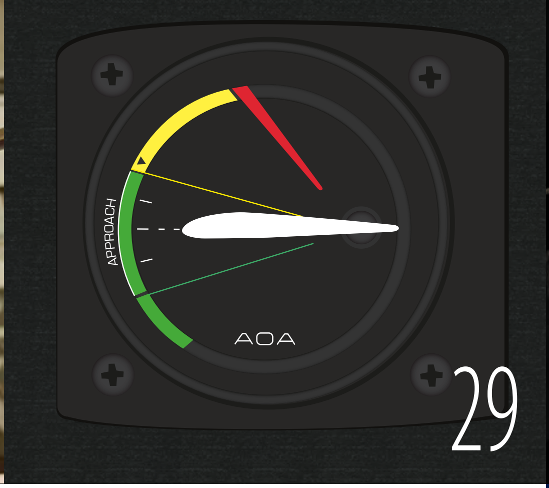

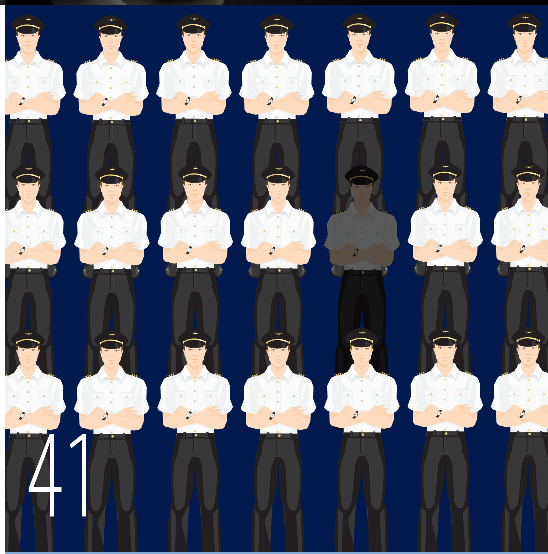

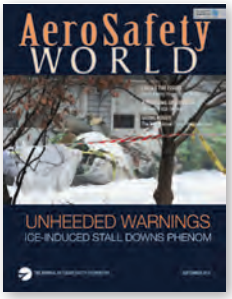

About the Cover
The wreckage of an Embraer Phenom lies near a house that it struck in Gaithersburg, Maryland, U.S.
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Share Your Knowledge

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 Editor-In-Chief Frank Jackman, 701 N. Fairfax St., Suite 250, Alexandria, VA 22314-2058 USA or jackman@flightsafety.org.

The publications staff reserves the right to edit all submissions for publication. Copyright must be transferred to the Foundation for a contribution to be published, and payment is made to the author upon publication.

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Clamp Down

Risk mitigation is necessarily a cooperative activity. It takes stakeholders from across the aviation industry doing their parts individually and in coordination with others to create the effective layers of mitigations that keep crews and passengers safe flight after flight, year after year. Organizations outside of aviation have an important role to play, too, and sometimes that role is to enforce standards and regulations that already are on the books.

Recently, the International Air Transport Association (IATA) and trade associations representing leaders of the lithium battery supply chain released a joint statement demanding stricter enforcement of international regulations regarding the transport of lithium batteries (see “Safety News,”4 p. 9). The call for stricter enforcement of regulations was aimed at ministers of trade, industry and transport and directors of civil aviation in the world's largest lithium battery manufacturing and export countries.

According to IATA Director General and CEO Tony Tyler, the rules that airlines, shippers and manufacturers have worked to establish to ensure that lithium batteries can be carried safely are only effective if they are enforced and backed up by significant penalties. “Government authorities must step up and take responsibility for regulating rogue producers and exporters. And flagrant abuses of dangerous goods shipping regulations, which place aircraft and passenger safety at risk, must be criminalized,” Tyler said.

Other interested parties should take a cue from IATA and the battery supply chain and pressure governments to take action against rogue battery manufacturers and shippers. According to IATA, lack of enforcement is increasing pressure on airlines and regulators to unilaterally ban all forms of lithium battery shipments from aircraft, which, in turn, could drive rogue manufacturers and shippers to increasingly mislabel battery shipments.

The safe shipment of lithium batteries and other dangerous goods requires transparency and adherence to the rules by manufacturers, shippers and all other involved stakeholders. Anything less could jeopardize safety.

Frank Jackman
Editor-in-Chief, ASW
Flight Safety Foundation

Serving Aviation Safety Interests for Nearly 70 Years

Since 1947, Flight Safety Foundation has helped save lives around the world. The Foundation is an international nonprofit 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.

MemberGuide

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Flight Simulation Training Devices

Responding to questions from AeroSafety World *during editorial research and to the article "Brave New World" (*ASW*, 7-8/16, p. 29) about flight simulation training devices, the U.S. Federal Aviation Administration (FAA) sent the following statement.*

After years of research and collaboration with aviation industry experts, the FAA published these new rules and guidance. The FAA is further emphasizing the expectations of the regulations through the training of inspectors and working directly with stakeholders as they develop their programs. Implementation will be progressive from now until 2019, as the FAA has begun to evaluate simulators and training programs put forth by early adopters. FAA guidance in the form of Advisory Circular (AC) 120-109A ["Stall Prevention and Recovery Training"] and AC 120-111 ["Upset Prevention and Recovery Training"] describe in detail the requirements that are set forth in the FAA regulations and the expectations for delivery of stall and upset prevention and recovery training (UPRT). The regulations for 2019 require that instructors must be satisfactorily trained to teach UPRT, and FAA guidance is explicit on what must be covered in that training.

Adoption of International Civil Aviation Organization [ICAO] Doc 9625 [*Manual of Criteria for the Qualification of Flight Simulation Training Devices,* Edition 3 and Edition 4] should not be used as an indicator of implementation of UPRT, as its focus is simulator evaluation standards, not training standards. The FAA is pleased to see so many U.S. airlines that are both developing their training programs and updating their full flight simulators before they are required to do so. That is the best indicator. Before the required 2019 start of UPRT in the United States, the FAA has witnessed wholesale changes in stall prevention training, which is important, as stall is the No. 1 cause of loss of control fatalities.

Those changes include better prevention strategies, recoveries from stall warnings at cruise altitudes, and the new focus on reducing the angle-of-attack to recover from a stall warning. Many U.S. airlines also perform upset recovery training now from non-stalled conditions and are paying closer attention to the challenges of delivering that training. These are a couple of key examples of how the training is changing. The FAA will begin measuring mastery of the issues involved in loss of control when the required training begins in 2019. As far as concern about sufficient qualified UPRT instructors, the FAA will remain vigilant, but it is encouraged by the steps being taken by many of the operators now to train their trainers.

The draft *ICATEE Research and Technology Report* [by the International Committee for Aviation Training in Extended Envelopes] served as a useful foundation for the development of FAA rules and guidance. This draft was approved by the Royal Aeronautical Society for publication in 2014. Then, on reflection, it was decided that it would be best to take advantage of what was learned with respect to UPRT in the creation of both Edition 4 of ICAO Doc 9625 and [U.S. Federal Aviation Regulations] Part 60 [*Flight Simulation Training Device Qualification Standards for Extended Envelope and Adverse Weather Event Training Tasks*]. Legally, it was not possible to do that until the March 2016 publication of Part 60. Now it is possible to make those refinements to the ICATEE document for consistency prior to its publication.

As research is ongoing on airplane state awareness and related technological advances, it is too early to tell what value the results may have. The FAA is hopeful that the results can tangibly reduce the loss of control accident rate even further beyond the full stall and upset training it is requiring in 2019.

U.S. Federal Aviation Administration

SEPTEMBER 7–8 ➤ Asia Pacific Aviation Safety Seminar. Association of Asia Pacific Airlines (AAPA). Tokyo. <aapairlines.org/Asia_Pacific_Aviation_Safety_Seminar.aspx>.

SEPTEMBER 12 ➤ Advancing Business Aviation in Southern California. Southern California Aviation Association. Carlsbad, California, U.S. <socalaviation.org>.

SEPTEMBER 14–15 ➤ IATA Crisis Communications Conference. International Air Transport Association (IATA). Hong Kong. <iata.org/events/Pages/crisis-comms-conference.aspx>.

SEPTEMBER 19–20 ➤ Barrier-Based Risk Management Network Event. CGE Risk Management Solutions. Amsterdam. <cgerisk.com/networkevent2016>.

SEPTEMBER 25 ➤ AACO 77th Executive Committee Meeting. Arab Air Carriers' Organization (AACO). Dubai, United Arab Emirates. <aaco.org>.

SEPTEMBER 26 ➤ ICAO World Aviation Forum. International Civil Aviation Organization. Montreal. <icao.int>.

SEPTEMBER 26–28 ➤ Air Medical Transport Conference. The Association of Air Medical Services. Charlotte, North Carolina, U.S. <aams.org/events/amtc/>.

SEPTEMBER 26–30 ➤ 67th International Astronautical Congress. International Astronautical Federation. Guadalajara, Mexico. <iac2016.org>.

SEPTEMBER 27–OCTOBER 7 ➤ ICAO 39th Triennial Assembly. International Civil Aviation Organization. Montreal. <icao.int/Meetings/a39/Pages/default.aspx>.

OCTOBER 3–4 ➤ USI 2016 Conference. Umanned Systems Institute (USI). San Francisco. <unmannedsystemsinstitute.com/sanfrancisco/>.

OCTOBER 5–7 ➤ BowTie Barrier-Based Training. TAG Bologna. Bologna, Italy. <sms@mys.it>. <mycs.it/bologna.htm>.

OCTOBER 11–12 ➤ 6th Lithium Battery Workshop. International Air Transport Association. Brussels. <lbworkshop@iata.org>, <iata.org/events/Pages/lb-workshop.aspx>.

OCTOBER 11–13 ➤ Helitech International Helicopter Expo and Conference. European Helicopter Association. Amsterdam. <helitechevents.com>.

OCTOBER 11–13 ➤ ERA General Assembly. European Regions Airline Association. Madrid. <eraa.org/events/era-general-assembly-2016>.

OCTOBER 12–13 ➤ Air Ops Europe. European Business Aviation Association. Cannes, France. <airopseurope.aero>.

OCTOBER 16–19 ➤ ATCA 61st Annual Air Traffic Control Conference and Exposition. Air Traffic Control Association (ATCA). National Harbor, Maryland, U.S. <atca.org/61annual>.

OCTOBER 17–20 ➤ ISASI 2016. International Society of Air Safety Investigators. Reykjavik, Iceland. <esasi.eu/isasi-2016>.

OCTOBER 24–27 ➤ Eighth Triennial International Aircraft Fire and Cabin Safety Research Conference. U.S. Cabin Safety Research Technical Group. Atlantic City, New Jersey, U.S. <fire.tc.faa.gov>.

OCTOBER 25–27 ➤ 2016 Rotorcraft Safety Conference. U.S. Federal Aviation Administration. Hurst, Texas, U.S. <eugene.trainor@faa.gov, <faahelisafety.org/>.

OCTOBER 31–NOVEMBER 2 ➤ SAFE Association 54th Annual Symposium. Dayton, Ohio, U.S. SAFE Association. <safe@peak.org>. <safeassociation.org>.

NOVEMBER 1–3 ➤ NBAA's Business Aviation Convention and Exhibition (NBAA-BACE). National Business Aviation Association. Orlando, Florida, U.S. <nbaa.org/events/bace/2016/>.

NOVEMBER 3–4 ➤ International Cross-Industry Safety Conference. Aviation Academy of the Amsterdam University of Applied Sciences. Amsterdam. <amsterdamuas.com/aviation/events>.

NOVEMBER 6–11 ➤ CANSO Global ATM Safety Conference 2016. Civil Air Navigation Service Organisation. Budapest, Hungary. <canso.org/canso-global-atm-safety-conference-2016>.

NOVEMBER 14–16 ➤ 69th annual International Air Safety Summit (IASS 2016). Flight Safety Foundation. Dubai, United Arab Emirates. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

NOVEMBER 24–25 ➤ 5th annual Safety in African Aviation (SiAA) Conference. AviAssist. Livingston, Zambia. <2gether4safety.org>.

NOVEMBER 28–30 ➤ AACO 49th Annual General Meeting. Arab Air Carriers Organization. Casablanca, Morocco. <aaco.org/events/aaco/aaco-49th-agm>.

NOVEMBER 29–30 ➤ Investigating Human Fatigue Factors. Clinton Marquardt. Toronto. <sleepanddreams.com>.

DECEMBER 5–9 ➤ ICAO Air Services Negotiation Event (ICAN2016). International Civil Aviation Organization (ICAO). Nassau, Bahamas. <icao.int/Meetings/ICAN2016/Pages/default.aspx>.

MARCH 6–9 ➤ HAI Heli-Expo. Helicopter Association International (HAI). Dallas. <heliexpo.rotor.org>.

MARCH 28–30 ➤ 3rd annual Singapore Aviation Safety Seminar (SASS) 2017. Flight Safety Foundation and Singapore Aviation Academy. Singapore. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

MAY 4–5 ➤ 62nd annual Business Aviation Safety Summit (BASS) 2017. Flight Safety Foundation in partnership with the National Business Aviation Association. Phoenix. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

MAY 16–18 ➤ ICAO/ACI Wildlife Strike Hazard Reduction Symposium. International Civil Aviation Organization (ICAO) and Airports Council International (ACI). Montreal. <icao.int/Meetings/wildlife/Pages/default.aspx>.

JUNE 6–7 ➤ 2017 Safety Forum. Flight Safety Foundation, Eurocontrol and European Regions Airline Association. Brussels. <skybrary.aero>.

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, 701 N. Fairfax St., Suite 250, Alexandria, VA 22314-2058 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

Worker Shortage Presents Risks

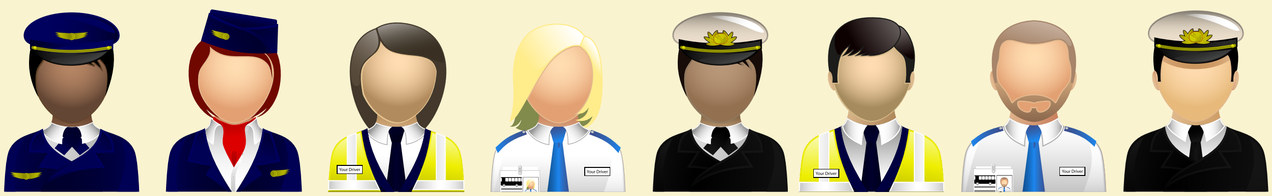
The "safe, secure and orderly expansion of international air transport" will be threatened over the next few years by global shortages of skilled human resources and training capacity, Fang Liu, secretary general of the International Civil Aviation Organization (ICAO), says.

In remarks before students at the Incheon Aviation Academy in Seoul, South Korea, in mid-August, Liu said the need for human resources development action is especially crucial in the Asia-Pacific region.

"The more than 100,000 daily flights now managed by air transport's global network will surpass 200,000 in just the next 14 years," Liu said. "It is … critical that everyone in aviation, from organizations like ICAO to airlines, airports and others do everything possible to attract more young and talented candidates."

She noted that ICAO's Next Generation of Aviation Professionals program is intended to bolster the number of skilled aviation personnel. The program was begun after ICAO began to emphasize its projections of pilot, controller and maintenance staff shortages in 2009.

"The aviation community needs to analyse future growth, determine its specific needs and collaborate on identifying, educating and retaining the next generation of skilled professionals who will help citizens and businesses benefit from the truly global connectivity which aviation provides," Liu said. "Determined collaboration amongst governments, industry, labour and educational organizations in the years ahead will be critical to ensuring that there will be enough qualified candidates to keep our network running safely, securely and efficiently."



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Reporting Runway Conditions

New standards are set to take effect Oct. 1 in the United States to reduce risks of runway overrun accidents and incidents associated with runway contamination.

The U.S. Federal Aviation Administration (FAA) says the takeoff and landing performance assessment (TALPA) standards were developed by an aviation rulemaking committee formed in the aftermath of the Dec. 8, 2005, accident in which a Southwest Airlines Boeing 737 overran a snow-contaminated runway at Midway International Airport in Chicago and skidded into motor vehicle traffic on an off-airport street. A 6-year-old boy — a passenger in a car hit by the 737 — was killed.

The committee's work resulted in a new method of communicating actual runway conditions to pilots of arriving aircraft "in terms that directly relate to the way a particular aircraft is expected to perform," the FAA said. "TALPA improves the way the aviation community assesses runway conditions, based on contaminant type and depth, which provides an aircraft operator with the effective information to anticipate airplane braking performance."

The system calls for use of a standardized analysis format to categorize runway conditions instead of the subjective judgments that have been used in the past. After receiving the runway conditions report, flight crews or dispatchers would consult manufacturer data to determine what stopping performance to expect from their aircraft, the FAA said.

Gabriel Widyna | Wikimedia CC BY 2.0

The agency added that pilot reports of braking action will continue to be provided to flight crews. However, braking action currently characterized as "fair" will be described as "medium," and reports of no braking action (NIL) will no longer be acceptable, the FAA said, noting that a NIL description of braking action on a runway or other surface will result in closure of that surface. After that surface is closed, it will not be reopened until the airport operator "is satisfied that the NIL braking condition no longer exists," the FAA said.

Cautions on Cataracts


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Pilots and aviation medical examiners should be more aware of the risks that cataracts may present to night vision, especially to night flight operations, the U.S. National Transportation Safety Board (NTSB) says.

In safety recommendations addressed to the U.S. Federal Aviation Administration (FAA) and the Aircraft Owners and Pilots Association (AOPA), the NTSB said that both the regulator and the pilots group should "develop and disseminate educational information" for pilots about a Dec. 26, 2013, general aviation accident in Fresno, California, U.S., and about "the risks cataracts may pose to flight safety."

The FAA should provide similar information for examiners, the NTSB recommended.

The recommendations said that pilots diagnosed with cataracts should consult eye care professionals for further diagnosis and treatment options.

The 2013 accident involved a Cessna 172K that struck a 62-ft (19-m) tall tree with its left wingtip and then crashed during a third attempt to land on a hazy, dark night in visual flight rules conditions, the NTSB said. The pilot and his passenger were killed.

The NTSB's final report on the accident said the pilot had been diagnosed with cataracts four years before the crash and cited as a causal factor the pilot's "continued operation of the airplane at night with a diagnosed medical condition that degraded his night vision."

Penalties Urged for Rogue Battery Shippers

Organizations representing airlines and lithium battery suppliers are calling on governments around the world to crack down on shippers that violate regulations governing air shipment of the batteries.

The International Air Transport Association said that it had been joined by The Global Shippers Forum, the International Air Cargo Association and lithium battery associations in drafting letters calling for stricter enforcement of international regulations on the transport of the batteries. The associations included PRBA – The Rechargeable Battery Association and RECHARGE, the Advanced Rechargeable and Lithium Batteries Association.


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In letters to ministers of trade, industry and transport in the world's major lithium-battery–producing countries, the signers said that lithium battery safety regulations must be enforced at the point of origin.

"Safety is aviation's top priority," IATA Director General and CEO Tony Tyler said. "Airlines, shippers and manufacturers have worked hard to establish rules that ensure lithium batteries can be carried safely. But the rules are only effective if they are enforced and backed up by significant penalties. Government authorities must step up and take responsibility for regulating rogue producers and exporters."

The letter called for cooperative enforcement initiatives among jurisdictions "to address situations where lithium batteries manufactured in one state are driven over a border to be flown from another state," IATA said, adding that such actions should be penalized by "significant fines and custodial sentences."

IATA said that governments have repeatedly been asked to address risks associated with "the willful disregard of the international regulations by rogue manufacturers and shippers and to close existing legal loopholes that prevent prosecutions of serial offenders."

Weak enforcement of international regulations has led to increased pressure on airlines and regulators to ban all forms of lithium battery shipments by aircraft, the organizations said.

"The actions of a minority threaten to undermine confidence in legitimate battery and product manufacturers," said PRBA Executive Director George Kerchner.

Upgraded Rating for Indonesia

Indonesia has been granted a Category 1 safety standards rating by the U.S. Federal Aviation Administration (FAA), signifying that the country is in compliance with safety standards set by the International Civil Aviation Organization (ICAO).

Indonesia previously held a Category 2 rating, which indicates either that a country lacks "laws or regulations necessary to oversee air carriers in accordance with minimum international standards, or [that] its civil aviation authority … [is] deficient in one or more areas, such as technical expertise, trained personnel, record keeping or inspection procedures."

Indonesia was first assigned the Category 2 rating in 2007; previously, from 1997 until 2007, it had a Category 1 rating.

The FAA said that the new Category 1 rating, issued under the FAA's International Aviation Safety Assessment (IASA) program, was based on a March 2016 assessment of safety oversight provided by the Indonesian Directorate General of Civil Aviation.

The IASA program evaluates the civil aviation authorities of countries whose air carriers operate in the United States, have applied to operate in the United States or participate in code-sharing arrangements with U.S. airlines. The purpose is to ensure that they comply with ICAO safety standards, not FAA regulations.

With a Category 1 rating, and authorization from the FAA and the U.S. Department of Transportation, a country's air carriers may fly to and from U.S. airports; without it, their operations in the United States are limited.

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New Rules on Fitness

The European Aviation Safety Agency (EASA) has proposed new rules on pilot medical fitness, including provisions to include drug and alcohol screening and mental health assessments in initial and recurrent aeromedical examinations.

EASA published the proposed rules in August as part of its response to the crash in March 2015 of Germanwings Flight 9525 (see "No Clear Pattern," p. 35, and "The Rogue Pilot Phenomenon," p. 41).

Other provisions call for improving the training and oversight of aeromedical examiners, and for all incomplete aeromedical assessments to be reported to authorities.

The proposals will be the basis of legislation to be presented later this year to the European Commission.

Issuance of the proposals nearly coincided with EASA's move to modify its recommendation, issued after the Germanwings crash, to have two crewmembers in the cockpit at all times. EASA Safety Information Bulletin (SIB) 2016-09 now recommends that "first, a risk assessment is performed, and then, based on the results of the assessment, the operator may decide to maintain the 'two-persons-in-the-cockpit' procedure as one possible mitigating measure."

The SIB says that when conducting the risk assessments, operators should consider the psychological and security screening of the flight crew, among other factors.

In Other News …

The U.S. Federal Aviation Administration says it is opening a new Air Transportation Center of Excellence for Technical Training and Human Performance to conduct research and development on **technical training** for air traffic controllers, aviation safety inspectors, engineers, pilots and technicians. Teams from the University of Oklahoma and Embry-Riddle Aeronautical University will lead the effort. … Transport Canada says it has begun a series of **safety-related improvements** at 13 regional airports across the country. Projects include rehabilitation of runways, taxiways and aprons; improvements in lighting and electrical systems; and purchase of aircraft rescue and fire fighting vehicles.

Compiled and edited by Linda Werfelman.

Too Low to Recover

BY MARK LACAGNINA

An ice-induced stall sent a Phenom hurtling into houses near the approach end of the runway.

According to the investigators, the warning signs were there. Airframe icing was imminent, and the airplane needed to be protected. But the warning signs were not heeded, and the protection was not provided. Moreover, the airspeeds used by the pilot during the final stages of the nonprecision approach were too slow for the existing conditions.

The subsequent ice-induced stall occurred at an altitude too low to permit recovery. The Embraer EMB-500 Phenom 100 descended out of control and struck three houses near the approach end of the runway at Montgomery County Airpark in Gaithersburg, Maryland, U.S. Three people in one of the houses were killed, as were the pilot and his two passengers. The airplane was destroyed by the impact and post-impact fire.

The accident occurred the morning of Dec. 8, 2014. The investigation by the U.S. National Transportation Safety Board (NTSB) concluded

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that the probable cause was "the pilot's conduct of an approach in structural icing conditions without turning on the airplane's wing and horizontal stabilizer deice system, leading to ice accumulation on those surfaces, and without using the appropriate landing performance speeds for the weather conditions and airplane weight."

Based on the findings of the investigation, the NTSB called for the development of equipment for single-pilot jets that warns the pilots when the ice-protection systems should be activated. The safety board also recommended the development of training beyond what is currently required to pass a type rating check ride in such airplanes.

Slow Progress

The pilot, 66, was a physician and chief executive officer of a clinical research company. He held an airline transport pilot certificate and an EMB-500 type rating, which he had received about seven months before the accident.

The pilot had about 4,737 flight hours, including 136 hours in the EMB-500, 1,500 hours in Socata TBM-700s and 60 hours in an Aero Vodochody L-39C, a former Czech fighter-trainer.

The NTSB accident report noted that the pilot had been involved in a previous accident while landing a TBM-700 at Gaithersburg. That accident occurred on March 1, 2010, during an attempted go-around following loss of directional control after touchdown.[1] The single-turboprop climbed about 10 ft before descending in a left turn and striking trees. Damage was substantial, but the pilot, who was alone in the airplane, was not hurt. The NTSB concluded that the probable cause of the accident was "the pilot's failure to maintain aircraft control while performing a go-around."

After the 2010 accident, the pilot successfully completed a certificate re-examination by the U.S. Federal Aviation Administration (FAA) that comprised a one-hour oral examination and a one-hour flight examination that included instrument approaches, missed approaches and landings.

"FAA records also indicated that the pilot received an enforcement action for violating a temporary flight restriction on August 18, 2011," the report said.

He had received training in the EMB-500 at two different facilities. "The company instructor who initially conducted the pilot's transition training in the EMB-500 characterized the pilot as highly motivated, very intelligent and possessing a strong aptitude for memorization," the report said.

"He stated, however, that the pilot had difficulty with planning and workload management, and sometimes became 'task saturated,' freezing up or fixating on a subtask at the expense of other critical subtasks. He said that, as a result, the pilot's training progress was slow."

Photos: U.S. National Transportation Safety Board

'Significant Weaknesses'

The pilot had requested an abbreviated transition training course in the EMB-500, but the instructor had convinced him that, based on his experience, a full course was required.

"However, after the pilot completed the [full] course, the instructor did not believe that he met the required standards to obtain a type rating in the EMB-500 and advised the pilot to receive more training," the report said.

The pilot subsequently received 24 additional hours of flight instruction at another training facility before receiving his type rating.

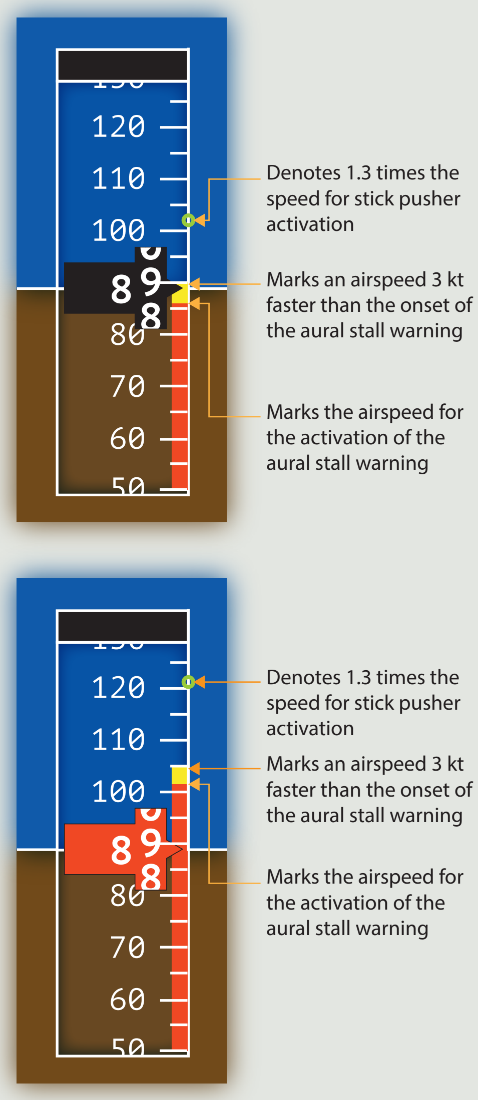
"Although his instructors said that he was proficient by the time he passed his check ride and that all of the required special emphasis areas were addressed in some manner, evidence from the flight before the accident flight — as well as errors made by the pilot during the accident flight — revealed significant weaknesses in his capabilities," the report said.

During the flight before the accident flight, data captured by the airplane's cockpit voice and data recorder (CVDR) "showed that the pilot had problems managing altitude during arrival," the report said. The airplane initially flew over the airport 5,400 ft above ground level (AGL), descended to 1,000 ft AGL on an extended straight-in approach and then climbed to 1,500 AGL before descending to the runway.

"The pilot also attempted to set flaps 2 on final without lowering the gear (which was out of sequence) and received a 'landing gear' aural warning as a result," the report said.

The report also noted that the pilot's records showed that he had flown the Phenom only about seven hours in each of the two months preceding the accident.

EMB-520 Airspeed Display



Notes: The top display shows stall-warning indications similar to what the accident pilot saw. The bottom display shows indications appropriate for icing conditions, which would have been presented if the ice-protection system had been activated.

Source: U.S. National Transportation Safety Board

Figure 1

'Bit of a Hurry'

The accident flight was intended to transport the pilot and two passengers from Horace Williams Airport in Chapel Hill, North Carolina, to Gaithersburg for a business meeting. That morning, the pilot called a line service facility at the Chapel Hill airport to advise that he would be departing at 0930 local time.

The line service technician who helped the pilot pull the Phenom from its hangar told investigators that the pilot "was 'in a bit of a hurry' but did not appear to be careless," the report said.

However, other factors led investigators to conclude that "the pilot's actions before takeoff for the accident flight were consistent with non-compliance with standard operating procedures."

Elapsed time from start of the first engine to takeoff was six minutes, "which left the pilot little time to perform the procedures for the Power Up, Before Start, Engine Start (for the second engine) and After Engine Start checklists," the report said.

CVDR data indicated that one item neglected on the Before Takeoff checklist was an airplane-configuration check. The CVDR did not record an aural annunciation of "takeoff OK," which confirms that the flaps and pitch trim are set properly for takeoff, and the parking brake is not engaged. The annunciation is generated when the pilot presses the "T/O CONFIG" button on the center console.

Unheeded Warnings

The airplane departed from Chapel Hill at about 0945 local time. CVDR data indicated that the Phenom encountered instrument meteorological conditions about 15 minutes after takeoff.

The pilot manually activated the engine anti-ice system, which routes bleed air to the inlet cowls, and the wing and horizontal stabilizer deice system, which comprises pneumatic boots on the leading edges. The systems were deactivated about two minutes later and remained off for the duration of the flight.

The airplane was cruising at Flight Level (FL) 230 (approximately 23,000 ft) when the pilot received the Gaithersburg automated weather observing system (AWOS) broadcast, which indicated that surface winds were from 070 degrees at

U.S. National Transportation Safety Board

2 kt, visibility was greater than 10 mi (16 km) and that there were a few clouds at 2,300 ft and an overcast ceiling at 2,800 ft. Temperature was minus 1 degree C (30 degrees F) and the dew point was minus 9 degrees C (16 degrees F).

The report said that the AWOS broadcast, as well as several pilot reports of structural icing, indicated that icing conditions could be expected during the descent and approach to Gaithersburg.

"Based on the AWOS-reported weather conditions, the pilot should have performed the Descent checklist items that appeared in the Normal Icing Conditions checklist, which included turning on the engine anti-ice and wing and horizontal stabilizer deice systems," the report said. "That action, in turn, would require the pilot to use landing distance performance data that take into account the deice system's activation."

The performance data called for the use of a landing reference speed of 121 kt with the deice system activated and at the airplane's landing weight.

"CVDR data show that, before beginning the descent, the pilot set the landing reference (V_{REF}) speed at 92 knots, indicating that he used performance data for operation with the wing and horizontal stabilizer deice system turned off and an airplane landing weight less than the airplane's actual weight," the report said.

'In and Out of Clouds'

The pilot began the descent from FL 230 at 1011. After establishing radio contact with Potomac Approach Control about 10 minutes later, he advised that he had the current weather observation at Gaithersburg.

The airport is uncontrolled and has a single, 4,202-ft (1,281-m) runway. It has one straight-in global positioning system (GPS) approach, a circling GPS approach and a VOR (VHF omnidirectional radio) approach.

The pilot requested, and received, clearance to conduct the straight-in GPS approach to Runway 14.

Because of a temperature inversion, the airplane encountered colder air during the descent. Total air temperature (TAT) was 12 degrees C (54 degrees F) above 6,000 ft but then decreased below 5 degrees C (41 degrees F).[2] TAT remained below 5 degrees C for the duration of the flight.

Investigators determined that the airplane encountered icing conditions for at least 15 minutes during the descent and approach to Gaithersburg.

At 1031, the approach controller told the pilot to cross an intermediate fix 11.3 nm (20.9 km) from the runway at 3,000 ft and cleared him to conduct the GPS approach.

Shortly thereafter, a pilot on the ground at Gaithersburg used the common traffic advisory frequency (CTAF) to ask the pilot if there was "any precip out there." The pilot replied, "We're kind of in and out of the clouds here at three thousand."

Loss of Control

The airplane was 5.5 nm (10.2 km) from the runway, with an indicated airspeed of 140 kt, when the pilot selected approach flaps. Airspeed subsequently began to slowly decrease.

The pilot told the right-seat passenger, "Your job is to find the airport. Just look straight ahead and say airport in sight." Shortly thereafter, the passenger said "snow," and the pilot replied, "Wow, there's snow."

At 1040, the passenger told the pilot that he had the airport in sight. The pilot confirmed the observation, selected full flaps and announced on the CTAF that the airplane was 3 nm (6 km) from the runway.

At this point, airspeed was decreasing below 115 kt as the autopilot increased pitch to maintain the GPS glide path. Airspeed had decreased to 92 kt at 1041:33 when the pilot increased power, which momentarily arrested the deceleration. However, as the pitch attitude and angle-of-attack (AOA) continued to increase, deceleration resumed.

"Because the deice system was not activated by the pilot before landing, the band indications (low speed awareness) on the airspeed display did not appropriately indicate the stall warning speed," the report said.

"There would have been sufficient warning of an aerodynamic stall had

U.S. National Transportation Safety Board

The NTSB investigation led to a recommendation for better training in winter-weather operations for pilots of very light jets like the EMB-500.

the wing and horizontal stabilizer deice system been used during the approach."

The report explained that when the wing and horizontal stabilizer deice system is activated, an aural stall warning is generated when AOA reaches 9.5 degrees, and the stick-pusher activates at 15.5 degrees. When the deice system is not selected, the stall warning horn sounds at an AOA of 21 degrees, and the stick-pusher activates at 28.4 degrees.

The Phenom's AOA reached 9.5 degrees about 20 seconds before the pilot lost control of the airplane.

The airplane was still on autopilot at 840 ft (300 ft above field elevation) when it began to roll left and right. Airspeed was 88 kt and AOA was 21 degrees when the stall warning sounded and the autopilot disengaged at 1041:35. The aural stall warning continued, but there was no indication that the stick-pusher activated.

"Once the airplane stalled, its altitude was too low to recover," the report said, noting that 300 to 500 ft of height typically is lost during a stall recovery in the Phenom.

Several large roll oscillations occurred before the airplane struck the three houses and the ground 900 ft (274 m) left of the extended centerline and about 4,000 ft (1,220 m) from the approach end of the runway at 1041:55.

Fire engulfed the airplane and one of the houses. The three occupants of the house on fire died of smoke inhalation; the pilot and his two passengers sustained multiple fatal impact injuries.

Awareness and Training

Based on the findings of the investigation, the NTSB recommended that the FAA and the General Aviation Manufacturers Association "work together to develop a system that can automatically alert pilots when the ice protection systems should be activated on turbofan airplanes that require a type rating and are certified for single-pilot operations and flight in icing conditions."

"In a single-pilot operation, no additional crewmember is present to help detect an error of omission," the report said. "Because pilots who may have neglected to activate the ice protection systems per procedures would receive a reminder of the need to do so, the NTSB believes that the benefit of active alerting to support the safe operation of this group of airplanes in icing conditions outweighs any potential drawbacks related to pilot overreliance on such prompting."

Citing ongoing work by the National Business Aviation Association to improve the safety of very-light-jet operations, the NTSB recommended that the association lead an effort to develop "enhanced pilot training guidelines pertaining to risk management in winter weather operations, including the use of ice protection systems and adherence to checklist, with special emphasis given to deficiencies in pilot performance identified in this accident, and make the results of this effort available to the community of pilots who fly these airplanes."

This article is based on U.S. National Transportation Safety Board Accident Report NTSB/AAR-16/01, "Aerodynamic Stall and Loss of Control During Approach, Embraer EMB-500, N100EQ, Gaithersburg, Maryland, December 8, 2014." The report is available at <ntsb.gov>.

Notes

1. NTSB accident report ERA10CA155.
2. Total air temperature, also called stagnation temperature and free stream air temperature, is warmer than outside air temperature due to compression heating. TAT is shown on the pilot's primary flight display in the EMB-500.

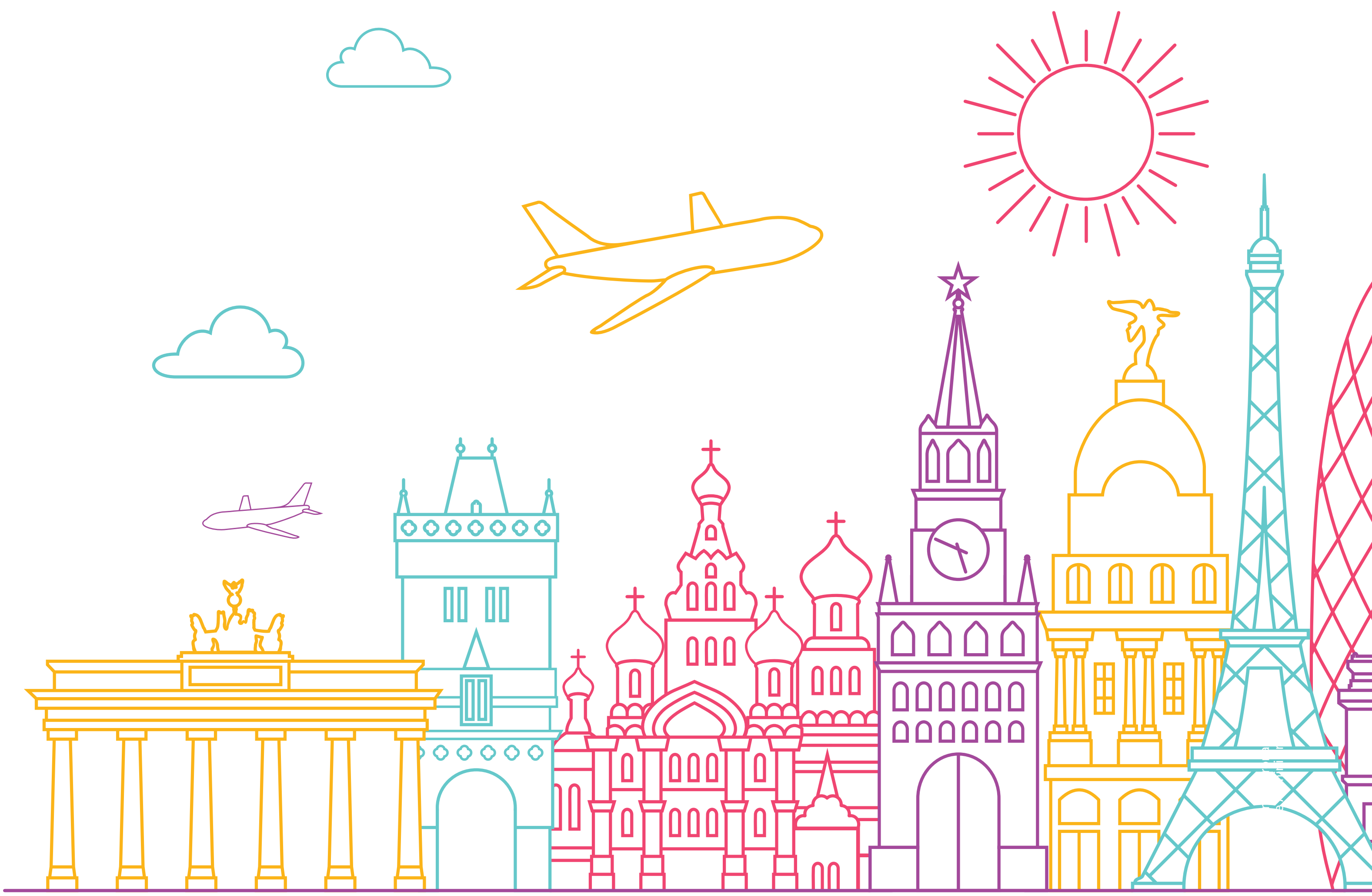
However else European nations may or may not unite, their collaboration in pursuit of civil aviation safety yields practices valuable for non-Europeans to study. A review of representative documents by *AeroSafety World* found that on the whole, the documents reflect openness and candor about significant challenges, successes and failures — along with strong emphasis on professional obligations to share knowledge with and to learn from peers worldwide.

The International Civil Aviation Organization's (ICAO's) Regional Aviation Safety Group–Europe (RASG-EUR) in 2015 described its safety environment as follows: "The region is very complex with various regional safety–related players, each compiling safety data and producing safety information from a different angle. … One of the main challenges, therefore, is to decide on the key risk areas to achieve properly coordinated safety efforts. … The region is an 'atypical environment' as regards its regulatory framework (national, sub-regional and ICAO)."[1]

Under the regional government structure, the European Aviation Safety Agency (EASA) has primary responsibility for guiding and coordinating risk mitigations by states. "Europe plays a leading role as regards aviation safety," the agency says in its current *European*

EUROPEAN Tour

BY WAYNE ROSENKRANS



Plan for Aviation Safety, which covers 2016–2020. "An increased emphasis has been put on using safety promotion and focused oversight activities to mitigate safety risks."[2]

Regarding the region's systemic issues, the key elements of this emphasis are incorporating the principles of safety management systems (SMS) into initial and continuing airworthiness, working with EASA member states to implement state safety programs (SSPs) as required by ICAO, and working with national aviation authorities (NAAs) so that adequate human resources exist when needed.

"The key safety actions to address operational issues are, for commercial air transport by aeroplanes, [to] review and promote new pilot training provisions in order to address the prevention of and recovery from upset scenarios; identify measures to prevent loss of control during go-around or climb; and introduce technology on board aircraft to mitigate the risk of runway excursions," EASA's report said. "For helicopter operations, [key safety actions are to] strengthen design requirements for helicopter gearbox lubrication; improve offshore helicopter safety in Europe; and develop risk awareness and training material to further improve helicopter safety through safety promotion."

Risk prioritization, just culture and safety nets capitalize on a wealth of cross-border expertise.

Corresponding priorities apply to emerging safety issues, including overcoming safety threats to commercial air transport that could arise from breaches of computer network security; harmonizing European Union (EU) rules governing remotely piloted aircraft systems (also known as *unmanned aircraft systems* and by other terms); and determining if any new or emerging business model used by an airline generates safety risks not adequately anticipated — or unknowable — through the state's oversight processes.

"Due to the increased complexity of the aviation industry, the number of interfaces between organisations, their contracted services and regulators has increased. … Upon the request of member states, [EASA] tasked a working group of national aviation authorities to assess airlines' emerging 'new' business models and to identify related safety risks posed to the aviation system," the report said.

The working group recommended new forms of cooperation and sharing best practices so that when authorities deal with such operators or people certified by the national aviation authority of another member state, the aircraft operator's management systems "capture new hazards that are introduced by different employment models within an individual operator, [such as] increased mobility of pilots, safety-critical services provided by non-certified service providers and (long-term) leasing." They also included better EU-wide occurrence-reporting data so an airline's safety culture can be benchmarked, periodically surveying a network of expert analysts about new concerns, and building expertise among safety professionals to anticipate, recognize

and mitigate business model–induced risks, including those involving the airline's safety-related governance and financial situation.

Deciding Relative Risks

EASA's prioritization of highest risk areas in commercial air transport is based on 2004–2013 fatal accidents, nonfatal accidents and serious incidents. This article cites a select few examples from all the challenges and responses covered in the report.

"The main objective of [the *European Plan for Aviation Safety*] is to create a common focus on European aviation safety issues as a continuation of the European work to increase aviation safety and to comply with ICAO standards," the report said. "This approach improves traceability and reinforces commitment to the current initiatives while contributing to avoiding duplication, overlapping of safety initiatives and competition for resources. While some safety issues stay at [the] national level and are addressed within the [SSP of a country] alone, there are other instances where common issues of pan-European scope require a collective action."

Aligning With ICAO

Although ICAO's *Global Aviation Safety Plan* influences oversight objectives in 2017–2019 for national aviation authorities throughout Europe, each state's priorities — for scheduled commercial air transport operations especially — are tied closely to analyses done within the region, according to EASA. Therefore, the plan does address Europe's efforts on the ICAO-designated high-risk areas of runway safety events (including abnormal runway contact, bird strikes, ground collisions, damage during ground handling, runway excursions, runway incursions, aircraft loss of control on the ground, collisions with obstacles, and runway undershoots and overshoots); controlled flight into terrain (CFIT); and loss of control–in flight (LOC-I).

"In 2015, a complete review of the [previous plans'] actions was performed with a view to aligning the various programming activities," the report said. Most recently, for example, EASA began treating aircraft tracking, aircraft rescue and fire fighting, and accident investigation as key systemic issues — often deficiencies in organizational processes and procedures with a significant effect on an event's outcome — being considered within the context of accident/incident causation. Also new is the treatment of key operational issues of the commercial air transport–fixed wing sector with specific consideration of how design and maintenance improvements can be applied to prevent technical failures, and with extra attention to risk mitigation in ground operations.

"Ground safety includes both ground collisions and ground handling. … Ground handling occurrences are the fourth most frequent risk area for fatal accidents," the report said. "The safety actions related to ground safety are aimed at bringing improvements in the following areas: incorporation of weight and balance measuring systems and ground contamination of aircraft systems."

The proactive aspect of the plan focuses on ways to anticipate and identify emerging issues. The first is concentration on airlines' use of new business models, as noted, and another involves explicit reminders to examine human factors and human performance in an integrated manner as part of every EASA risk-mitigation initiative. "The safety data we can collect tells us about the past and it can be used to make predictions

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about the short-term future. … This [emergent issue] area gives some consideration to safety issues derived from operations or regulations that have not been fully deployed and where data [are] not always available," the plan said.

Through ICAO's Universal Safety Oversight Audit Program Continuous Monitoring Approach, and its own work, EASA recognizes significant variations among member states in levels of effective implementation of ICAO oversight standards, often because of variation in NAA resources. As a result, one part of the plan advocates cross-border sharing of resources by methods such as promoting "the concept of 'pooling' available expertise among NAAs in order to make subject matter experts available, in a cost-effective way, to those states that need resources," the report said.

"The [plan's] safety actions related to safety management are aimed at introducing safety management requirements in the domains of initial and continuing airworthiness, ensuring a common understanding at the international level, working with member states to implement the SSPs, and enabling the usage of flight data monitoring (FDM) programmes to identify safety risks and take action in a predictive manner."

Paris Charles de Gaulle Airport

Assisting Non-Europeans

Consideration of how European practices may benefit other regions is explicit in some parts of the plan. For example, SMS implementation objectives within air traffic management (ATM) and air navigation service providers (ANSPs) are considered both an internal and external matter.

"[Objectives include] support to ANSP SMS implementation, [especially] outside the EU; a structured approach to the identification of safety key risk areas and to gathering information on operational safety and SMS best practices from the industry; harmonise SMS approaches in functional airspace blocks [and] develop and promote SMS guidance and best practices for air traffic management," the report said.

The plan calls for EASA, in 2016, to help member states share knowledge to overcome any operator's inexperience using FDM-based risk indicators, and for EASA itself to "further assess, together with member states, the benefits of FDM-based indicators for addressing national safety priorities." This is complemented by regionwide distribution of accident summaries with key findings and lessons learned. Complementing this effort in 2017 will be mandatory establishment of a new European risk classification for effective comparison of events across the industry, and introduction of performance indicators to continuously measure and verify ATM safety performance by ANSPs.

In the commercial air transport–fixed wing sector, the plan asked airlines in 2016 to devote special attention within their FDM programs to precursors of LOC-I and CFIT, and assigned to EASA the task of establishing "good practices [in] enhancing the practical implementation of operators' FDM programmes" including integration with their other processes. "Member states should set up a regular dialogue with their national aircraft operators on [FDM] programmes [in the framework of just culture]," the report said, encouraging airlines to conduct analyses that also will help to prevent runway excursions, midair collisions and other high-priority issues described in their home country's SSP.

Loss of Control

Regarding airplane upset prevention and recovery training (UPRT), the plan commits to adapting the extensive standards and recommendations from ICAO — which originated in part with and were driven by a European committee — noting that "the main purpose is to include in the European provisions elements from ICAO Doc 9625 [*Manual of Criteria for the Qualification of Flight Simulators, Edition 4, Volume I – Aeroplanes*] for the use of [flight simulation training devices] in flight training. … Harmonisation with the U.S. Federal Aviation Administration (FAA) should be considered."

In one part of EASA's plan regarding UPRT, the report said, "The overall goal is to mitigate the safety risk (for large aeroplanes) of loss of control or loss of the flight path of the aircraft during the go-around or climb phases executed from a low-speed configuration and close to the ground. The second objective is to prevent an excessive nose-up trim condition when transitioning from a low-speed phase of flight to go-around or climb when high level of thrust is applied. This may be achieved by different means, such as increasing the flight crew awareness of the low speed/excessive nose-up trim condition, or incorporating active systems preventing an unusual configuration (low speed/excessive nose-up trim condition) from developing."

As part of encouraging all member states to incorporate LOC-I risk mitigation into their SSPs, EASA will supplement ICAO's complete regulatory package on UPRT with relevant safety promotion material to help states inform and influence their airlines and the approved training organizations from the European perspective.

"On average, there are three fatal accidents every year related to LOC-I worldwide and one every second year involving an EASA member state operator," the report said. "Loss of control in flight shall be addressed by the member states on their SSPs. This will include, as a minimum, agreeing on a set of actions and measuring their effectiveness." The plan also highlights the importance of mitigating the effects of startle.

Beyond pilot training, EASA's plan presents relevant LOC-I risk mitigations related to less-often mentioned causal factors. "Erroneous weight or centre of gravity have been identified as a potential safety issue leading to LOC-I accidents. The [plan's] task is to perform a survey of approval processes for the use of the electronic flight bags with a focus on applications for performance calculations including weight and balance, and to identify best practices," the report said.

Equipment Design and Maintenance

Regarding the plan's focus on improved designs for aircraft equipment, EASA said the objective is limiting the probability of equipment-related and maintenance-related causal factors in unsafe events. "Technical failure is the most frequent cause of accidents and serious incidents in Europe," the report said. "Excluding post-crash fires, it is also the second highest cause of fatal accidents. The safety actions related to design and maintenance are aimed at bringing improvements in the following areas: assessment and coordination of the responsibilities of maintenance organisations, protection of occupants on board large aeroplanes through improved seat crashworthiness, engine bird ingestion, aeroplane-level safety assessments, tyre inflation pressures remaining within specifications, as well as the process to review the airworthiness status of the aircraft."

For example, the plan has identified the need for not only adequate legal obligations for each state to properly conduct tire pressure checks but also to include tire pressure monitoring systems that reliably alert the flight crew when tire pressure is abnormal or out of tolerance.

Safety Nets

Regarding the safety nets mentioned in EASA's report, Eurocontrol has said, "The implementation of safety nets is mandated by four objectives contained in the [Single European Sky ATM Research (SESAR) program] documents. … Not only are safety nets inherently complex, they also have to operate in an increasingly complex environment. This calls for sustained effort to optimise and improve safety nets. New technological developments need to be exploited.

"Ground-based safety nets are an integral part of the ATM system. Using primarily [air traffic services'] surveillance data, they provide warning times of up to two minutes. Upon receiving an alert, air traffic controllers are expected to immediately assess the situation and take appropriate action. Airborne safety nets provide alerts and resolution advisories directly to the pilots. Warning times are generally shorter, up to 40 seconds. Pilots are expected to immediately take appropriate avoiding action."[3]

Part of EASA's plan is to promote and support the Europe-wide deployment of ground-based ATM safety nets with "high-level specifications complemented by safety promotion material for system safety defences (short-term conflict alert, approach path monitoring and area proximity warning)."

Increasing the effectiveness and expanding the deployment of airborne safety nets also is covered. "Prepare studies to further evolve airborne safety nets [traffic alert and collision avoidance system (TCAS), and terrain awareness and warning system]," the report said in one objective. "These studies will collect information on the current performance of safety nets and forecast their performance for possible future operational environment. In addition, [these] studies will assess the performance implications of the envisaged changes to the safety nets."

Notes

1. RASG-EUR. *2014 Safety Report.* First Edition, August 2015.
2. EASA. *European Plan for Aviation Safety 2016–2020.* Final, Jan. 25, 2016.
3. Eurocontrol. *HindSight 22.* Special issue on safety nets in air traffic management. Winter 2015.

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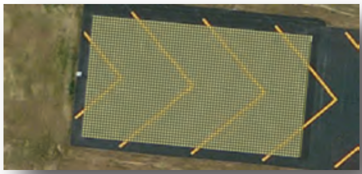

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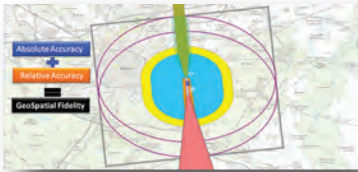

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Operational audits show that some aircraft operators are having continuing difficulty in tracking the recent experience and the duty and rest limits of their pilots, as well as conducting risk assessments for new routes or new operations.

These and other weaknesses are detailed in a data analysis report from Flight Safety Foundation's Basic Aviation Risk Standard (BARS) Program, which was implemented in 2010 in Australia to address safety issues facing contracted aviation operations in the mining and resource sector. It has since expanded to include aviation operations in humanitarian, government and insurance organizations.

The April *BARS Finding Data Analysis Report*[1] notes that the Program now includes member organizations in 30 countries on six continents. The basic audit protocol has been revised six times, and new BAR standards have been developed for offshore helicopter operations, unmanned aircraft systems (also called *remotely piloted aerial systems* or *drones*) and aerial mustering of livestock; 400 audits have been completed.

Between November 2010 and November 2015, BARS audits identified 9,219 non-conformances out of a total of 118,870 audit issue questions examined in 361 audits. Some 990 non-conformances were not analyzed for the report because of structural changes in the program that made meaningful comparisons impossible. Information

BARS auditors probe aircraft operators' weaknesses.

FACING UP to the Issues

BY LINDA WERFELMAN

in the report associated with individual audit participants was deidentified.

'A Potential … Breach'

Analysis of the audit data showed that the greatest rate of conformance involved "P1" issues — described as high priority issues that, if neglected by the operator, would indicate "a potential safety, legal, regulatory or contractual breach" (Figure 1). These issues accounted for just 4.9 percent of all non-conformances, and 8.1 percent of audit issue questions.

Three P1 issues stood out.

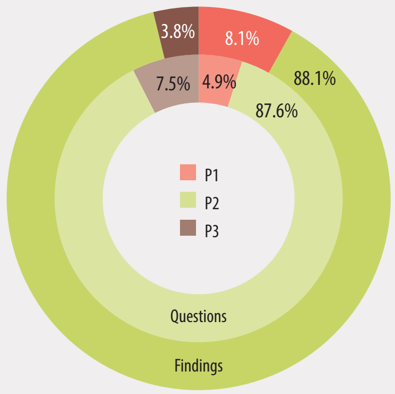
Thirty-three operators had difficulty tracking their pilots' recent flight experience; of the 33 operators, 57 percent were from southern and eastern Africa, and 25 percent were from western and central Africa, the report said.

"The issues in compliance included issues in available facilities to track recency, especially that of contract pilots," the report said. "Where solutions were implemented to close out the finding, in five cases, a later audit found that the solution … was not managed robustly enough to ensure ongoing conformance, and [these] were later supported by more robust procedures."

On their initial audits, 21 operators were found in non-conformance with requirements for flight crew check and training, which say, among other things, that crewmembers must be checked annually "to a standard defined by local regulations" and must undergo two flight checks a year. The 21 operators were distributed evenly among nine BARS regions.

"Most often," the report said, "flight crew were being checked annually, in line with the minimum requirements of the local regulatory authority. … In two cases, lack of oversight or adherence to procedure was the root cause of a second finding against this control."

Questions and Findings, by Priority



P1 = High-priority issues that, if neglected, would indicate a significant non-conformance and "a potential safety, legal, regulatory or contractual breach"

P2 = Requirements derived from the BAR Standard, or aviation best practices "of significant importance"

P3 = Non–safety-critical requirements of the BAR Standard

Source: Basic Aviation Risk Standard Program

Figure 1

The finding has never been issued for a third time for the same operator, the report added.

Eighteen operators — 89 percent from the two Africa regions — were not in conformance with the BARS requirement to track flight crew flight time, the report said, noting that the BARS limits "may well be more or less stringent than the local regulatory authority."

The reasons for the operators' difficulty involved a "lack of suitable systems available, or in use," the report said.

"A number of repeat findings were made on later audits when the systems instituted as a fix were not well enough developed or managed to provide a robust solution," the document added. "The difference between the regions in this respect can be as stark as each pilot having a tablet [computer] with which they can update flight and duty to a bespoke [customized] software system, to there being only one computer available for the organization, leaving pilots at remote bases devoid of reliable methods of communicating their data."

Other, less critical issues were associated with "P2" issues — described as "a BARS Program requirement as drawn from the BAR Standard, or an aviation best practice of significant importance" — which accounted for 87.6 percent of non-conformances and 88.1 percent of audit issue questions, and with "P3" issues — described as "non–safety-critical requirements, some of which may be difficult to comply with because of equipment limitations" — which accounted for 7.5 percent of non-conformances and 3.8 percent of audit issue questions.

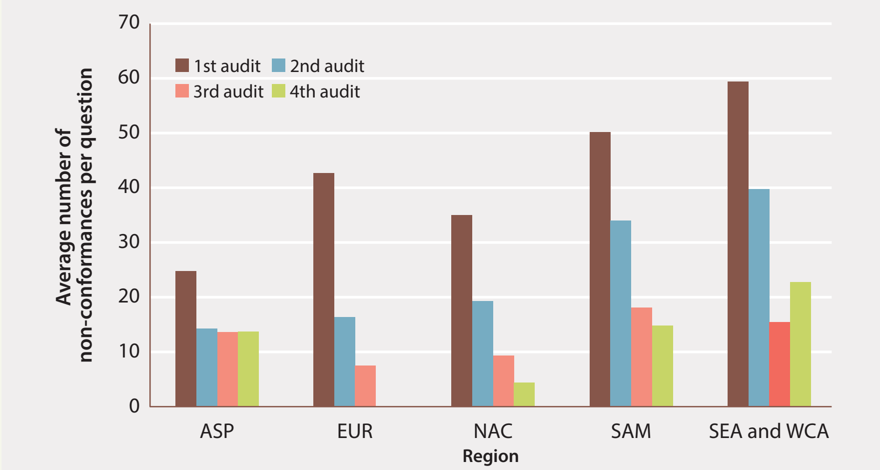
Fewer Findings

Of operators that had undergone at least four audits, results of the first four were examined; the general trend was a declining number of findings from one audit of an individual operator to the next (Figure 2, p. 26). Nevertheless, the report said, "There is a plateau in overall finding numbers in [Australia and the South Pacific] and an uptick in the [two African regions], the factors of which are as yet undetermined." (Some operators have undergone fifth and sixth audits, but the number of participants has been too low to ensure anonymity, so they were excluded from this comparison.)

Safety Management Systems

A breakdown of findings related to safety management systems (SMS) showed that 189 audits of 104 operators resulted in 681 non-conformances (Figure 3, p. 26). The most frequent non-conformance — cited 72 times — involved failure to set targets or

Average Number of Non-Conformance Findings, by Region

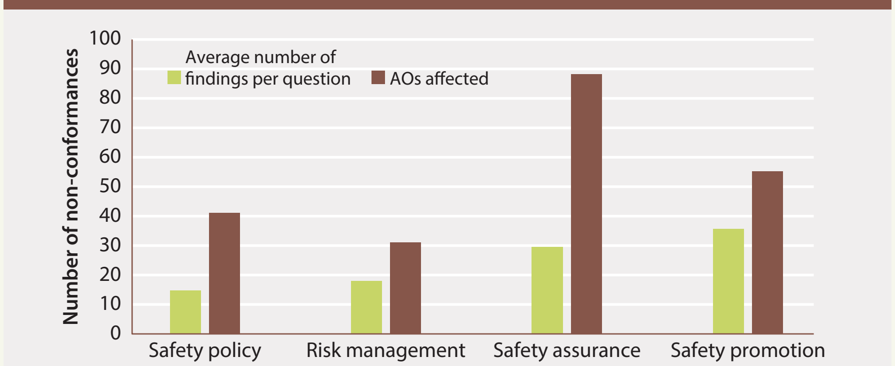


ASP = Australia and South Pacific; EUR = Europe; NAC = North and Central America; SAM = South America; SEA = Southern and Eastern Africa; WCA = Western and Central Africa

Source: Basic Aviation Risk Standard Program

Figure 2

Non-Conformance Findings on SMS Elements



AO = aircraft operator SMS = safety management systems

Source: Basic Aviation Risk Standard Program

Figure 3

performance metrics for safety, an item that was grouped in the audit's "safety assurance" area, which overall drew 443 non-conformances, more than any other area.

"The identification and setting of metrics with which to measure safety performance was troublesome for a number of [operators]," the report said, adding that the absence of metrics also complicated auditors' work.

Smaller totals of non-conformances were cited in three other audit areas: safety policy, safety risk management and safety promotion.

Offshore Helicopter Operations

As part of the analysis of audit findings involving the BARS Program designed specifically for offshore helicopter operations (BARS OHO), the report said that, since BARS OHO was introduced in 2012, 44 BARS OHO audits have been conducted for 22 operators in 11 countries. Some 1,294 non-conformances have been issued, including 256 "within the specific operational category of offshore operations."

The audit area most frequently cited involved emergency response plans (ERPs), especially two audit issue questions that require the operator to "consider worst-case scenarios in its ERP drills — specifically that they should cover helicopter ditching at last-light in adverse weather with increased time of missing aircraft location." Half of all BARS OHO organizations audited were cited for non-conformance with that standard, the report said.

"Of the 11 organizations subject to this finding, six … did not present evidence of having conducted any ERP drills and five did conduct drills, though not with the rigour demanded by the standard," the report said. "The root causes tendered by the operators basically fell into two camps, one that documented procedures simply did not exist, or alternatively, that the BAR Standard exceeded existing regulatory or contractual requirements."

Repetitive Findings

A separate but related analysis examined "repetitive findings" — non-conformances that were identified not only in a current audit but also in a previous audit of the same operator — and found that many of the findings most likely to be cited repeatedly were in audit areas where BARS requirements "exceed local regulatory requirements, and implementation evidence is not available at finding closure, ordinarily with the corrective action addressing only documentation."

These repetitive findings were most likely "within an [operator] whose internal procedures are not robust enough to ensure ongoing conformity, or in an [operator] with poor control and oversight over their external service providers," the separate *BARS Repetitive Findings Analysis Report* said.[2]

Analysts began this task by reviewing 8,495 P1 and P2 findings from audits that were conducted from November 2010 through December 2014, ultimately identifying 213 separate issues that yielded a total of 473 repetitions. They then focused on the top 10 issues that resulted in the most repetitive findings. These 10 issues represented 5 percent of all issues that resulted in repetitive findings; the repetitive findings associated with these 10 issues accounted for 25 percent of all repetitive findings.

At the top of the list was an audit issue question that said, "The appointed maintenance organization(s) should ensure that the initial and then recurrent training for maintenance personnel includes human factors for maintenance elements." The data showed that auditors had documented 21 instances of repetitive findings.

The remaining issues on the top 10 list included scheduling of ERP drills; ensuring that maintenance organizations have programs for initial maintenance training, as well as recurrent training, to be conducted at least every 36 months; and ensuring that, when passenger operations are involved, the number and weight of baggage items are recorded on a manifest for each flight.

Causal Factors

After further review of the top 10 issues, analysts identified the most common causal factors, which accounted for 80 percent of the detected issues, the report said.

At the top of the causal factors list were issues associated with insufficiently robust procedures, such as temporary documents that "go adrift or do not find their way into procedure." This causal factor was cited in 25 of the repetitive findings.

The other common causal factors included that "the previous corrective action only addressed the documentation and no implementation correction was carried out," cited in 19 repetitions; "ambiguous or incomplete evidence presented and accepted in order to close the corrective action," cited in 18 repetitions; and "disturbances in [operator] continuous improvement processes, i.e., interfaces between personnel or departments are not defined," cited in 15 repetitions.

Corrective Actions

After BARS audit findings are issued, operators are expected to take corrective action to resolve the issues and close each finding, but an auditor's ability to check on the corrective action taken (CAT) can be difficult because the auditor likely has moved on to another, unrelated audit, with limited time available for reviewing CATs, the report said, adding, "Where time pressure and difficulties in communication exist, the variability of the output of checking CATs increases."

The issues associated with the greatest numbers of repetitive findings are also issues that may be difficult to resolve quickly, and in some cases, corrective actions may be decided upon but their implementation may be delayed, the report said.

"As implementation is far off, documented procedures and/or schedules are accepted [by the auditor] as conforming for the purposes of closing the finding," the report added. "At the next audit, the documents pass [as actual implementation], though implementation was neglected, so we see an increase in 'lack of adherence to published policy or procedure,' 'lack of specified training or education' and 'lack of oversight' in subsequent audits."

Operators sometimes incorrectly identify the root causes of nonconformances, the report said, adding that in case of eagerness to close the finding, "an easy root cause fix may be proffered" and that if an operator is sensitive to criticism, "a root cause palatable to the organization will be produced." Often, if a drop-down menu in an online program allowed the operator to identify a root cause, "findings which were later repeated were three times more likely to [prompt the operator to respond by saying that] the … 'BARS requirements exceed that of local regulatory requirements,'" the report said. "None of the later repeated findings has a thought-out [root cause analysis]."

The report concluded by noting that the BARS Program Office is committed to strengthening both the BARS Program and the auditing process, in part through eliminating unnecessary repetitive findings.

"There will be cases where a repetitive finding has a legitimate cause," the report said. "However, good auditing practices, adequate preparation and robust effort on the part of the [aircraft operator] in providing a thorough corrective action will reduce the number of events experienced in the program."

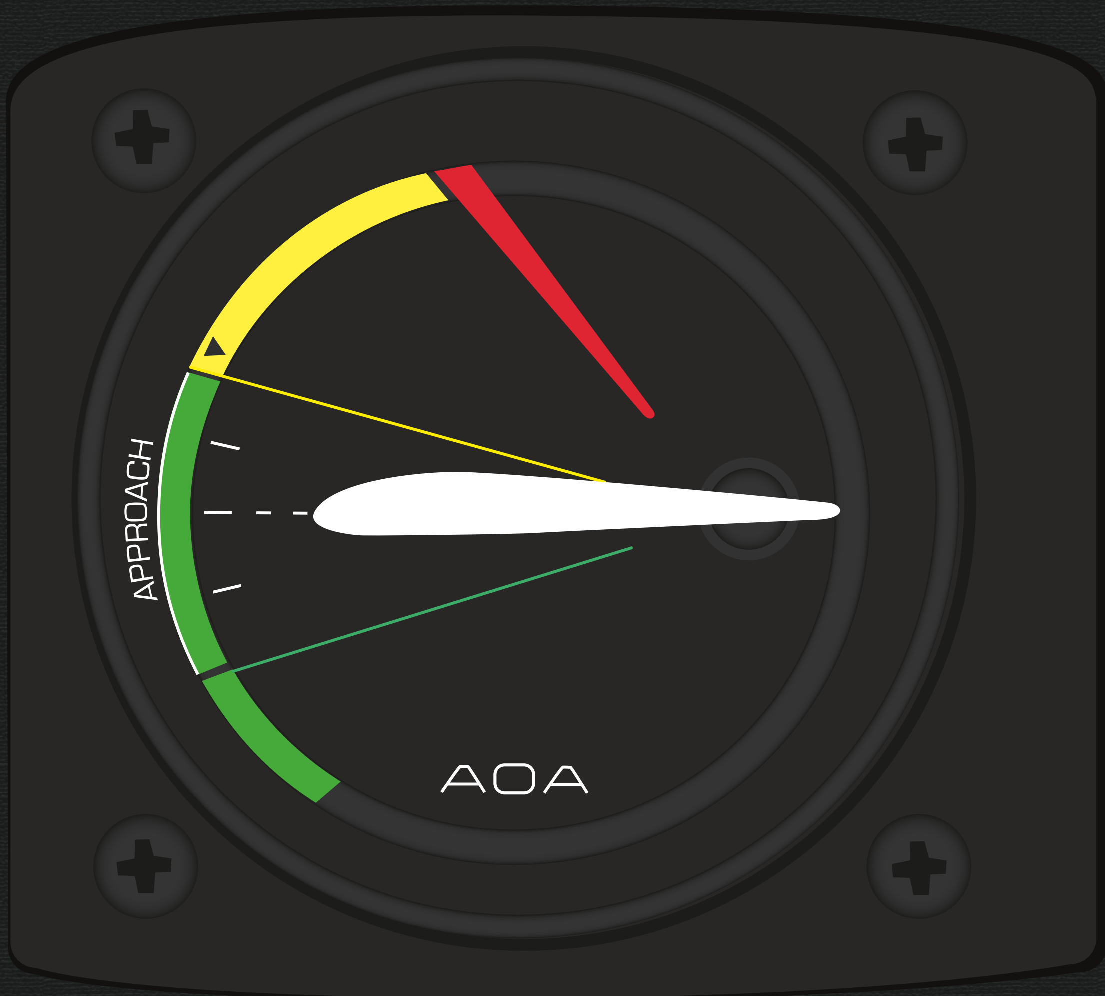
Notes

1. Ayre, Peter. *BARS Finding Data Analysis Report*, No. 3. Melbourne, Australia: Flight Safety Foundation, April 2016.

2. Bisciotti, Eduardo; Ayre, Peter. *BARS Repetitive Findings Analysis Report*, No. 1. Melbourne, Australia: Flight Safety Foundation, April 2016.

Unforgettable AOA

BY WAYNE ROSENKRANS



Advances in visual and aural cues and warnings target wing angle-of-attack and energy state awareness.

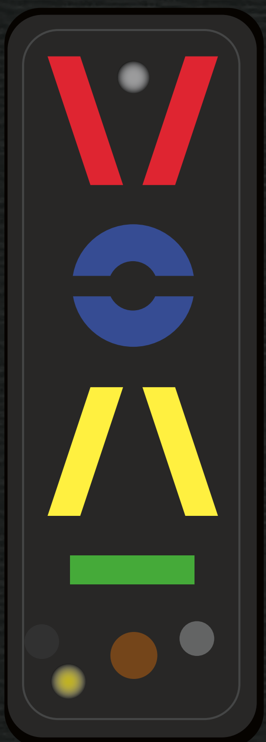
While airplane upset prevention and recovery training (UPRT) continues to be implemented by airlines (*ASW* 7–8/16, p. 29) over the next few years, complementary strategies call for technologically enhanced applications of angle-of-attack (AOA) data and energy state alerting.

Discrete AOA displays in military aircraft cockpits have long been standard, but equivalent civilian technology has been characterized as an option for large commercial jets since the 1990s — influenced then, as now, by desire to mitigate risks of loss of control–in flight (LOC-I) to the extent feasible.

Since 2015 in the United States, Federal Aviation Administration (FAA) guidance on stall-related training reminds the industry that optional AOA indicators already exist in the current fleet of large commercial jets, and AOA management using them should be demonstrated. Airline pilots' airplane-specific systems knowledge is expected to include "understanding of AOA indicators (if installed) or interpretation of other representations of AOA such as ['barber pole' on speed tape, pitch limit indicator [PLI] and flight path symbology relative to pitch attitude on a head-up display] that can assist in stall prevention."[1]

LOC-I accidents continue to influence AOA discourse worldwide. In April, for example, while looking back on AOA-awareness issues identified while investigating the Air France Flight 447 LOC-I accident, an investigator from the Bureau d'Enquêtes et d'Analyses (BEA) of France said in a conference presentation: "In a normal situation on a majority of modern aircraft, [the primary flight display

Illustration: Jennifer Moore
Based on image © Icon Aircraft



An example of an AOA indicator (Icon A5 Angle of Attack Safety System, p. 29) and an example of an AOA indexer (Alpha Systems AOA Griffin, above) — each FAA-approved strictly for pilots' supplemental reference and only in GA aircraft — have similarities to their standard counterparts in military jets and to their optional counterparts in large commercial jets and business jets.

Illustration: Jennifer Moore
Based on image © Alpha Systems

(PFD)] speed tape displays current speed (a raw number). Current speed is assessed in relation to 'known' limits ([maximum Mach operating speed], green dot, [lowest selectable speed] or equivalent), which represent visual thresholds or boundaries. Current speed is 'projected' via the speed trends [band adjacent to speed tape]. … Crews' awareness of the aircraft energy seems fragile. … [Their] energy awareness appears to be more dependent on speed tape indications than on pitch/thrust (see "Energy State Alerts in Peripheral Vision," p. 32); [their] initial focus is to keep the wings level, not to control the aircraft energy; 'stall' is not verbalized; [and] the stall recovery procedure is not applied."[2]

Philosophical and technological changes during the evolution of AOA displays are prominent in a technical article published in 2000 by Boeing Commercial Airplanes[3] and in a literature review published in 2014 by the U.S. National Aeronautics and Space Administration (NASA)[4] — including the benefits and risks of providing discrete AOA information.

Previous AOA Philosophy

The Boeing article reflects the aviation industry's heightened interest 16 years ago in the prevention of upset incidents and accidents — and in AOA generally. The authors cautioned that any airline's decision to introduce optional AOA indications first requires a thorough assessment of the technological, human factors and training implications — not unlike UPRT in 2016. "Awareness of AOA is vitally important as the airplane nears stall," the article said. "It is less useful to the flight crew in the normal operational range. … For AOA information to be useful to a flight crew, [many complex] parameters must be considered and accounted for in the indications and associated crew procedures."

Another emphasis was that pilots already were trained to use standard AOA data–derived displays on airplane models then in production. The context for Boeing to introduce optional types of AOA displays at that time included their use on military aircraft, sparse equipage of commercial airplanes, advocacy by the U.S. National Transportation Safety Board (NTSB) of a visual indication of AOA in commercial airplanes, and safety priorities of operators, as noted.

"A dedicated AOA indicator shown on the PFD recently has been developed in cooperation with airline customers [as of 2000]. … [This] independent AOA indicator is being offered as an option for the 737, 767-400 and 777 airplanes," the article said.[5]

NASA Summary

The NASA literature review, covering 1958–2014, summarizes what studies reveal about potential benefits of discrete AOA displays in commercial transport jets. It focused on "how they may aid a pilot in energy state awareness, upset recovery and/or diagnosis of air data system failure," the report said.

Many of the studies called for detailed requirements for AOA and evidence of the full scope of uses and benefits of displaying AOA in the aircraft, the report said. The author noted, however, "Studies of this nature were not found. In fact, research into displaying AOA information directly in the cockpit was primarily conducted prior to the 1980s."

NASA also cited a prescient 1960 study describing a device that had several characteristics of those that the FAA now approves for general aviation (GA) aircraft.[6]

For example, according to the pilot's handbook issued by BendixKing by Honeywell for its device, "The KLR 10 [Lift Reserve Indicator] system is primarily designed to improve the pilot's awareness of available lift during operations at high angles-of-attack. … The KLR 10 display has chevron and bar–styled, [light-emitting diode]–driven color-coded segments which … illuminate corresponding to the AOA of the aircraft. …The remote audio [interface system] provides warning annunciations ['Check AOA,' 'Caution, Too Slow' and 'Too Slow! Too Slow!'] in the pilot's headset."[7]

Prevailing Designs

After the 1980s, according to the NASA report, examples of AOA-display systems on U.S. military jet fighter aircraft included one (U.S. Navy

F/A-18) with the indicator of true AOA in degrees on the head-up display (HUD) and with an AOA indexer shown on the left side of the HUD. The first device shows an AOA bracket to the left of the HUD velocity vector symbol when landing gear are extended, and a vertically centered bracket indicates the optimum approach AOA.

Another military jet fighter (U.S. Air Force F-16) provides the pilot with a vertical-tape–style AOA indicator in true degrees with moving color arcs along the right edge rectangular AOA indexer on the top left side of the glareshield; the indicator operates regardless of landing gear status, the report said.

AOA indexers are most associated with discrete AOA data in military aircraft, displaying AOAs as digits, angles, normalized units or symbols. "The scale on the indicator may display AOA in arbitrary units [e.g., colored arcs/wedges on a circular scale], normalized units [e.g., 0.0 to 1.0 with 0.6 showing that approximately a 30 percent margin above stall exists] or actual degrees [e.g., 0 to 30]. The dial-type scale not only gives current AOA information but also can function as a rate-of-change indicator," the report said.

LOC-I Accidents

LOC-I accidents (Table 1) since 2000 influenced the NASA author to advocate research and development into untapped possibilities for AOA displays. "When stall warning systems are misunderstood, as in Air France Flight 447 … an AOA indicator can be a single point of reference where the pilot can see the margin to stall and determine whether the aircraft is in a stall," her report said. "An AOA indicator would have given the [flight crew] knowledge of how the wing was flying. … Current [post-1977] studies researching the use of AOA indicators as an aid in airplane energy state awareness or upset recovery were not found. … Current research into the use of AOA as a verification for pitot static system failure was not found." This Airbus A330 flight from Rio de Janeiro to Paris crashed in the Atlantic Ocean on June 1, 2009, killing all 228 people on board.

NASA's report discussed NTSB Safety Recommendation A-96-094, issued to the FAA after investigation of the controlled flight into terrain crash of American Airlines Flight 965. It stated, "Require that all transport-category aircraft present pilots with angle-of-attack info in a visual format, and that all air carriers train their pilots to use the info to obtain maximum possible airplane climb performance." In correspondence between October 1996 and January 2001, NTSB and FAA disagreed about whether the requirement was warranted. FAA's responses said, in part, "The FAA contends that there is adequate angle-of-attack information already displayed in current aircraft indicator displays. The FAA considers that current industry safety programs, like the flight management systems with vertical navigation capability and global positioning [system], are addressing the underlying causes that result in situations where maximum possible airplane performance is necessary." The Boeing 757 crashed near Cali, Colombia, on Dec. 20, 1995, killing 151 of 159 crewmembers and passengers on board.

CAST Efforts to Address Airplane State Awareness (ASA)

Loss of Control–In Flight Accident (LOC-I)	Distraction	Crew Resource Management	Automation Confusion/Awareness	Ineffective Alerting	Inappropriate Control Actions
Formosa Airlines Saab 340	■ ■	■ ■		■ ■	
Korean Air 747-200F	■	■ ■		■ ■	
Flash Airlines 737-300	■	■ ■	■	■ ■	■ ■
Adam Air 737-400	■ ■	■ ■	■	■ (green only)	■ ■
Kenya Airways 737-800	■	■ ■	■	■ ■	■ ■
Aeroflot-Nord 737-500	■	■ ■	■	■ ■	■ ■
Gulf Air A320	■	■ ■		■	■ ■
Icelandair 757-200 (Oslo)	■ ■	■ ■	■	■	■ ■
Armavia A320	■	■ ■	■	■	■ ■
Icelandair 757-200 (Baltimore)	■ ■	■ ■	■ ■	■ ■	■
MidwestExpress 717	■ ■	■ ■		■ ■	■
Colgan Air DHC-8-Q400	■	■ ■	■ ■	■ ■	■ ■
Provincial Airlines DHC-8	■		■ ■	■ ■	■ ■
Thomsonfly 737-800	■ ■		■ ■	■ ■	
West Caribbean MD-82	■	■ ■	■ ■	■	■ ■
XL Airways A320	■ ■	■ ■	■	■ ■	
Turkish Airlines 737-800	■ ■	■ ■	■	■ ■	
Empire Air ATR-42	■	■ ■	■	■ ■	

(In each cell: first ■ = blue, second ■ = green, unless noted.)

■ (blue) Issue applies to accident ■ (green) ASA issue theme has been addressed by CAST safety enhancements

Note: "Ineffective Alerting" is notable as one of the ASA issue themes, related to airline pilots' angle-of-attack and energy state awareness, among 12 in the original source table.

Source: CAST (U.S. Commercial Aviation Safety Team) ASA Joint Safety Implementation Team

Table 1

Energy State Alerts in Peripheral Vision

One aviation company developing a retrofittable system to alert airline pilots to energy state mismanagement was motivated by the frequency of this causal factor appearing in reports from investigators of loss of control–in flight (LOC-I) and approach-and-landing (ALA) accidents. Aerospace engineer Andrew Skow, president of Tiger Century Aircraft, told *AeroSafety World* in August that he decided initially that LOC-I risk could be mitigated further by generating visual and visual-aural alerts primarily from airspeed and aerodynamic load (g force) data — with angle-of-attack (AOA) data used as a less important parameter by the alerting algorithm.

At this stage of development, the algorithm fuses flight parameters from the existing aircraft databus to immediately make the flight crew aware of any trend toward too-high or too-low energy. LOC-I and ALA accident scenarios involve high cognitive loads for the flight crews, Skow said, yet energy state information provided by the vertical moving speed tape format on a primary flight display (PFD) may contribute to what he calls the "already cluttered PFD environment," resulting in "weak salience." The scenario also may include cognitive impairment from degraded hand-flying skills, inadequate training, fatigue or a medical reason.

When flight crews exhibit over-reliance on automation, "the perceived need to check airspeed is reduced," he said. "The most common LOC-I accident sequence begins with an unintended and unnoticed loss of airspeed — not an unintended increase in AOA that results in loss of airspeed." Flying with optional AOA indicators and indexers, airline flight crews must look directly at them to interpret the energy state and the margin to stall, he said.

After two years of research, Skow and Peter Reynolds completed the design for a device they named the Energy State Awareness (ESA) Display. (Reynolds, a retired vice president of flight test at Bombardier Aerospace, died in April 2014.)

"Although discrete displays of AOA are perfect for flying intentionally near stall, AOA has no chance to mitigate LOC-I. There are many flight situations — combinations of pitch attitude, power setting, bank angle and altitude — in which AOA can remain low while the airplane is rapidly losing airspeed. In these situations, an alerting system based only on AOA will be completely ineffective," Skow said.

The ESA Display was designed to alert pilots to deteriorating energy state early enough so that their control inputs will interrupt an LOC-I accident sequence, for example, long before a stall. "It has been designed so that energy state information can be extracted by a pilot at a brief glance — instantly recognizable, clear and unambiguous, without eye or head movement," he said.

In June, a company test pilot completed a 16-hour evaluation of the ESA Display in a high-fidelity, transport category research simulator operated by the U.S. National Aeronautics and Space Administration, he said. In this simulator, the pilot tested its stable approach monitor mode, conducting automation-coupled and visual approaches to runways at San Francisco International Airport. The test pilot intentionally mismanaged the energy and glide slope tracking, as actually has occurred when a flight crew assumed incorrectly that automation was handling control inputs and proper energy state.

"Our silver dollar–size disk [approximately 38 mm/1.5 in diameter] with 12 red-green-blue, light-emitting diodes was installed at the left edge of the simulator's glareshield within each plot's peripheral vision," Skow said. During the simulator approaches, if the pilot flying was within operator-specified, stable-approach criteria of acceptable deviation from the V_{REF} (reference landing speed), for example, the ESA Display showed solid green lights. Solid yellow lights with an aural alert indicated the aircraft had slowed below the acceptable V_{REF} deviation. If speed dropped to 15 kt less than V_{REF}, the device displayed flashing yellow lights and emitted a 1-Hz aural alert. At stick shaker AOA, the pilots saw a solid red "donut" symbol and got the standard aural alert from the existing stall warning system, he said.

— WR

The NASA report also cited the 2012 safety recommendation from the investigation of Air France Flight 447, in which the BEA advised "that EASA [the European Aviation Safety Agency] and the FAA evaluate the relevance of requiring the presence of an angle-of-attack indicator directly accessible to pilots on board aeroplanes."[8]

Regarding the Turkish Airlines Flight TK1951 LOC-I accident, the Dutch Safety Board noted, "As Flight TK1951 disengaged the autopilot beyond the critical angle-of-attack, the accident aircraft was flown by the crew into a stall on autopilot. … As the airspeed [had] continued to drop, the aircraft's pitch attitude [had] kept increasing. The crew failed to recognise the airspeed decay and the pitch increase until the moment the stick shaker was activated. Subsequently, the approach to stall recovery procedure was not executed properly, causing the aircraft to stall and crash. … Despite the indications in the cockpit, the cockpit crew did not notice the [extent of] decrease in airspeed until the approach to stall warning. … Boeing, FAA and [EASA] should assess the use of an auditory low-speed warning signal as a means of warning the crew and — if such a warning signal proves effective — mandate its use."[9] The 737-800 crash on approach to Amsterdam (Netherlands) Schiphol Airport on Feb 25, 2009, killed nine of 135 passengers and crew.

AOA Work Under Way

The present U.S. Commercial Aviation Safety Team (CAST) strategy for ensuring adequate AOA awareness among airline flight crews comprises safety enhancements (SEs) published on the Eurocontrol SKYbrary website <www.skybrary.aero/index.php/Commercial_Aviation_Safety_Team_(CAST)> by this government-industry collaboration group. The SEs emerged from research into 18 LOC-I accidents studied by its Airplane State Awareness (ASA) Joint Safety Analysis Team and led to research and implementation initiatives scheduled by its ASA Joint Safety Implementation Team (JSIT).[10]

"The ASA SEs are integrated into a coordinated safety plan, with the goal of balancing short-term tactical mitigations provided by operational and training programs against longer term, more strategic solutions resulting from improved design," CAST said. "The analysis estimates that implementation of the 11 training, operations and design SEs would reduce the risk of future ASA events [equivalent to about half of all LOC-I accidents and incidents] approximately 70 percent by 2018 and 80 percent by 2025."

Several of these active research projects emphasize enhanced flight envelope protection in fly-by-wire aircraft — including bank alerting with recovery guidance, bank angle protection and computer-generated displays of the aircraft operating in virtual day–visual meteorological conditions (*virtual VMC*) regardless of external visibility — but one particular ASA JSIT focus for existing, non–fly-by-wire aircraft is low-airspeed alerting.

Regarding current production and in-development non–fly-by-wire transport category airplane type designs, the AOA-relevant ASA JSIT research focus of SEs includes low-airspeed caution alerting and "energy state cues, such as flight path, acceleration, and speed deviation, in a manner similar to modern head-up displays … as part of a virtual-VMC display and as a standalone implementation on [PFDs]," CAST said. Under SE 205, aircraft manufacturers also are studying the feasibility of incorporating these design features into existing, out-of-production, transport category airplane type designs.

SE 207 could be considered the most explicit concerning AOA technology as it describes research under way on attitude and energy state awareness technologies that address the overall strategy's alerting theme. This SE specifies, in part, that the research will "assess the relative benefits associated with various methods of displaying angle-of-attack on the flight deck; develop and refine algorithms and display strategies to provide control guidance for recovery from approach-to-stall or stall; [and] develop and refine systems that predict the future aircraft energy state and/or autoflight configuration if the current course of action is continued, and provide appropriate alerting."

Notes

1. FAA. Advisory Circular 120-109A, "Stall Prevention and Recovery." Nov. 24, 2015.
2. De Ziegler, Nathalie. BEA. "AF 447 Rio-Paris 2009, Air Asia QZ 8501 Surabaya-Singapore 2014 — A Common Thread for Training?" Presentation to the World Aviation Training Conference and Tradeshow (WATS 2016), April 19, 2016.
3. Cashman, John E.; Kelly, Brian D.; and Nield, Brian N. "Operational Use of Angle of Attack on Modern Commercial Jet Airplanes." *Aero* (QTR_04 2000), pp. 10–22. Boeing Commercial Airplanes Group.
4. Le Vie, Lisa R. "Review of Research on Angle-of-Attack Indicator Effectiveness." Langley Research Center, NASA. Report number NASA/TM–2014-218514. August 2014.
5. Boeing said in 2000, "The [optional AOA] indicator itself consists of an analog scale and pointer. … Stall warning AOA is shown with a red tick mark, which will change position as a function of Mach number for those airplanes with Mach-dependent stall warning schedules. … For upset recovery, either the PLI or the red stall warning mark on the AOA indicator may be used to assess the margin to stall warning."
6. ATSM International. ASTM F3011-13, *Standard Specification for Performance of Angle of Attack System*. FAA Memorandum AIR100-14-110-PM01,"Approval of Non-Required Angle of Attack (AOA) Indicator Systems," was issued Feb. 5, 2014. Related FAA guidance for GA said, "The objective of AOA-based displays is to provide input to the pilot as a cross-check to standard required instrumentation. … An AOA-based system is for reference only, used to supplement a GA airplane's existing stall warning system, and cannot be used as a primary flight instrument."
7. BendixKing by Honeywell. "KLR 10 Lift Reserve Indicator Pilot's Guide." Revision 1, part number D201306000109, February 2014.
8. BEA. "Final Report on the Accident on 1st June 2009 to the Airbus A330-203 Registered F-GZCP Operated by Air France Flight AF 447 Rio de Janeiro – Paris." July 2012.
9. The Dutch Safety Board. *Crashed During Approach, Boeing 737-800, Near Amsterdam Schiphol Airport, 25 February 2009.* May 2010.
10. CAST. *Airplane State Awareness Joint Safety Implementation Team Final Report Analysis and Recommendations.* June 17, 2014.

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Research fails to identify ways of predicting or preventing pilot suicides and murders.

No Clear Pattern

BY LINDA WERFELMAN

An analysis of cases in which pilots used their aircraft to commit suicide or murder-suicide reveals no identifiable pattern of motivations that could be used to help identify those most likely to perpetrate such events, according to a team of aeromedical researchers.[1]

Pilot Suicides Involving Large Aircraft

Date	Event
July 20, 2012	A SkyWest pilot wanted by police on charges of killing his former girlfriend and placed on leave by the airline, tried to steal a Canadair RJ-200 in St. George, Utah, U.S., crashed while taxiing and shot himself.[1]
Oct. 11, 1999	An Air Botswana captain who had been grounded for medical reasons stole an ATR-42 and crashed it into two parked aircraft at the airport in Gaborone, Botswana.
July 13, 1994	A Russian Air Force engineer who, according to media reports, wanted to commit suicide, stole an Antonov 26 and flew until it ran out of fuel and crashed.

Note:

1. Miller, Jessica; Neugebauer, Cimaron. "SkyWest Pilot Kills Self After Trying to Steal Plane at St. George Airport." *The Salt Lake Tribune*. July 18, 2012.

Source: Kenedi, Christopher; Friedman, Susan Hatters; Watson, Dougal; Preitner, Claude. "Suicide and Murder-Suicide Involving Aircraft." *Aerospace Medicine and Human Performance* Volume 87 (April 2016): 388–396.

Table 1

Researchers from New Zealand and the United States reviewed medical and aviation safety databases, conducted internet searches and examined relevant articles to identify 65 cases of pilot suicide and 13 cases of murder-suicide committed by pilots during a 60-year period that ended April 17, 2015.[2] They also identified six cases of passengers who jumped from aircraft and five cases in which people other than the pilots used aircraft in murder-suicide events — these people typically were passengers who disabled the pilots.

Generalizations about causes of suicide or murder-suicide involving an aircraft as the method, or weapon, were difficult, the researchers said in a report on their work, published in the April issue of *Aerospace Medicine and Human Performance*, the journal of the Aerospace Medical Association.

"There does not seem to be a clear pattern of background factors or motivations which could suggest a recognizable pattern of which pilots would be more likely to commit suicide or homicide-suicide," the report said. "There [are] not enough data to suggest that mental illness plays a significant role in either suicide or homicide-suicide by pilots. Rather, perpetrators were often noted to have other stressors, such as relationship or financial problems. Patterns similar to other cases of homicide-suicide (including multiple stressors) emerged."

The report emphasized that suicide by aircraft and murder-suicide by aircraft are two "distinct forms of pathology, with unique risk factors that should be recognized and considered separately."

Overall, the researchers identified 71 occurrences involving aircraft and suicide, including three events in which pilots used commercial airliners to kill themselves (Table 1), six events in which passengers were killed after jumping from aircraft, and 62 events in which pilots used general aviation aircraft in successful suicide attempts.

In addition, the researchers identified 18 occurrences that they believed "were consistent with strong evidence suggesting homicidal and suicidal intent by the pilot or passenger"; of these, 13 events involved a pilot as the perpetrator, including six cases in which the pilots were flying passenger airliners.

The report cited data from the U.S. Centers for Disease Control and Prevention that placed the suicide rate among the general population in the United States at 13 per 100,000 people and identified risk factors that include mental illness, substance abuse, family history of completed suicides, impulsive or aggressive tendencies, and the diagnosis of progressive and debilitating diseases such as cancer.

Pilots, however, "should have a lower rate of suicide than the general public because they are screened for mental illness, monitored for significant physical illness and substance abuse, required to demonstrate problem-solving skills, and usually do not have prior suicide attempts," the report said.

"In addition, most pilots will be part of a sense of community involving other pilots and air staff. This reduction in risk factors and exposure to protective elements are not universally protective; they only reduce the risk."

Estimating Suicide Flights

The researchers said that their review of official accident reports left them with "a strong sense that suicide is only identified when there is incontrovertible data" and noted that earlier research generally estimated that aircraft crashes attributed to pilot suicide in the United States accounted for between 0.29 percent and "less than 2 percent" of all crashes. Data from Germany placed the estimate between 0.17 and 3 percent; in the United Kingdom, 0.72 percent of fatal crashes were considered definite suicides, and 1.69 percent were "probably suicide or involved some degree of self-destructive behavior," the researchers said.

For the 65 suicide flights, the average age of the pilots was 40. Sixty-three of the pilots were men, and alcohol or recreational drugs were involved in nearly half of the flights for which such information was available. Of the 44 cases in which background information was available, 36 percent involved pilots with a known history of mental illness — or for whom post-accident tests found antidepressants in their systems, they said.

The study found that pilots do not necessarily lose their medical certificates because of mental illness — including previous suicide attempts. Several countries, including Australia and New Zealand, consider pilots' treatment, continued remission and their support systems, among numerous other factors, in determining whether they should be granted aeromedical certification.

Legalities and Relationships

The study found that personal legal or financial issues played "a significant but not major role" in pilot suicides, noting that 21 occurrence reports contained information indicating that the pilot had legal or financial problems. "This

Changing Rules

In the aftermath of the March 24, 2015, crash of Germanwings Flight 9525, an Airbus A320 flown into the ground in the French Alps by its suicidal copilot, the International Civil Aviation Authority (ICAO) and many national aviation authorities and airlines have adopted new requirements or new recommendations to prevent accidents involving pilot suicide or murder-suicide.[1]

Several years before the Germanwings crash, in August 2012, the Aerospace Medical Association (AsMA) recommended that the aviation community — and especially aeromedical examiners — pay more attention to issues involving pilots' mental health. ICAO agreed, including updated mental health information in the 2012 revision of its *Manual of Civil Aviation Medicine* (Doc 8984), along with recommended questions for examiners to ask when evaluating pilots' mental health.

Within days after the crash, the European Aviation Safety Agency (EASA) issued its first recommendation for airlines to keep at least two crewmembers, including at least one qualified pilot, in the cockpit at all times during flight. Similar requirements had already been in place in some countries, including the United States, and in the months since the Germanwings crash, the requirement has become common at international airlines.

An EASA task force also recommended that pilots be required to undergo psychological testing before starting work at an airline and that airlines establish internal pilot-support systems.

In its final report on the Germanwings crash, issued in March 2016, the French Bureau d'Enquêtes et d'Analyses (BEA) issued nearly a dozen mental health–related recommendations, including some calling for a clear determination of the appropriate balance between medical confidentiality and public safety, and a requirement that follow-up conditions be defined whenever a Class 1 medical certificate is issued to a pilot with any history of psychiatric trouble.

In the United States, the Federal Aviation Administration (FAA), airlines and pilots' unions agreed to increase the use of programs to aid pilots with mental health problems, and the FAA asked the Aerospace Medical Association to develop recommendations on how to handle the issue of medical confidentiality versus physicians' reporting responsibilities.

Note

1. BEA. *Final Report: Accident on 24 March 2015 at Prads-Haute-Bléone (Alpes-de-Haute-Provence, France) to the Airbus A320-211, Registered D-AIPX, Operated by Germanwings*. March 2016. Available at <www.bea.aero>. The crash killed the copilot and all 149 other people in the airplane.

—LW

Pilot Murder-Suicides With Pilot as Perpetrator

Date	Deaths	Event
March 24, 2015	150	The first officer of a Germanwings Airbus A320 locked the captain out of the flight deck and flew the airplane into the ground in the French Alps.
Nov. 29, 2013	33	Investigators concluded that the captain of a LAM Mozambique Airlines Embraer ERJ-190 crashed the airplane in Bwabwata National Park, Namibia, after the first officer left the flight deck.[1]
Feb. 18, 2010	2 (1 on the ground)	A pilot flew his Piper Dakota into a U.S. Internal Revenue Service office building in Austin, Texas, U.S.[2]
March 5, 2007	2	A student pilot involved in a custody dispute crashed a Cessna 150M into his mother-in-law's house. The pilot and his only passenger — his young daughter — were killed.[3]
Oct. 31, 1999	217	An EgyptAir Boeing 767 crashed into the Atlantic Ocean about 30 minutes after takeoff from Kennedy International Airport in New York, killing all passengers and crew. The U.S. National Transportation Safety Board (NTSB) said the crash resulted from "the relief first officer's flight control inputs." Egyptian authorities disputed the conclusion that the crash was intentional.[4]
Feb. 9, 1982	24 (150, including pilot, survived)	A Japan Air Lines McDonnell Douglas DC-8 was ditched in Tokyo Bay by the captain as the first officer and flight engineer fought him for the controls.

Notes:

1. Aviation Safety Network. Aviation Safety Database.
2. NTSB. Report No. CEN10FA124. Feb. 18, 2010.
3. NTSB. Report No. CHI07FA079. March 5, 2007.
4. NTSB. NTSB/AAB-02/01, *Aircraft Accident Brief: EgyptAir Flight 990, Boeing 767-366ER, SU-GAP; 60 Miles South of Nantucket, Massachusetts; October 31, 1999*. March 31, 2002.

Source: Kenedi, Christopher; Friedman, Susan Hatters; Watson, Dougal; Preitner, Claude. "Suicide and Murder-Suicide Involving Aircraft." *Aerospace Medicine and Human Performance* Volume 87 (April 2016): 388–396.

Table 2

included a pilot wanted for murder who crashed a commercial airliner while taxiing and then killed himself," the study said.

Twenty-six occurrence reports contained information suggesting that a "relationship conflict" played a part in a pilot's suicide; of these, two reports involved pilots of large commercial transport aircraft. Six of the pilots with relationship conflicts also were included among those with legal or financial issues.

'Difficult … to Predict'

Murder-suicide involving an aircraft is "difficult to both predict and prevent," the researchers said, noting the rarity of such events as well as "the difficulty of meaningful study because the perpetrator and victim(s) are dead."

The researchers cited an earlier, general study of 408 murder-suicides in the United States (cases not related to aviation) and found that only 10 percent involved a victim who was not a member of the perpetrator's family. That earlier study discussed "adversarial" murder-suicides in which the perpetrator believes that another person — typically an employer or another authority figure — has "wronged him."

The researchers added, "Though he may target a single person whom he perceives as the source of his distress, others may be killed as well. This is in distinction to a 'pseudo-commando' homicide-suicide, where a crowded public place is chosen so that the perpetrator can kill as many people as possible, people with whom he does not usually have any relationship and who happen to be there."

Motives for murder-suicide are complex, the researchers said, adding that these cases "can arise from a primary homicidal motive or a primary suicidal motive" and that depression or other psychological problems may play a part.

"Family pressures and social stressors, including work difficulties, legal issues and separations" also are common in cases of murder-suicide, the researchers said.

As an example, they cited a 2007 event in which the pilot of a small aircraft, a man involved in a child custody dispute, flew an airplane — with his child as a passenger — into the home of his mother-in-law.

Although the number of murder-suicides committed by pilots is low, the statistical impact is "not negligible," the researchers said, noting that, since 1945, the annual death toll in aviation accidents has ranged between 224 and 2,429 per year. During that time, 572 deaths occurred in commercial airline crashes attributed to murder-suicide (Table 2).

The number of murder-suicide events also was too small to detect patterns in background factors, the researchers said. Nevertheless, of the nine cases in which the pilot's age was available, the average was 37 years; in addition, in all cases in which background information was available, the perpetrators were men.

Of 14 murder-suicide events (including those in which someone other than the pilot was responsible), three perpetrators had legal issues, two had financial problems and four had relationship conflicts, the researchers said.

"Four appeared to have occupational or workplace conflict," they added. "Four of the perpetrators [all pilots] who destroyed aircraft in flight had reports of mental illness."

In five of the six cases involving the pilot of a commercial jetliner, the researchers said, "the pilot appeared to wait for the copilot to leave the flight deck before destroying the aircraft"; in the sixth case, the first officer and flight engineer forced the suicidal captain off of the flight controls. In three cases, the pilots may have had mental illnesses. In two cases, the pilots had "occupational issues" and two had relationship issues. (One of these pilots had both relationship issues and a history of mental illness.)

The researchers said that in their sample of 14 murder-suicide reports, 29 percent "suggested the presence of mental illness," compared with 36 percent of the 43 suicide reports. Both numbers were "smaller than we would expect for similar behavior in the general population," the researchers said.

They said their data were "clearly incomplete" and that no conclusions could be drawn because of the small sample sizes.

Nevertheless, they added that they had detected an unexpected trend — that in all six of the cases in which the perpetrator was the pilot of a passenger airliner, all of those killed were occupants of the airplane; the pilots did not crash their aircraft in populated areas.

The motives for the pilot murder-suicides were similar to those described in psychiatric literature, the researchers said.

"In two cases, a family member was the murder victim," they wrote. "Anger appeared as a prominent emotion in multiple homicide-suicides: In four cases in which there had been occupational strife, the boss or supervisor was targeted, and in another case, the IRS [U.S. Internal Revenue Service] was targeted. Many perpetrators were under stress at the time, be it financial/work-related, romantic or legal issues. Unlike the vast majority of homicide-suicide cases with other methods/weapons such as guns, family members were only rarely the victims when aircraft were involved."

The researchers noted that cases of suicide using aircraft as the weapon should not be considered the same as cases of murder-suicide using aircraft.

"They are not identical events," they said. "Just as we would not equate someone who shot himself in a car outside a movie theater with a person who entered a mall and shot others before taking his own life, we should not equate pilots who kill themselves with pilots who choose to kill others."

New Requirements

In recent years — and particularly after the March 24, 2015, crash of Germanwings Flight 9525, an Airbus A320 flown into the ground by its suicidal copilot (*ASW*, 5/16, p. 12) — regulatory authorities have adopted new requirements or issued new recommendations intended to prevent accidents involving pilot suicide or murder-suicide (see "Changing Rules," p**. 37**).

In addition, some countries, including Canada and New Zealand, require medical practitioners to file a report with relevant authorities if they treat a pilot "for any condition that may impair him/her," the researchers said. "These laws circumvent privacy restrictions on the sharing of information to further public safety and public confidence in the aviation system."

Such mandatory reporting requirements might limit suicide and murder-suicide events, but "due to the disparate patterns of motivations and background factors we found in this study … , [they] would not provide a total shield," they wrote. Moreover, they said that mandatory reporting would have no effect on cases involving personal financial, occupational or legal factors.

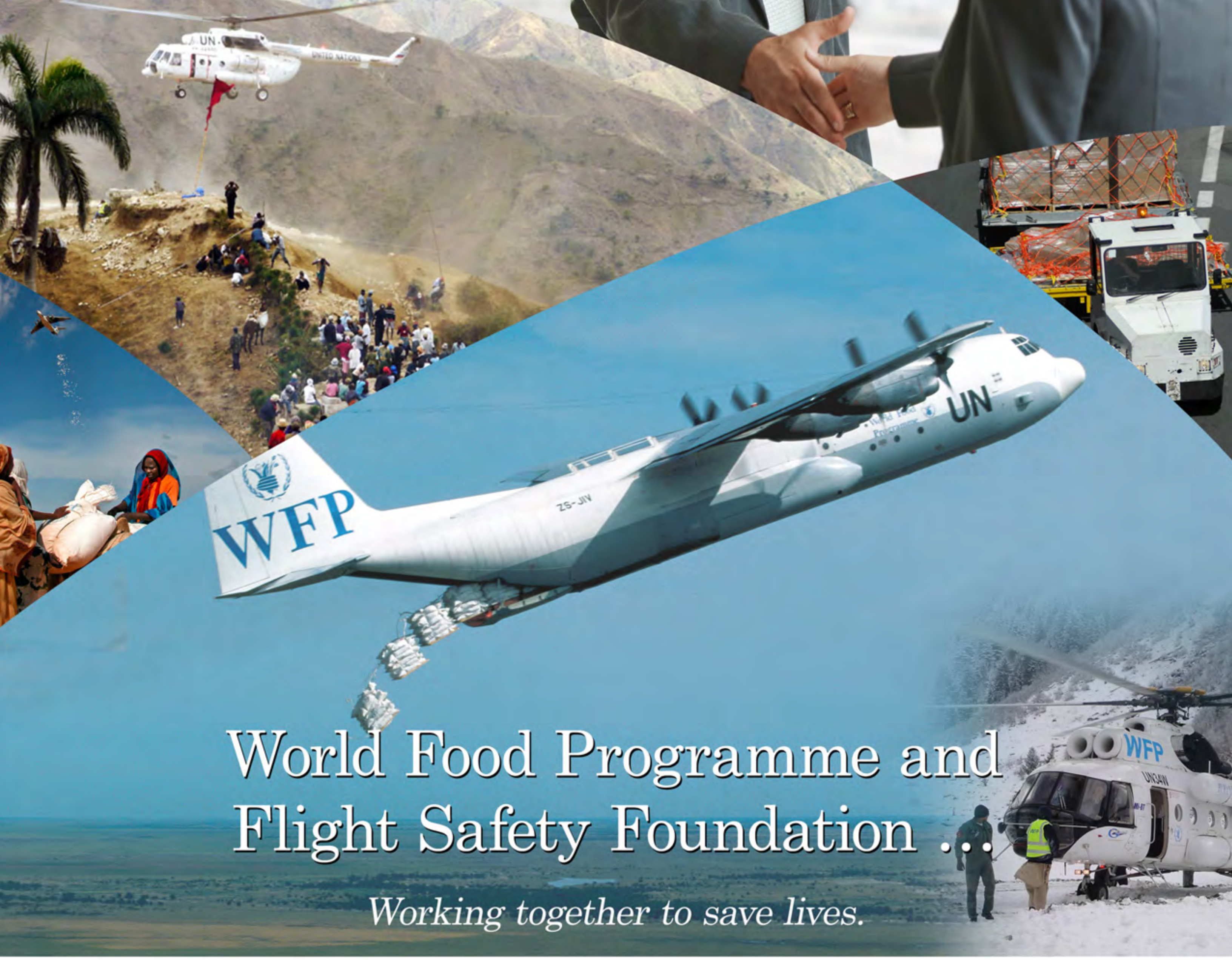
A more practical mitigation of this risk might involve the requirement — implemented by a number of regulators after the Germanwings crash — that the flight deck must always be staffed by two crewmembers.

The researchers cited an earlier study that concluded that chances of a suicide were 38.4 percent lower when two people were on the flight deck. However, they also said that there could be drawbacks to the presence of another person on the flight deck, which would lead to "more flow, more distractions"; in addition, in most jurisdictions, non-flying crewmembers have had less rigorous aeromedical screening than pilots, including less screening for mental illness.

Notes

1. Kenedi, Christopher; Friedman, Susan Hatters; Watson, Dougal; Preitner, Claude. "Suicide and Murder-Suicide Involving Aircraft." *Aerospace Medicine and Human Performance Volume* 87 (April 2016): 388–396.

2. The researchers excluded from their count politically and religiously motivated terrorist attacks, such as the September 2001 attacks in the United States.



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

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

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WFP United Nations World Food Programme

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FLIGHT SAFETY FOUNDATION

Safety specialists inevitably struggle to comprehend murder and/or suicide attributed to a flight crewmember.

BY THOMAS ANTHONY

The Rogue Pilot Phenomenon

Composite Illustration: Jennifer Moore
Pilot Image: © TatianaKrylova | iStockphoto


© Jeanine Bernard | "Malibu Creek State Park" | Oil on Canvas

The March 24, 2015, crash of Germanwings Flight 9525 brought the rogue pilot–intentional crash phenomenon to the forefront of aviation safety discourse. Unlike most aircraft accident investigations that first delve into physical evidence and data at the accident site, a rogue pilot–related investigation takes the accident investigator into non-traditional areas of inquiry, including the personal, and often private, lives of the flight crew.

While accident investigators have adeptly addressed human factors for decades via the lenses of crew resource management, threat and error management and human factors analysis and classification, intentional crashing of an aircraft by the pilot remains largely a dark corner of their professional knowledge. This article focuses on understanding these events from perspectives outside their domain so that investigators can take a confident step forward when indications of possible homicide and/or suicide arise in an accident investigation.

The article is not intended to review facts or conclusions of the Germanwings crash — which, the French Bureau d'Enquêtes et d'Analyses (BEA) said, occurred after the first officer locked the captain out of the cockpit and flew the Airbus A320 into the ground in the French Alps, killing all 150 passengers and crew. Rather, the article covers several events that fall into the rogue pilot–intentional crash category and a few broader theories of causality.

Precedents provide context. Also necessary is a clear understanding of the terms that may apply to these events (see "Definitions," p. 44). Let's examine the rogue pilot–intentional crash phenomenon from two complementary perspectives outside the field of aviation safety: first, as a crime that takes place within an aviation context; and second, as a human factors–psychological situation that has profound aviation safety repercussions.

I am not a mental health professional, but as a former investigator, I dedicated 18 years of my U.S. Federal Aviation Administration (FAA) and Transportation Security Administration career to the investigation and mitigation of unlawful acts against civil aviation. *Unlawful* implies *intentional*. Unlawful and intentional are two elements of the rogue pilot–intentional crash phenomenon.

I led the Los Angeles portion of the Egypt Air Flight 990 crash investigation[1] in cooperation with the U.S. Federal Bureau of Investigation (FBI), and I have directed and participated in dozens of investigations into intentional acts of unlawful interference against civil aviation, most notably hijackings and bombings of aircraft.

This article draws primarily from the work of two authors: John E. Douglas, special

agent (retired) of the FBI Behavioral Analysis Unit — who is considered the father of criminal profiling — and Thomas Joiner, a psychologist and expert on murder-suicide, a phenomenon that provides many relevant insights into rogue pilot–intentional crash psychology.

Mass Murder

The rogue pilot–intentional crash in commercial air transport fits within the definition of mass murder in the list of definitions noted. The commonalities and characteristics of individuals who commit mass murder, therefore, can inform our understanding. Douglas says, "Most violent crime careers have a quiet, isolated beginning within the offender's imagination." In his time with the FBI Behavioral Analysis Unit, Douglas offered the following metaphor to new investigators learning criminal profiling: "If you want to understand the artist, you have to look at the painting." In other words, the crime provides insights into the criminal. This observation has been significant because of the planned and premeditated nature of most of these cases. The specifics of the crime are planned and chosen, and reflect intention.

Training by Douglas also stresses the concept of victimology, in which a complete understanding of the relationship between the killer and the victim can often yield insights into the motive or the reason for the action to have taken place.

Some experts so far have concluded that a mass murderer will likely have an unusually active fantasy life. The internet has fed this, because, as Douglas said, "Old concepts of boundaries and borders and limitations are gone. ... People did things in cyberspace they might have never done anywhere else." Using the internet to research suicidal/homicidal intentions offers a sense of privacy, although law enforcement authorities typically can obtain records of this research after an event.

Some investigative organizations use a psychological model that can be called *the three selves* as a way of looking at any individual's behavior. This model posits that each of us can be seen as having "three selves." The first is the *social self,* who is known to friends, colleagues and other individuals with whom we routinely come into contact. The second self is the *personal self,* who is only shared with our spouse or other confidants. The third self is the *private self*, who is shared with no one else. It is often within this private self where the fantasy life exists and where, for some people, the seeds of plans to commit a violent crime or suicide grow. The collision of this private self and fantasy life with the real lives of the two external selves can be devastating. In 1998, for example, the U.S. Customs Service broke up an internet

The rogue pilot–intentional crash in commercial air transport fits within the definition of mass murder.

child pornography ring. As a result of the public disclosure of their involvement, four individuals committed suicide.

Cases have shown that the degree to which mass murderers succeed in keeping secret the criminal intentions developed in their fantasy lives is the most notable characteristic. In a case in 2000, in Olathe, Kansas, U.S., a middle-aged man named John Robinson contacted six women via the internet, developed a cyber-relationship with them and killed each of them over time. When convicted, neighbors recalled only normal behavior from him, and his wife and children denied that he was responsible.

The case of serial murderer Edmund Emil Kemper also has been cited by law enforcement authorities as another example of impenetrable secrecy and of his private self planning real homicides in his fantasy life. During one appointment with state psychiatrists in a period when he was not incarcerated — a day following one of the murders — Kemper was assessed as no longer a threat to himself or others.

Definitions

Homicide — The action, by a human being, of killing a human being (*The Oxford English Dictionary*).

Murder — The unlawful taking of human life.[1] The rogue pilot has no right to take the lives of the passengers; therefore this action is, at its most basic level, murder.

Mass murder — The unlawful killing of four or more victims by the same offender(s) acting in concert, at one location in a single continuous event that may last minutes, hours or days.[2]

Murder-suicide — The term that suicide researcher Thomas Joiner uses in *The Perversion of Virtue* to describe "a murder followed by a suicide." Joiner says that the intention to commit suicide comes first, and only once suicide is decided upon does the individual seek to justify his own death by the murder of others. He said, "Given the contingent nature of suicide and murder in these incidents, and given that both are tied together in perpetrators' minds by a perversion of virtue, it is not a surprise that the time interval between murder(s) and suicide is almost always on the order of minutes or hours." Further, Joiner said that "far from being impulsive," murder-suicide is premeditated.[3]

Psychosis — The mental disorder of not being able to distinguish reality from unreality; that is, of being delusional.

—TA

Notes

1. Douglas, B.B. *Crime Classification Manual* (3rd Edition).
2. Ibid.
3. Joiner, Thomas. *The Perversion of Virtue*. Oxford, England: Oxford University Press, 2014.

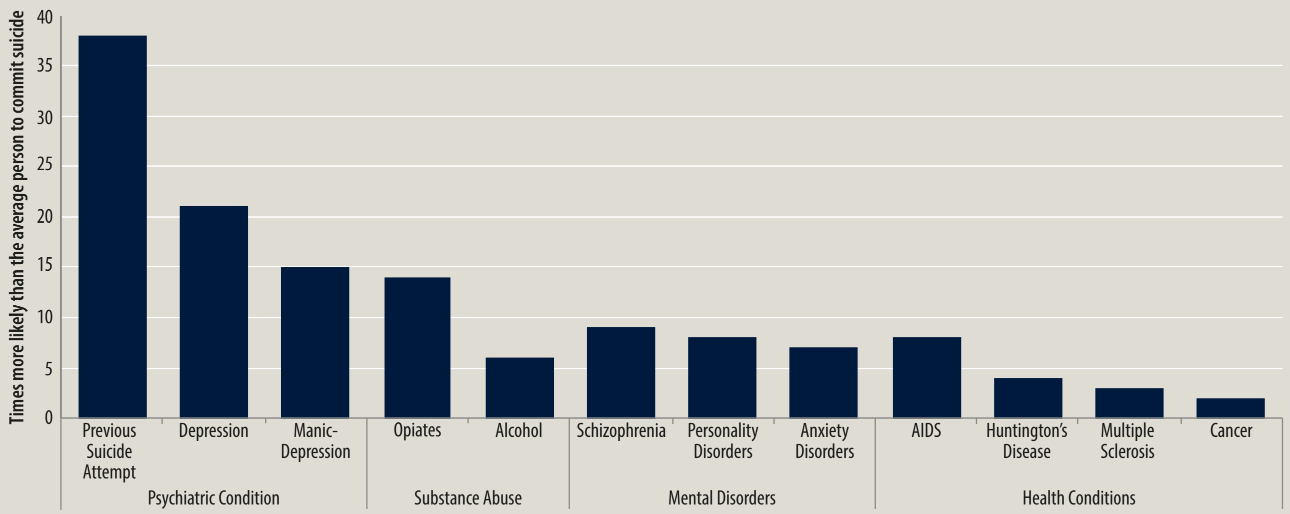
Psychology of Murder-Suicide

Joiner's book titled *The Perversion of Virtue* explains his theory of murder-suicide. As noted, the rogue pilot–intentional crash phenomenon in commercial air transport fits the definition of murder-suicide and the definition of mass murder. The central idea from Joiner's research is that cases of murder-suicide begin with an individual's intention to commit suicide. He states that suicide "is not only primary, but it is also the source of all that follows, especially including the appalling murders; murder occurs because of suicide, as a consequence of suicide having been settled on."

Joiner says that the thinking of such individuals can be summarized as "if I am to die, it is only virtuous that they do, too." He calls this thinking *perversion of virtue.* His theory holds that an individual reaches the conclusion — by suicidal ideation and commitment — to kill himself first and, only after this conclusion, moves to an internal justification of the murder of others. One type of ideation associated with some suicides includes making conclusions about personal burdensomeness and lack of effectiveness. The person concludes, "I am just a burden upon those that I care about" and "I really don't belong."

He describes four ideation themes, which he calls *virtues* that are operative in the minds of many of those studied after committing murder-suicide: justice, glory, mercy and duty. The justice-oriented thinking is, "Soon I'll be dead. But is it fair that I suffer that end while those who have deeply wronged me go unpunished and live happily on?" The case of a mentally ill university student, Seung-Hui

Suicide Risk of Individuals With Select Conditions



Note: This table shows the increased likelihood, as measured against the average, of someone with one of the identified conditions committing suicide. For example, an individual with cancer is twice as likely as the average person of committing suicide.

Source: Study by E. Clare Harris and Brian Barraclough; from *Night Falls Fast* by Kay Redfield Jamison. New York: Alfred A. Knopf, 1999.

Figure 1

Cho, who killed 32 people at Virginia Tech University in April 2007, has been cited as an example. In Cho's writings, he described his peers as "deceitful charlatans" and "rich kids" who engaged in "debauchery." Joiner points out that in the eyes of an individual enacting murder-suicide, the actions are not "cowardly, vengeful, or selfish." They are instead compelled to act by the perverse logic about virtue.

Copycat behavior — a way of attaining glory in this logic — emerged as a psychological element cited often in two cases in the history of U.S. murder-suicides. News reports said that in the 1999 attack at Columbine High School in Colorado, U.S., Eric Harris and Dylan Klebold killed 13 people before shooting themselves. Messages left said they had sought to achieve greater infamy than Timothy McVeigh, who killed 168 people in the bombing of the U.S. Federal Building in Oklahoma City in 1995. Similarly, the mass murder investigation of Charles Whitman — who on Aug. 1, 1966, killed 13 people and wounded 30 by gunfire from the University of Texas Tower — found that he was motivated to act on his previous fantasies, he told others, by news of the July 1966 killings of eight nurses in their Chicago dormitory.

Joiner also argues that because of psychological and practical barriers involved in succeeding at suicide, suicides and murder-suicides typically are not carried out on impulse or on the spur of the moment. Mental health professionals note that a person may follow a path leading through incidents of non-lethal self-harm and ultimately to lethal self-harm, he said.

How common is murder-suicide? Based on 24 studies in the United States covering 2004–2013, the range varied from 0.17 to 0.55 murder-suicides per 100,000 population, or a mean value of 0.32 per 100,000. According to the *Boeing 2013 Statistical Summary,* one rate of occurrence familiar to investigators in the operation of large commercial jets from 2004 through 2013 was 0.33 fatal accidents per 1 million departures, Joiner noted.[3]

In terms of death toll, murder-suicides resulted in 10 times more people killed than in commercial air transport crashes over 10 years. To put an even finer point on it, Joiner based this conclusion on data showing that there are 1,574 deaths per year due to murder-suicide in the United States. A 10-year average of commercial aviation fatalities in the United States from 2003 through 2012 was 15.3 per year.

As with murder-suicide, 90 percent of individuals who commit murder are male. And while 75 percent of the victims of murder are also male, 76 percent of the victims of murder-suicide are female.

It is important, however, to point out that the individual committing murder-suicide, according to Joiner, is generally not a psychopath. Psychopathic murderers derive pleasure from killing. This is not the same as the murder-suicide mentality noted, involving perversion of virtues.

Since most cases of murder-suicide involve the suicide as the precondition for both actions, what conditions increase an individual's likelihood of committing suicide? The results of 250 clinical studies done by E. Clare Harris and Brian Barraclough in England show the habituation to self-harm that Joiner says is necessary emotionally to move along a path to lethal self-harm. The results show depression and manic-depression (also known as bipolar disorder) as the primary preconditions seen for suicide, which also complements Joiner's explanation that suicidal ideation is based upon feeling a lack of belonging and a lack of effectiveness.

Two risk factors that increase a person's likelihood of suicide are living alone and the death of a partner within the previous two months. Joiner points out that disturbed sleep and nightmares also are related to suicide. Insomnia has also been linked to advanced depression and thoughts of suicide. He presents genetic and neurobiological explanations for these behaviors. The most significant neurochemical in the depression-suicide evolution is serotonin. Serotonin regulates emotion, sleep and appetite. Further, several studies have shown that suicidal predisposition is transmitted genetically through families and their descendants, he said.

Joiner also adds something that may seem contradictory. People can conduct activities that indicate that they are planning for the future yet also planning their own death in the short term. "Attention and emotion do not always operate in lockstep," he says.

What does all this mean to an aircraft accident investigator or other aviation safety professional? Situational awareness of a colleague's risk factors and adverse behavioral changes — and our own — can be a precursor of seeking help and influencing the favorable outcomes seen most often. Pilot suicides are extremely rare, and the incidence of rogue pilot–intentional crashes has been infinitesimal. Nevertheless, just because a pilot already has paid in full for his vacation next month, and his social self and personal self seem fine, we should recognize that potentially lethal problems of another person's private self may be impossible to identify in time to intervene.

Thomas Anthony is the director of the Aviation Safety and Security Program at the University of Southern California.

Notes

1. U.S. National Transportation Safety Board (NTSB). NTSB/AAB-02/01, *Aircraft Accident Brief: EgyptAir Flight 990, Boeing 767-366ER, SU-GAP; 60 Miles South of Nantucket, Massachusetts; October 31, 1999*. March 31, 2002. Flight 990 crashed into the Atlantic Ocean near Nantucket, Massachusetts, U.S., on Oct. 31, 1999, killing all 217 people on board. U.S. accident investigators said the crash resulted from the relief first officer's control inputs. Egyptian authorities challenged that conclusion.

2. NTSB. Accident Report DCA88MA008. Dec. 7, 1987.

3. According to Joiner, there are approximately 38,500 deaths by suicide annually in the United States. Murder-suicides account for 2 percent of the total.

Accidents, Fatalities Down in 2015

BY FRANK JACKMAN

The global accident rate for scheduled commercial operations involving aircraft with a maximum takeoff weight (MTOW) of more than 5,700 kg (12,566 lb) declined to 2.8 accidents per 1 million departures in 2015 — its lowest point in the past five years, according to the *ICAO Safety Report 2016 Edition,* released in July by the International Civil Aviation Organization (ICAO). The 2014 accident rate was 3.0 accidents per million departures (Figure 1).

The ICAO statistics for 2015 show declines in the number of accidents, the number of fatal accidents and the number of fatalities when compared to 2014 data. The total number of scheduled commercial aviation accidents declined to 92 last year. That represents a 5.1 percent improvement from 2014's 97 accidents, but still is greater than the 90 accidents recorded in 2013, which is the low point for the five-year period under review. The number of fatalities recorded in 2015 fell sharply from 2014, but still was significantly higher than in 2013 (Figure 2).

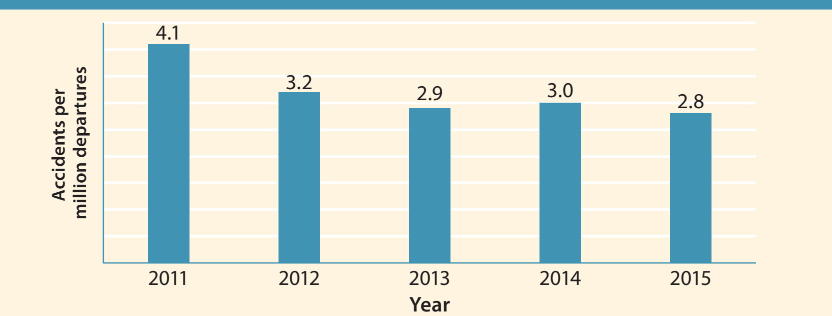
"The 474 fatalities in 2015 represent a substantial decrease from the 904 fatalities in 2014, despite the tragic events of the Germanwings and Metrojet accidents, which caused significant loss of life," the ICAO report said. "The aviation community remains focused on achieving the highest level of cooperation among the various safety stakeholders. To keep pace with expansion and progress sector-wide, ICAO continues to promote the development and implementation of new safety initiatives."

The crash of Germanwings Flight 9525 in March 2015 killed 150 passengers and crew, including the co-pilot, who investigators determined intentionally flew the aircraft into the ground in the French Alps. The October crash of Metrojet Flight 9268 in Egypt resulted in the deaths of 224 passengers and crew. ICAO has placed Germanwings in the "other" category and Metrojet in the "unknown" category.

The number of fatal accidents in scheduled commercial aviation last year declined to six, from seven in 2014 and nine in 2013. Fatal accidents in the past five years peaked at 19 in 2011 (Figure 3, p. 48).

ICAO has identified runway safety–related events, loss of control–in flight (LOC–I) and controlled flight into terrain (CFIT) as high-risk accident occurrence categories (HRC). According to ICAO analysis, these three high-risk categories accounted for 57 percent of accidents, 50 percent of fatal accidents and 10 percent of fatalities in 2015 (Figure 4, p. 48).

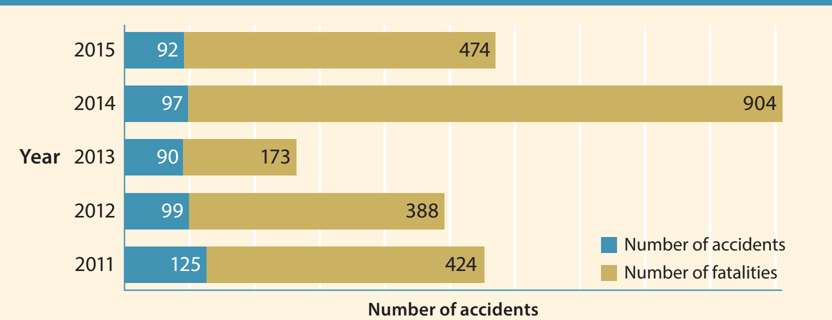
ICAO Global Accident Rate



Source: *ICAO Safety Report 2016 Edition*

Figure 1

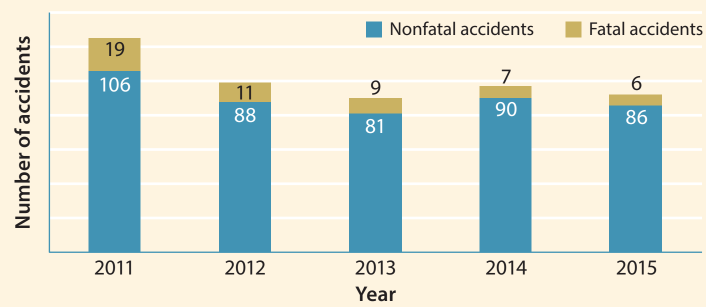
Accidents Involving Scheduled Commercial Flights



Source: *ICAO Safety Report 2016 Edition*

Figure 2

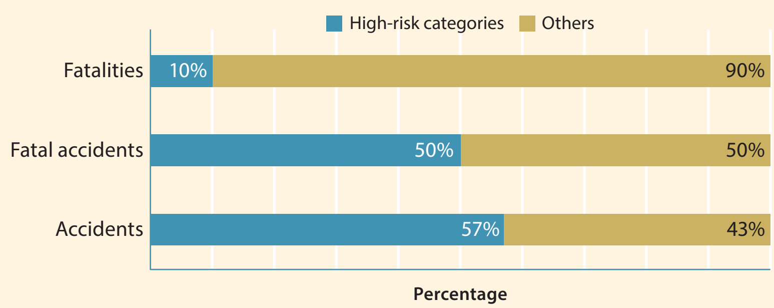
Accident and Fatal Accident Trend



Source: *ICAO Safety Report 2016 Edition*

Figure 3

High-Risk Category Accident Distribution

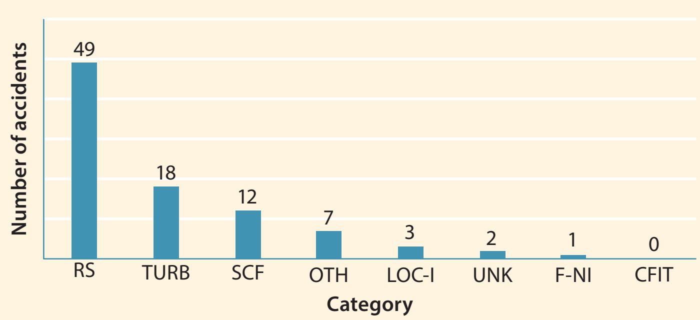


Note: ICAO has identified runway-safety related events, loss of control–in flight and controlled flight into terrain as high-risk accident occurrence categories, and uses these categories as a baseline in its safety analysis.

Source: *ICAO Safety Report 2016 Edition*

Figure 4

Commercial Aviation Accidents by Category, 2015



CFIT = controlled flight into terrain; F-NI = fire–non-impact; LOC-I = loss of control–in flight; OTH = other; RS = runway safety; SCF = system component failure; TURB = turbulence encounter; UNK = unknown

Source: *ICAO Safety Report 2016 Edition*

Figure 5

For the first time in recent history, scheduled commercial operations did not suffer any CFIT accidents in 2015. Runway safety-related events accounted for 53 percent of all accidents last year and 17 percent of fatal accidents, but only 0.2 percent of all fatalities. LOC-I accounted for 3 percent of all accidents, but 33 percent of fatal accidents and 9 percent of fatalities, ICAO said. The Germanwings and Metrojet accidents accounted for 79 percent of all fatalities recorded in 2015. Eighteen accidents fell into the turbulence encounter category and 12 into the system component failure category (Figure 5).

ICAO analyzes safety data based on its Regional Aviation Safety Group (RASG) geographic areas. There are five RASGs: Pan America (PA), which comprises North and South America and the Caribbean, Africa (AFI), the Middle East (MID), Europe (EUR) and the Asia and Pacific (APAC) region (Table 1).

The PA region, which is one of the largest regions geographically, accounted for roughly 13 million, or 40 percent, of worldwide scheduled commercial departures in 2015, and for about 37 percent, or 34, of the 92 total accidents (Figure 6). The region had only one fatal accident and two fatalities. The region's overall accident rate was 2.6 accidents per million departures. The APAC and MID regions had the lowest accident rates at 2.5 accidents per million departures each. The EUR accident rate was 3.0 and the AFI rate was 7.3 accidents per million departures.

The EUR and MID regions, with the Germanwings and Metrojet accidents, accounted for 32 and 47 percent, respectively, of all the fatalities. The APAC region, however, had half of the fatal accidents — three, which resulted in 98 fatalities. The AFI region did not suffer any fatal accidents in 2015.

Each ICAO member state is expected to establish and implement an effective safety oversight system, and ICAO's Universal Safety Oversight Audit Programme Continuous Monitoring Approach (USOAP CMA) is intended to measure the effective implementation (EI) of a state's safety oversight program. To standardize audits conducted as part of USOAP CMA, ICAO has established protocol questions that are based on its safety-related standards and recommended practices established in the various annexes to the Chicago Convention, Procedures for Air Navigation Services, ICAO DOC-series documents and guidance material. Each protocol question contributes to assessing the effective implementation of one of eight critical elements in one of the eight audit areas. USOAP results for 2015 show that the EI percentage is highest in the airworthiness audit area (73.5 percent) and lowest in accident investigation (54.4 percent).

Six years ago, ICAO, the U.S. Department of Transportation, the European Commission and the International Air Transport Association (IATA) signed a memorandum of understanding on a Global Safety Information Exchange (GSIE), the object of which is to identify information that can be exchanged between the parties to enhance risk reduction activities. The GSIE developed a harmonized accident rate through close cooperation between ICAO and IATA to align accident definitions, criteria and analysis methods. The joint analysis includes accidents meeting the ICAO Annex 13, *Aircraft Accident and Incident Investigation*, criteria for all typical commercial airline operations for scheduled and non-scheduled flights, ICAO said.

A total of 104 accidents, including scheduled and non-scheduled commercial operations and ferry flights for aircraft with an MTOW of more than 5,700 kg were considered as part of the harmonized criteria. The GSIE accident rate last year was about 2.75 accidents per million sectors, down from nearly 3.5 accidents per million sectors in 2014. The harmonized injuries-to-persons accident rate was just under 0.5 per million sectors.

GSIE has seven accident categories: CFIT, LOC-I, runway safety (RS), ground safety, operational damage (OD), injuries to and/or incapacitation of persons (MED), other and unknown. More than 50 of the 104 accidents considered under GSIE were categorized as RS-related, with the next two most common categories — MED and OD — both coming in at just under 20 accidents each. RS events include runway excursions and incursions, undershoot/overshoot, tail strike and hard landing events. OD is defined as damage sustained by the aircraft while operating under its own power, and includes in-flight damage, foreign object debris and all system or component failures. MED covers all injuries or incapacitations sustained by anyone coming into direct contact with any part of the aircraft structure. It includes turbulence-related injuries; injuries to ground staff coming into contact with the structure, engines or control surfaces; and on-board injuries or incapacitations and fatalities not related to unlawful external interference.

Overview by RASG Region

RASG	Estimated Departures (in millions)	Percent of Departures	Accidents	Accident Rate**	Fatal Accidents	Fatalities
AFI	0.8	2%	6	7.3	0	0
APAC	9.8	30%	24	2.5	3	98
EUR	8.1	25%	24	3.0	1	150
MID	1.2	3%	3	2.5	1	224
PA	13.0	40%	34	2.6	1	2
World	32.9	—	92*	2.8	6	474

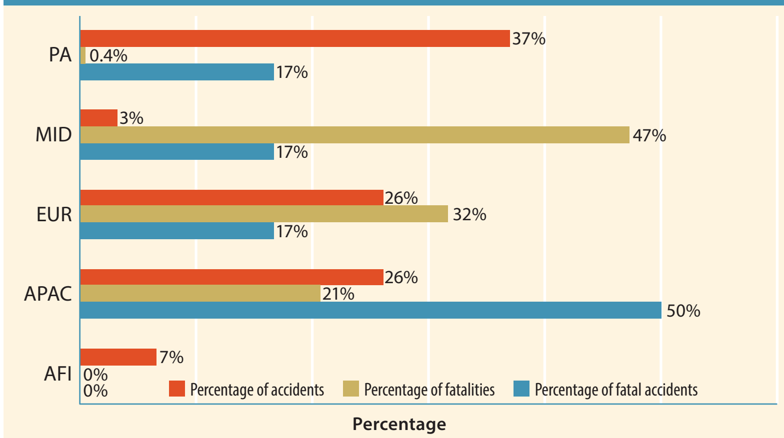
AFI = Africa; APAC = Asia and Pacific; EUR = Europe; MID = Middle East; PA = Pan America; RASG = regional aviation safety group

*One accident occurred in oceanic airspace and is not attributed to any region.
** Per million departures

Source: *ICAO Safety Report 2016 Edition*

Table 1

Accident Overview by RASG Region



AFI = Africa; APAC = Asia and Pacific; EUR = Europe; MID = Middle East; PA = Pan America; RASG = regional aviation safety group

Note: Numbers do not total 100 percent because of rounding.

Source: *ICAO Safety Report 2016 Edition*

Figure 6

SKYbrary

TheSingle Point

of reference in the network of Aviation safety knowledge

SKYbrary Partners

SKYbrary was initiated by EUROCONTROL in partnership with the following organisations:

- ICAO
- Flight Safety Foundation

The initiative aims at developing a comprehensive source of aviation safety information and make it available to users worldwide.

'In the Same Boat'

Deteriorating weather and dwindling fuel forced the pilots of two 737s to attempt landings below minimums.

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

Inaccurate Forecasts

Boeing 737-800s. No damage. No injuries.

The forecasts obtained by the flight crews of two 737s the morning of June 18, 2013, indicated that the weather conditions at their common destination — Adelaide, South Australia — would be such that planning for alternate airports was not even required.

However, as the aircraft proceeded toward Adelaide, unexpected fog began to significantly affect conditions in the area.

The aircraft were operated by different airlines. One of the 737s, Flight 1384, departed from Brisbane, Queensland, with 85 passengers and six crewmembers, at 0638 Australian Eastern Standard Time (AEST), with an expected time of arrival at Adelaide of 0920 AEST.

The other aircraft, Flight 735, departed from Sydney, New South Wales, at 0727 AEST, with 146 passengers and six crewmembers, and was scheduled to arrive in Adelaide at 0917 AEST.

"Both flight crew uploaded sufficient fuel for the originally forecast conditions in accordance with their operators' fuel policy and Civil Aviation Safety Authority requirements," said the report by the Australian Transport Safety Bureau (ATSB). As mentioned, however, extra fuel to reach alternate airports was not required.

As the aircraft proceeded westbound toward the destination, the forecast was revised twice — first, to indicate the possibility of fog developing at Adelaide and, subsequently, to indicate that fog had developed at the airport but was expected to clear by 0900, before the aircraft arrived.

The 737s were nearing Adelaide when the fog decreased visibility below approach minimums, and the forecast for improvement was revised to 0930. Based on this information and on reports of significantly better weather at Mildura, about 200 nm (370 km) east of Adelaide, the crews of both aircraft elected to divert to Mildura.

However, the weather conditions at Mildura also began to deteriorate rapidly. A special weather observation at 0918 indicated that visibility was better than 10 km (6 mi) but that the ceiling had lowered to 200 ft. Subsequent observations indicated that visibility also was decreasing in mist.

As the 737s neared the airport at 0936, visibility had decreased to 2,100 m (about 1 1/4 mi).

Although the visibility was sufficient for the global positioning system (GPS) approach to Runway 27 at Mildura, the ceiling was below the minimum of 660 ft (493 ft, above ground level, AGL).

The report said that, at this point, neither aircraft had sufficient fuel to divert to another airport. The crew of Flight 735 radioed on the uncontrolled airport's common traffic advisory frequency that they were going to conduct the

GPS approach "due to fuel." The crew of Flight 1384 then radioed that they were "in the same boat."

At 0946, the crew of Flight 735 radioed that they had gained visual contact with the runway after descending below the cloud base at 150 ft AGL and had subsequently landed. The crew also reported that the fog appeared to be clearing.

The crew of Flight 1384 entered a holding pattern while awaiting improvement in the weather. However, with no indication of improvement in the weather conditions, they attempted the GPS approach. They were unable to see the runway on the first attempt and initiated a go-around from 132 ft AGL at 1004.

"The aircraft was positioned for a second approach, during which the cabin crew were briefed and prepared for an emergency landing, briefing the passengers to brace accordingly," the report said. "At 1014, [Flight 1384] landed at Mildura in foggy conditions with fuel below the required reserves."

The report said that, in response to ATSB recommendations based on the investigation of the incident, Airservices Australia and the Bureau of Meteorology had taken steps to improve the dissemination of information about significantly deteriorating weather conditions.

'Lapse in Concentration'

Beech Premier, Robinson R22. No damage. No injuries.

Visual meteorological conditions (VMC) prevailed at Port Elizabeth, South Africa, the afternoon of Sept. 2, 2014. The R22 pilots were engaged in an instrument instructional flight and had established radio communication with approach control while climbing northeast-bound during a go-around from Runway 06 at the airport.

At the time, the Premier, with four passengers aboard, was nearing the airport from the northeast. The pilot had been cleared to descend to 4,000 ft.

Both aircraft were being handled by a student controller under the supervision of an instructor controller. The student controller had been on duty for four hours, and both controllers had returned from a break about 13 minutes earlier.

When one of the R22 pilots checked in on the approach control frequency, the student controller instructed him to climb to 3,000 ft. "The pilot incorrectly read back 4,000 ft, but there appears to [have been] a lapse in concentration by the [student] controller, who did not notice this error," said the report by the South African Civil Aviation Authority (CAA). The error also was not noticed by the instructor controller, who was working on the duty roster at the time.

Moreover, the altitude read-back error was not detected by either of the helicopter pilots, and the climb was continued to 4,000 ft.

The conflict between the helicopter and the jet was detected by the approach control facility's clear level alert monitoring (CLAM) system, but neither the student controller nor the instructor controller noticed the warning displayed on their radar screens.

"The CLAM amber warning on both the controllers' display screens was on for four minutes without any intervention by either controller," the report said, noting that the system's aural warning feature was deactivated at the time.

The report also noted that a red short-term conflict warning did not appear on the radar screens because the helicopter was traveling more slowly than the 90-kt threshold programmed in the system software.

The Premier was level at 4,000 ft when the pilot received a traffic-alert and collision avoidance system (TCAS) warning on his primary flight display and turned right to take evasive action. Recorded radar data showed that the aircraft passed within 1 nm (2 km) laterally and 100 ft vertically.

The Premier pilot landed at Port Elizabeth without further incident. The CAA credited his evasive action as likely having prevented a major accident. The helicopter pilots never saw the jet and were not aware of the near-head-on collision until after they landed.

Battery Bus Fails

Boeing 737-300. Minor damage. One minor injury.

En route from Spain, the 737 was descending to land at England's East Midlands Airport the evening of Sept. 3, 2014, when the commander noticed that the public-address system wasn't working.

Several indications then disappeared from the pilots' flight displays, and faults occurred with an equipment cooling fan, the weather radar, standby instruments and other equipment.

The flight crew diagnosed the anomalies as having been caused by failure of the battery bus. The aircraft was landed successfully, but while it was being taxied to the stand, an acrid mist began forming in the cabin and flight deck, said the report by the U.K. Air Accidents Investigation Branch (AAIB).

The commander declared an emergency and ordered an evacuation. One passenger sustained minor injuries during the evacuation.

Investigators found that the bus failure was caused by relay terminals that had become loose, causing a break in continuity. This resulted in deactivation of the air cycle machine cooling fans, which caused dust and oil residue on hot duct surfaces to ignite and release fumes that subsequently entered the cabin and flight deck.

TURBOPROPS

'Insufficient Fuel'

Beech King Air C90. Substantial damage. One serious injury, two minor injuries.

Before beginning a multiple-leg business flight the afternoon of Sept. 19, 2013, the pilot checked the fuel gauges and found that the nacelle tanks were full, with about 60 gal (227 L) in each, but that the main tanks were nearly empty. He had 30 gal (114 L) of fuel pumped into each of the main tanks before departing with two passengers from Idaho Falls, Idaho, U.S., for the first leg to Pocatello, about 45 nm (83 km) away.

After another passenger was boarded, the King Air was flown to Boise, about 165 nm (306 km) from Pocatello. The pilot later told investigators that, after landing, the nacelle tanks appeared to be full and that the main tanks "were not empty."

However, he "did not note the actual quantity of fuel," said the report by the U.S. National Transportation Safety Board (NTSB).

The pilot had 40 gal (151 L) of fuel added to the main tanks at Boise. After a five-hour meeting, the pilot flew the airplane back to Pocatello, where the passenger who had been picked up there earlier deplaned.

Although the precise amount of fuel remaining in the airplane could not be determined, investigators concluded that the pilot took off from Pocatello to Idaho Falls with "significantly less" fuel than the manufacturer's recommended minimum of 39.5 gal (150 L) in each wing fuel system. Beech Aircraft calculated that the King Air would have consumed about 28.5 gal (108 L) during this last leg of the flight.

"While on final approach to the home airport, both engines stopped developing power, and the pilot conducted a forced landing to a field about 1.2 [nautical] miles [2.2 km] short of the runway," the report said.

One passenger was seriously injured, the other passenger and the pilot sustained minor injuries, and the airplane was substantially damaged during the forced landing.

Propeller Moves Into Beta

DeHavilland Twin Otter. Substantial damage. One serious injury, one minor injury.

The two pilots and their passenger were conducting an aerial observation flight that began in Washington, Pennsylvania, U.S., the morning of Sept. 6, 2015. VMC prevailed that afternoon as the pilots prepared to land on the 2,650-ft (808-m) runway at a private airport in Louisburg, North Carolina.

As the pilot reduced power on final approach, he heard sounds similar to the right propeller moving into beta mode, in which the blade angle varies from ground idle to maximum reverse. The pilot increased power, and the sound ceased.

"As the airplane got closer to the runway, he decreased the engine power, and the sound returned," said the NTSB report. "In addition, the airplane began to yaw right. The pilot applied left aileron and rudder inputs to remain above the runway centerline without success."

When the pilot applied full power to initiate a go-around, the Twin Otter yawed 30 degrees right, touched down in a grassy area and struck trees. The passenger was not hurt, but the copilot was seriously injured and the pilot sustained minor injuries.

Investigators found that the airplane had been flown for nine hours after the right propeller was overhauled two days earlier. Post-accident tests revealed no anomalies, "However, the speed settings were improperly configured [and] the beta valve travel from the neutral position was out of tolerance," the report said.

"Although this could have let oil pressure port to one side of the spool or the other — and thus changed the propeller blade angle — it could not be determined whether this occurred during the accident landing."

Stressed and Distracted

Piper Cheyenne II. Substantial damage. No injuries.

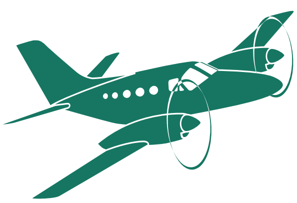
The Cheyenne was en route on a medevac flight from Reno, Nevada, U.S., to Oakland, California, the night of Sept. 23, 2014. The pilot later told investigators that he struggled to keep the airplane on the localizer and glide path while conducting an instrument landing system (ILS) approach to Oakland.

"As the airplane descended through 800 to 900 feet above the ground, he broke out of the cloud layer but had difficulty locating the runway in the dark night conditions," the NTSB report said. "During the landing flare, he reduced the throttle, and as the airplane touched down on the runway surface, he realized the landing gear were retracted; he did not hear any [warning] horns."

The Cheyenne's lower fuselage and engine mounts were substantially damaged, but the passenger and the three crewmembers were not injured.

"The pilot recalled that when he selected the landing gear, he may have put the handle in neutral rather than keeping his hand on the lever and waiting for the three green lights to illuminate, confirming the extended position," the report said.

The pilot also said that he did not conduct the Before Landing checklist because of the demands of the ILS approach. "He also cited a few stressors in his life that may have contributed to a distraction, including a change of airplanes and few ILS approaches performed in the recent six months," the report said.



PISTON AIRPLANES

VMC Roll

Cessna 421C. Destroyed. One fatality.

The pilot was conducting the first flight of the 421 the afternoon of Dec. 8, 2012, following an annual inspection and repainting. He performed a lengthy engine run-up before initiating the takeoff from Lantana, Florida, U.S.

"The airplane lifted off about halfway down the runway and initially climbed at a normal rate," the NTSB report said. "Several witnesses then observed the airplane suddenly yaw to the left [as] the airplane's nose continued to pitch up. … The airplane rolled left and descended vertically, nose-down."

One witness, a flight instructor, told investigators that the 421 appeared to have entered an uncommanded roll at V_{MC} (minimum controllable airspeed with one engine inoperative).

The NTSB concluded that the probable cause of the accident was "the pilot's failure to follow established engine-out procedures and to maintain a proper airspeed after the total loss of [left] engine power." The left propeller had been feathered, but the landing gear had not been retracted.

Examination of the left engine revealed contact between the piston domes and the valves, separation and distortion of the crankcase halves, and other internal damage. Investigators determined that there had been a loss of torque on the crankcase bolts, but they were unable to determine the reason due to impact- and fire-related engine damage.

The 421's maintenance records showed that there was no requirement for the crankcase bolts to be loosened since the most recent overhaul of the engine more than three years and 314 flight hours earlier.

Discontinued Go-Around

Piper Aztec. Destroyed. No injuries.

Instrument meteorological conditions (IMC) and a 10-kt tailwind prevailed as the pilot conducted an NDB (nondirectional beacon) approach to St. Mary's Airport on England's Scilly Isles the afternoon of Aug. 20, 2015.

"At MDA [minimum descent altitude], having not acquired any visual references, the pilot commenced a go-around," the AAIB report said. "Shortly thereafter, the pilot saw the precision approach path indicators (PAPIs), discontinued the go-around and continued to land."

The Aztec touched down about 200 m (656 ft) beyond the threshold of the 603-m (1,978-ft) runway. "Believing the aircraft was too fast to stop before the end of the runway [with a precipice beyond], the pilot steered it to the right," the report said.

The report said that the aircraft was damaged beyond economic repair during the excursion, but the pilot and his two passengers escaped injury.

Incorrect Bushings

Beech 76 Duchess. Substantial damage. No injuries.

A student pilot under the supervision of a flight instructor was conducting touch-and-go landings at Weston Airport near Dublin, Ireland, the afternoon of Sept. 20, 2013. After a series of circuits of the airport, the left main landing gear collapsed on touchdown, and the Duchess veered off the runway into a grassy area. Damage was substantial, but the occupants were not hurt.

Examination of the landing gear revealed that incorrect bushings — made from aluminum bronze rather than corrosion-resistant steel — had been installed on the lower lugs of the shock absorber.

The steel bushings require no lubrication, and there was no provision for lubricating the aluminum-bronze fittings. Friction between the bushings and the shock absorber pin caused increased wear on the components and the eventual failure of the pin and collapse of the landing gear.

HELICOPTERS

Obstacle Alert

Eurocopter AS350-B3. Destroyed. Three fatalities.

Night VMC prevailed when the pilot and two medical crewmembers departed from Memphis, Tennessee, U.S., to pick up a patient at a hospital in Bolivar, Tennessee, on Oct. 22, 2013.

Satellite tracking data showed that the helicopter was following a highway when it entered a right, climbing turn near Somerville, Tennessee, and crashed in a wooded area at 1,116 ft. "The helicopter impacted the trees at a steep angle, and the orientation of the main wreckage was indicative of a loss of control before impact," the NTSB report said.

A nearby airport was reporting a few clouds at 800 ft and a broken ceiling at 1,200 ft. Two obstacles were near the impact site: an unlighted and nonoperational cellular tower and a water tower. The NTSB concluded that the pilot likely lost control after inadvertently entering IMC while responding to an obstacle warning by the on-board helicopter terrain awareness and warning system.

There were night vision goggles aboard the helicopter, and the pilot had been trained on their use. However, "the helicopter was not equipped for flight under instrument flight rules," the report said.

Skewed Tail Rotor Bearing

Airbus EC130-B4. Substantial damage. No injuries.

En route on a positioning flight the afternoon of Aug. 12, 2014, the helicopter was on approach to Norway's Rørvik Airport to refuel. As it crossed 5 to 10 m (16 to 33 ft) above the threshold at 30 kt, the helicopter began to rotate left.

"The pedals had no effect, and the rotation increased rapidly, said the report by the Accident Investigation Board Norway (AIBN).

"The helicopter rotated twice around its own axis before it was landed on the runway. … The helicopter hit the ground somewhat hard." The pilot and loadmaster were not hurt, and the helicopter was not damaged during the forced landing.

Examination of the helicopter revealed that the tail rotor shaft had fractured due to the incorrect installation of a shaft bearing during scheduled maintenance 98 flight hours before the incident. The AIBN determined that the bearing had not been positioned correctly on the shaft.

"The work was performed without the correct measuring tools, and the described procedure in the AMM [aircraft maintenance manual] was not followed," the report said. "This caused a skewed installation of the bearing. … The incorrect installation led to cyclic loads in the tail rotor shaft which eventually caused a fracture," the report said.

<table>
<tr><th colspan="5">Preliminary Reports, June 2016</th></tr>
<tr><th>Date</th><th>Location</th><th>Aircraft Type</th><th>Aircraft Damage</th><th>Injuries</th></tr>
<tr><td>June 3</td><td>Mountain City, Tennessee, U.S.</td><td>Bell 407</td><td>substantial</td><td>1 minor, 3 none</td></tr>
<tr><td colspan="5">The pilot heard a loud bang as the medevac helicopter departed from a parking lot and began yawing left. He sustained minor injuries during the subsequent forced landing.</td></tr>
<tr><td>June 4</td><td>Ilaga, Indonesia</td><td>Cessna 208B</td><td>substantial</td><td>2 NA</td></tr>
<tr><td colspan="5">No fatalities were reported when the Grand Caravan overran the runway while landing and traveled down a hillside before striking a fence.</td></tr>
<tr><td>June 4</td><td>Yambio, South Sudan</td><td>Antonov 30A-100</td><td>substantial</td><td>30 NA</td></tr>
<tr><td colspan="5">No fatalities were reported when the An-30 touched down at midfield on the 1,000-m (3,281-ft) airstrip, overran the runway, crossed a highway and came to a stop after the nose landing gear collapsed.</td></tr>
<tr><td>June 5</td><td>Neryungri, Russia</td><td>British Aerospace 125-800B</td><td>substantial</td><td>8 none</td></tr>
<tr><td colspan="5">Night instrument meteorological conditions (IMC) prevailed when the Hawker struck trees on approach about 18 km (10 nm) from the runway. The flight crew regained control and landed the substantially damaged aircraft without further incident.</td></tr>
<tr><td>June 6</td><td>Seoul, South Korea</td><td>McDonnell Douglas MD-11F</td><td>substantial</td><td>4 NA</td></tr>
<tr><td colspan="5">No fatalities were reported when the nose landing gear collapsed and the engines struck the ground as the freighter overran the runway during a rejected takeoff.</td></tr>
<tr><td>June 10</td><td>Apopka, Florida, U.S.</td><td>Cessna 310G</td><td>substantial</td><td>1 none</td></tr>
<tr><td colspan="5">The pilot was conducting a post-maintenance check flight when the left brake failed on landing and the 310 veered off the side of the runway.</td></tr>
<tr><td>June 11</td><td>Marina di Cecina, Italy</td><td>Pilatus PC-6</td><td>destroyed</td><td>2 fatal, 7 none</td></tr>
<tr><td colspan="5">The parachute on the last skydiver to exit the Turbo Porter opened prematurely and snagged the aircraft's tail. The pilots were killed when the aircraft struck the ground out of control, but the skydiver survived by activating his emergency parachute.</td></tr>
<tr><td>June 12</td><td>Jonesboro, Arkansas, U.S.</td><td>Robinson R44</td><td>destroyed</td><td>1 fatal</td></tr>
<tr><td colspan="5">A witness said the pilot told him that he was going to put on an air show. He saw the R44 climb steeply before descending out of sight behind hangars. He heard the sound of an impact and saw the helicopter rise above the hangars with apparent damage to the landing skids and tail rotor. The R44 then struck terrain and burned.</td></tr>
<tr><td>June 14</td><td>Bishop, California, U.S.</td><td>Bell 206L-1</td><td>substantial</td><td>3 none</td></tr>
<tr><td colspan="5">The LongRanger was descending to land when the pilot heard an explosion in the engine compartment. The helicopter touched down hard during the subsequent autorotative landing.</td></tr>
<tr><td>June 14</td><td>Lolat, Papua, Indonesia</td><td>Cessna 208B</td><td>destroyed</td><td>4 none, 3 NA</td></tr>
<tr><td colspan="5">Three people in a house were injured when it was struck by the Grand Caravan during approach.</td></tr>
<tr><td>June 14</td><td>Bor, South Sudan</td><td>Antonov 32A</td><td>substantial</td><td>3 none</td></tr>
<tr><td colspan="5">No fatalities were reported when the An-32 overran the runway while landing.</td></tr>
<tr><td>June 16</td><td>State College, Pennsylvania, U.S.</td><td>Piper Navajo</td><td>destroyed</td><td>2 fatal</td></tr>
<tr><td colspan="5">IMC prevailed when the Navajo struck trees during an instrument landing system approach to Runway 24.</td></tr>
<tr><td>June 19</td><td>Beja, Portugal</td><td>Pilatus PC-6</td><td>destroyed</td><td>1 fatal, 7 NA</td></tr>
<tr><td colspan="5">The Turbo Porter was climbing when the skydivers on-board heard a bang in the tail section. The pilot was killed and the passengers were injured when the aircraft crashed out of control.</td></tr>
<tr><td>June 19</td><td>Kharg, Iran</td><td>British Aerospace 146-300</td><td>substantial</td><td>88 NA</td></tr>
<tr><td colspan="5">No fatalities were reported when the aircraft overran the runway while landing.</td></tr>
<tr><td>June 19</td><td>Hayward, California, U.S.</td><td>Piper Apache</td><td>destroyed</td><td>1 fatal</td></tr>
<tr><td colspan="5">The Apache struck a railroad utility vehicle after the pilot radioed that the left engine had lost power on approach.</td></tr>
<tr><td>June 23</td><td>Wikieup, Arizona, U.S.</td><td>Robinson R66</td><td>destroyed</td><td>2 fatal</td></tr>
<tr><td colspan="5">The R66 was en route from Prescott, Arizona, to Riverside, California, when it struck terrain.</td></tr>
<tr><td>June 26</td><td>Dervenochoria, Greece</td><td>Canadair CL-215</td><td>destroyed</td><td>2 minor</td></tr>
<tr><td colspan="5">The CL-215 was on a fire fighting mission when the left engine caught fire. The aircraft was destroyed during the subsequent forced landing.</td></tr>
<tr><td colspan="5">NA = not available
This information, gathered from various government and media sources, is subject to change as the investigations of the accidents and incidents are completed.</td></tr>
</table>

The Foundation would like to give special recognition to our BARS Benefactors, Benefactor and Patron members. We value your membership and your high levels of commitment to the world of safety. Without your support, the Foundation's mission of the continuous improvement of global aviation safety would not be possible.

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Pratt & Whitney A United Technologies Company

TransAsia

DOMINION DIAMOND

Cerrejón Responsible Mining

ILUKA

Downer

Copa Airlines

FREEPORT-McMoRAN COPPER & GOLD

BARRICK

NEWCREST MINING LIMITED

GLENCORE

International SOS

WorleyParsons resources & energy

NEWMONT

GOLD FIELDS

PATRONS

BOMBARDIER the evolution of mobility

CAE

WFP World Food Programme

Gulfstream A GENERAL DYNAMICS COMPANY