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THE JOURNAL OF FLIGHT SAFETY FOUNDATION

MARCH 2013

58TH ANNUAL BUSINESS AVIATION SAFETY SEMINAR

BASS 2013



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THE FOUNDATION AND Business Aviation



Did you know that Flight Safety Foundation counts more than 600 business aviation-related companies and organizations among its members? Many think that the Foundation focuses primarily on the global airline industry, but business aviation also is a focal point, as exemplified by our annual Business Aviation Safety Seminar (BASS), formerly known as the Corporate Aviation Safety Seminar, and our long-running Business Aviation Committee.

This year's BASS is scheduled for April 10–11 in Montreal, and we are very pleased to have the National Business Aviation Association (NBAA) as a co-presenter and the Canadian Business Aviation Association (CBAA) as a supporter. NBAA represents more than 8,000 member companies of all sizes across the United States, and CBAA has 430 member companies and organizations, including operators, management companies and suppliers.

Together, our three organizations have thousands of members involved with business aviation in this region of the world, which makes a formidable, collective voice for safety in the business aviation segment. So one could ask, what can be done with that influence?

FSF, NBAA and CBAA all have safety committees that work on issues that will benefit not only their members but also all of business aviation. Topics such as terrain avoidance, stabilized approaches, runway excursions, and safety management system (SMS) programs have been discussed and worked on; lots of good things have come from the committees.

I recently talked with a couple of the top professionals in business aviation, and our discussion

led to what will become some of the items we will work on next. Our focus items will be training, fatigue and data. To write in detail about each one of these items would take more column inches than I have been allotted.

What I will say is that training for business aviation operations must be revisited. Different operations have different needs. Let those needs dictate the training, not the training dictate the needs. Fatigue issues, particularly in long-range business operations, need to be better understood. Air carriers have figured out a minimum standard, and business aviation needs to do the same.

The key to the next generation of safety enhancements will be the collection and sharing of data. Effective collection and standardization of data will move safety from being reactive to predictive. Being predictive will help business aviation operations mitigate threats. Many of you are participating in data gathering programs. The question is how are you using that data? By sharing data (with the usual protocols), comparisons to similar aircraft types and airport operations can be extremely helpful.

So take those thousands of business aviation entities and focus them on these three items, and just see how far we can go!

A stylized, handwritten signature in white ink, consisting of three distinct parts: a large 'K', a smaller 'L', and a large 'H'.

*Capt. Kevin L. Hiatt
President and CEO
Flight Safety Foundation*

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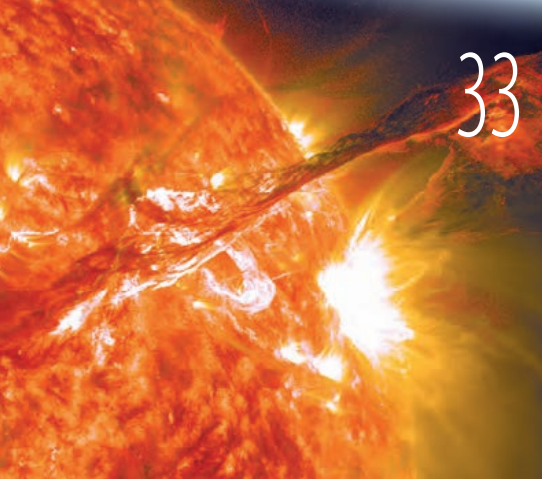
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This Sukhoi Superjet struck Mount Salak in Indonesia.
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If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about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

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A New Perspective

BY DAVID MCMILLAN



Wayne Rosenkrans

AeroSafety World is a key tool for us at Flight Safety Foundation to keep in contact with you, the professionals who keep the world's aviation system safe for all its users. So we thought it would be good to add to the mix a few words from the volunteer leadership of the Foundation, both to offer our perspective on current issues and to encourage you to continue actively to support the Foundation.

I took over as chairman of the Board of Governors at a vibrant and interesting International Air Safety Seminar (IASS) in Santiago, Chile, in October. It was an honor to become the first person from outside North America to serve as chairman. At IASS, I was heartened to see support for the Foundation from safety professionals from all over the globe. It was particularly encouraging to hear many Latin American voices engaging in the discussions and bringing their local experience to the debate. Clearly, Latin America's aviation safety leaders are resolved to continue to improve their system's safety performance. That is just as well, because — unlike

in Europe — aviation is growing fast in the Latin America and Caribbean region, a welcome fact, but one that poses its own challenges.

Participation at such events keeps you up to date with the latest thinking. It also supports the Foundation through revenue from participation fees, so I would strongly encourage you to attend FSF seminars. But I understand that it can be hard to fit such events into busy lives. So I ask you to consider supporting the Foundation in other ways — in particular, by becoming a member. Individual membership is not expensive, but every dollar, euro or pound goes to the great cause of advocating aviation safety across the globe. Another important way of supporting the Foundation is through checking that the organization you work for has itself shown its commitment to safety by becoming a corporate member.

There have been other important changes in recent weeks at the Foundation. Our longstanding president and CEO, Bill Voss, who is well known far beyond the Foundation faithful, decided that it was time to return to the U.S. Federal Aviation Administration in

a senior safety role. We do, of course, wish Bill all the best for this next stage in his impressive career. But we will miss his enthusiasm, his tireless efforts to get safety onto the top of everyone's to-do list and his commitment to doing things right. Bill literally went to the ends of the earth — regularly — to get the good word out. The world's news reporters, who considered him the go-to guy for dealing with aviation safety issues, will also miss him. He had a knack for explaining complex issues in terms that could be understood by a wide audience.

But the good news is that we were able to promote Kevin Hiatt, previously our chief operating officer, to the president and CEO role. This will give the Foundation needed continuity at a challenging time for all not-for-profit organizations, and put at our disposal a true aviation professional, who has held major safety roles at some of the world's biggest carriers. Kevin has all the support of the Board of Governors, and I know that, with his appointment, the Foundation continues to be in great hands.

Fly safely! ➡

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➤ Flight Data Monitoring (FDM) & Flight Operational Quality Assurance (FOQA) in Commercial Aviation	16 - 19 Sept 2013
➤ Airworthiness Fundamentals	16 - 20 Sept 2013
➤ Hazards and Evidence Awareness for Air Accident Responders	25 - 26 Sept 2013
➤ Accident Investigation for Aviation Management	28 Oct - 08 Nov 2013
➤ Practical Reliability	04 - 08 Nov 2013
➤ Legal Skills for Accident Investigators	18 - 22 Nov 2013

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Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 1,000 individuals and member organizations in 150 countries.

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THREAT FROM Below

In February, a U.S. Coast Guard C-130 on approach to Kalaeloa Airport in Hawaii was hit by the beam from a laser pointer. According to media reports, no one was hurt, but it was the third time in four months that a Coast Guard aircraft operating in the region had been tagged by a laser. Here at Flight Safety Foundation, we fielded a report in January from a pilot at a European airline who days earlier had been on final approach to an airport in Brazil when his aircraft was attacked by “a strong green laser” for about 45 seconds as he was passing the outer marker. The crew’s night vision was affected, but they continued and landed the aircraft without additional problems.

A quick Internet search turns up numerous reports and statements of concern about laser interference with flight from airlines, pilot unions, regulators and law enforcement officials around the world. The laser targeting of aircraft, particularly low-flying aircraft, is growing and dangerous. According to data from the U.S. Federal Aviation Administration, the number of reported laser incidents grew from 283 in 2005 to 3,591 in 2011, the latest year for which complete data are available.

Despite the increase in attacks, we have been lucky. “No accidents have been attributed to the illumination of crewmembers by lasers, but given the sizeable number of reports and debilitating effects that can accompany such events, the potential does exist,” the FAA says on its website.

But how long will that luck hold out? This is particularly frustrating because it is in many

ways a security issue out of the hands of aviation safety professionals. We cannot control the sale of relatively cheap and increasingly powerful hand-held lasers, or the urge of individuals to point the devices at aircraft.

Laser attacks are a threat to all types of aviation, and combating them will take coordination among all of the industry’s various interest, regulatory and labor groups. We must step up efforts to remind the public that pointing a laser at an aircraft is dangerous and against the law. We need to encourage flight crews to report all incidents of laser targeting, no matter how seemingly minor, and we need to urge local, provincial/state and national law enforcement agencies and courts to actively enforce the laws and prosecute violators. Beyond that, legislation to restrict the sale of certain lasers should be considered, as should working with laser manufacturers to develop more effective warning labels for their products.

FAA offers a variety of laser-related information on a special website it launched in 2011 <faa.gov/go/laserinfo> and it also has available a brochure on the subject at <faa.gov/pilots/safety/pilot-safetybrochures/media/laser_hazards_web.pdf>.

A large, stylized black ink signature of Frank Jackman, consisting of a series of fluid, overlapping loops and strokes.

Frank Jackman
Editor-in-Chief
AeroSafety World

MARCH 11-15 ➤ Aircraft Maintenance

Investigation. Southern California Safety Institute. San Pedro, California, U.S. Denise Davalloo, <denise.davallo@scsi-inc.com>, <www.scsi-inc.com/AMl.php>, +1 310.940.0027, ext.104. (Also AUG. 26-30.)

MARCH 12-13 ➤ Safety Across High-Consequence Industries Conference.

Parks College of Engineering, Aviation and Technology, Saint Louis University. St. Louis, Missouri, U.S. Damon Lercel, <dlercel@slu.edu>, <www.slu.edu>, +1 314.977.8527.

MARCH 12-13 ➤ Risk Management.

ScandiAvia. Stockholm. <morten@scandiavia.net>, <bit.ly/U9yyPm>, +47 91 18 41 82.

MARCH 18-20 ➤ CHC Helicopter Safety and Quality Summit.

Vancouver, British Columbia, Canada. <summit@chc.ca>, <bit.ly/tmyQll>, +1 604.232.7424.

MARCH 18-22 ➤ Investigation Management.

Southern California Safety Institute. San Pedro, California, U.S. Denise Davalloo, <denise.davallo@scsi-inc.com>, <www.scsi-inc.com/IM.php>, +1 310.940.0027, ext.104.

APRIL 3 ➤ Safety Show-Down.

North Texas Business Aviation Association. Addison, Texas (near Dallas). Marj Rose, mrose@market-lift.com, www.ntbaonline.com, +1 214.862.8992.

APRIL 9-11 ➤ Heliport Evaluation Course.

U.S. Department of Transportation, Transportation Safety Institute. Oklahoma City, Oklahoma, U.S. Lisa Colasanti, <AviationTrainingEnrollment@dot.gov>, <1.usa.gov/WD7WWR>, +1 405.954.7751. (Also JUNE 11-13.)

APRIL 10-11 ➤ 58th annual Business Aviation Safety Seminar.

Flight Safety Foundation and National Business Aviation Association. Montreal. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/aviation-safety-seminars/business-aviation-safety-seminar>, +1 703.739.6700, ext. 101.

APRIL 11-13 ➤ Internal Evaluation Program Theory and Application.

U.S. Transportation Safety Institute. Oklahoma City, Oklahoma, U.S. Troy Jackson, <troy.jackson@dot.gov>, <www.tsi.dot.gov>, +1 405.954.2602. (Also SEPT. 17-19.)

APRIL 15-17 ➤ Ops Conference.

International Air Transport Association. Vienna. <www.iata.org/events/Pages/ops-conference.aspx>.

APRIL 15-19 ➤ OSHA/Aviation Ground Safety.

Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, case@erau.edu, <bit.ly/wtWHln>, +1 386.226.6000.

IATA Ops Conference 2013 to Focus on Safety

The International Air Transport Association (IATA) Ops Conference 2013, scheduled for April 15-17 in Vienna, will focus on driving forward the industry agenda on all issues related to safety, security, operations and infrastructure, according to IATA. Safety-related issues and agenda topics expected to be addressed include maximizing the benefits of operational and safety data; enhanced IOSA (the IATA Operational Safety Audit program); cargo safety with a focus on lithium batteries; improving pilot training provisions; and promoting regional safety initiatives. Other topics to be addressed include the promotion of infrastructure efficiency; moving toward paperless operations in maintenance and aircraft transfers; increasing airport and airspace capacity and efficiency; and the Security Checkpoint of the Future.

Expected keynote speakers include Tony Tyler, CEO and director general of IATA; Doris Bures, Austria's minister of transport, innovation and technology; Raymond Benjamin, secretary general of the International Civil Aviation Organization; Jaan Albrecht, CEO of Austrian Airlines; Patrick Goudou, executive director of the European Aviation Safety Agency; and Peggy Gilligan, associate administrator, U.S. Federal Aviation Administration.

The three-day event is structured to blend workshops, interactive sessions and streamed discussions with traditional plenary sessions to create an effective learning and discussion environment, IATA said.

More information is available on IATA's website at <iata.org/ops>.

APRIL 22-26 ➤ Aviation Safety Program

Management. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, case@erau.edu, <bit.ly/wtWHln>, +1 386.226.6000.

APRIL 23-25 ➤ International Accident

Investigation Forum. Air Accident Investigation Bureau of Singapore. Singapore. Steven Teo, <steven_teo@mot.gov.sg>, fax: +65 6542-2394.

APRIL 29-MAY 3 ➤ Aircraft Accident

Investigation. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, case@erau.edu, <bit.ly/wtWHln>, +1 386.226.6000.

APRIL 30-MAY 2 ➤ Maintenance

Management Conference. National Business Aviation Association. Fort Worth, Texas, U.S. <info@nbaa.org>, <www.nbaa.org/events/mmc/2013>, +1 202.783.9000.

MAY 2-3 ➤ Air Transportation of

Hazardous Materials. U.S. Department of Transportation, Transportation Safety Institute. Anchorage, Alaska, U.S. Lisa Colasanti, <AviationTrainingEnrollment@dot.gov>, <1.usa.gov/VRFRYQ>, +1 405.954.7751. (Also JULY 30-AUG. 1, Oklahoma City, Oklahoma, U.S.)

MAY 6-10 ➤ Advanced Aircraft Accident

Investigation. Embry-Riddle Aeronautical University. Prescott, Arizona, U.S. Sarah Ochs, case@erau.edu, <bit.ly/wtWHln>, +1 386.226.6000.

MAY 13-17 ➤ SMS Theory and Principles.

MITRE Aviation Institute. McLean, Virginia, U.S. Mary Beth Wigger, maimail@mitre.org, <bit.ly/14E7NFV>, +1 703.983.5617. (Also JULY 15-18, SEPT. 16-20, DEC. 9-13.)

MAY 14-16 Advanced Rotorcraft

Accident Investigation. U.S. Department of Transportation, Transportation Safety Institute. Oklahoma City, Oklahoma, U.S. Lisa Colasanti, <AviationTrainingEnrollment@dot.gov>, <1.usa.gov/ZM138r>, +1 405.954.7751.

MAY 16-17 ➤ Air Medical and Rescue

Congress. China Decision Makers Consultancy. Shanghai, China. <info@cdmc.org.cn>, <www.cdmc.org.cn/2013/amrc>, +86 21 6840 7631.

MAY 20-24 ➤ Unmanned Aircraft Systems.

Southern California Safety Institute. Prague, Czech Republic. Denise Davalloo, <denise.davallo@scsi-inc.com>, <www.scsi-inc.com/unmanned-aircraft-systems.php>, +1 310.940.0027, ext.104.

MAY 21-23 ➤ European Business Aviation Convention & Exhibition (EBACE). European Business Aviation Association. Geneva, Switzerland. <www.ebace.aero/2013>.

MAY 30-31 ➤ 2Gether 4Safety African Aviation Safety Seminar. AviAssist Foundation. Lusaka, Zambia. <events@aviassist.org>, <bit.ly/TtMkqD>, +44 (0)1326-340308.

JUNE 4-6 ➤ Advanced Commercial Aviation Accident Investigation. U.S. Department of Transportation, Transportation Safety Institute. Oklahoma City, Oklahoma, U.S. Lisa Colasanti, <AviationTrainingEnrollment@dot.gov>, <1.usa.gov/XY6yet>, +1 405.954.7751.

JUNE 6-7 ➤ Overview of Aviation SMS and Proactive Hazard ID and Analysis Workshop. ATC Vantage. Tampa, Florida, U.S. <www.atcvantage.com/sms-workshop.html>, +1 727.410.4759. (Also NOV. 7-8.)

JUNE 21 ➤ Dangerous Goods Training Course for Safety Assessment of Foreign Aircraft Programme Inspectors. Joint Aviation Authorities Training Organisation. Hoofddorp, Netherlands. <jaato.com/courses/106/#>. (Also DECEMBER 13.)

JUNE 21-23 ➤ Flight Attendants/Flight Technicians Conference. National Business Aviation Association. Washington, D.C. Jay Evans, <jevans@nbaa.org>, <www.nbaa.org/events/fat/2013>, +1 202.783.9353.

JUNE 24-28 ➤ Safety Assessment of Aircraft Systems. Cranfield University. Cranfield, Bedfordshire, England. <shortcourse@cranfield.ac.uk>, <bit.ly/TMAE39>, +44 (0) 1234 754192. (Also NOV. 25-29.)

JULY 10 ➤ Hazardous Materials Air Shipper Certification Public Workshop. Lion Technology. Dedham, Massachusetts, U.S. (Boston area). Chris Trum, <info@lion.com>, <bit.ly/XNDWUv>, +1 973.383.0800.

JULY 29-AUG. 2 ➤ Fire and Explosion Investigation. Southern California Safety Institute. San Pedro, California, U.S. Denise Davalloo, <denise.davallo@scsi-inc.com>, <www.scsi-inc.com/FEI.php>, +1 310.940.0027, ext.104.

OCT. 14-16 ➤ SAFE Association Annual Symposium. SAFE Association. Reno, Nevada, U.S. Jeani Benton, <safe@peak.org>, <www.safeassociation.com>, +1 541.895.3012.

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

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

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

OCT. 22-24 ➤ SMS II. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Beth Wigger, <mainmail@mitre.org>, <bit.ly/YJofEA>, +1 703.983.5617.

OCT. 23-25 ➤ 65th annual International Air Safety Summit. Flight Safety Foundation and Latin American and Caribbean Air Transport Association. Washington, D.C. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/aviation-safety-seminars/international-air-safety-seminar>, +1 703.739.6700, ext. 101.

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ULTIMATE Indicator



Over the past six to eight weeks we have seen a multitude of articles, interviews and other sources of information telling us how safe 2012 was for commercial aviation. According to each source and specific safety metrics, operators of large commercial jets enjoyed one of the safest years on record, if not the safest. In fact, the 2012 metrics show about a 50 percent improvement over 2011, in itself a record year. Everyone in aviation should be proud to achieve such performance. But, as aviation professionals, we know that challenges continue, especially because all the commercial jet accidents we saw in 2012 were preventable.

The accident rate is the ultimate safety *performance* indicator, and may in fact be an indication of a declining latent risk in operations, especially when analyzed over long periods. However, it is important to understand that precursors to accidents (safety *risk*) continue to exist in aviation. System failures and human errors sometimes produce “near misses,” which fly below the public radar, often just one or two variables away from being classified as accidents.

In other words, the absence of an accident does not indicate a lack of

possibility. For the purposes of safety management systems, “safety” has been defined as “the reduction of risk to a level that is as low as reasonably practicable [ALARP].” Understanding that accident metrics are a measure of how the system performed during a specific period, but not necessarily of how much safety risk exists in current or future operations, safety professionals continue to focus on managing latent risk to the ALARP level.

In effect, the safety level is a measure of the risk posed by hazards in the aviation system, not necessarily a measure of past consequences of those hazards. As we have seen in the past, latent conditions may not manifest as an accident for a long time, and may not become readily visible until the accident happens. If we are truly moving to proactive and predictive safety management, we will need to enhance the ability to identify and manage low-probability, high-severity hazards, focusing on the overall impact and context of the hazards as they relate to other deficiencies and safety barriers, not just focus on the probability of the hazard causing an event.

The consequence of a hazard, although considered “low probability,” also may be more severe as a result of

interaction with other system failures. For example, in the case of Air France Flight 447, each failure was arguably a low-probability hazard, which drives down the overall risk (using the current established process). But if you could somehow identify the possible interfaces with other hazards, you could develop safety barriers to prevent the interaction of hazards. With large amounts of data gathered through maturing safety programs (state safety programs, safety management systems), we often can see precursors to accidents when performing post-accident investigations and analysis. Our challenge is to enhance the tools and methodology for identifying the systemic hazards that cause these issues and unwanted states, and mitigate risk posed by those hazards *before* they actually cause an event.

Aviation is an extremely safe mode of transportation, but for aviation professionals, the reduction of risk remains the number one goal. Enhancement of strategies to identify causes of accidents before they happen must continue to be a priority. The Flight Safety Foundation is committed to this goal of preventing the preventable. 🍌

— Rudy Quevedo
Director of Global Programs

Susan Reed

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49th Edition



Measuring the safety performance of 2012.

This year's edition will feature a return of the Cabin Safety section and a new five-year focus making available in-depth correlations and trends for Safety Managers to use.

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787 Fire Source Identified

A malfunction in a single cell of a Japan Airlines (JAL) Boeing 787 lithium ion battery triggered the Jan. 7 fire in the airliner, which was parked at Boston Logan International Airport, the U.S. National Transportation Safety Board (NTSB) says.

"After an exhaustive examination of the JAL lithium ion battery, which was comprised of eight individual cells, investigators determined that the majority of evidence from the flight data recorder and both thermal and mechanical damage pointed to an initiating event in a single cell," the NTSB said.

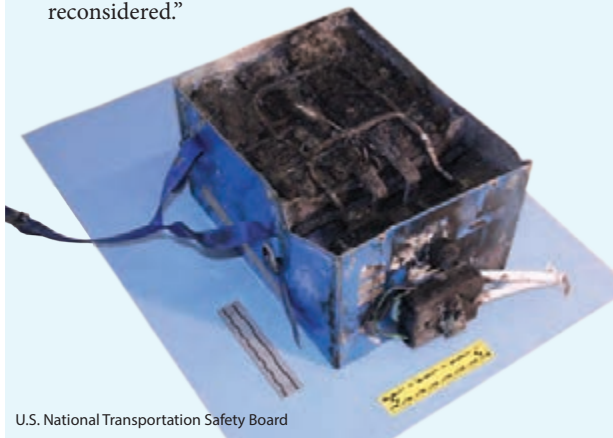
"That cell showed multiple signs of short circuiting, leading to a thermal runaway condition, which then cascaded to other cells. Charred battery components indicated that the temperature inside the battery case exceeded 500 degrees F [260 degrees C]."

The battery fire and other similar events, including a Jan. 16 in-flight incident on an All Nippon Airways 787, prompted the U.S. Federal Aviation Administration and other civil aviation authorities to ground all 787s worldwide until Boeing can show that the batteries are safe.

The NTSB said potential causes of the battery fire in the JAL airplane had not been determined, but investigators were reviewing "the design and construction of the battery and the possibility of defects introduced during the manufacturing process."

NTSB Chairman Deborah Hersman said that Boeing had concluded during the 787's certification process that "the likelihood of a smoke emission event from a 787 battery would occur less than once in every 10 million flight hours."

However, the two critical battery events occurred with fewer than 100,000 flight hours, Hersman said, adding, "The failure rate was higher than predicted as part of the certification process and the possibility that a short circuit in a single cell could propagate to adjacent cells and result in smoke and fire must be reconsidered."



U.S. National Transportation Safety Board



© PRIVOLZHISKY investigatory management on transport

Runway Excursions

Citing several incidents so far in 2013, the Russian Federal Air Transport Agency, Rosaviatsiya, has issued a safety bulletin intended to prevent runway or taxiway excursions associated with snow- or ice-covered runways.

Aviation Safety Network reported five recent incidents in snow conditions in which passenger airplanes ran off runways or taxiways at Russian airports. Human factors and low runway friction coefficients were considered major factors in the incidents.

In the safety bulletin, the agency said that major airport operators should ensure friction coefficients are acceptable before airplanes are operated on runways and taxiways, and that airlines should tell their flight crews about runway and taxiway excursions and provide guidance for operations on snow- and ice-covered runways and taxiways.

Cabin Altitudes Rising

Peak cabin altitudes have gotten higher in recent years, increasing the likelihood that passengers with some heart and lung problems may need supplemental oxygen during flights, according to a study by medical personnel at the Virginia Mason Medical Center in Seattle.

Physicians participating in the study carried mountaineering altimeters to measure peak cabin altitude during 207 domestic commercial flights in the United States from 2005 through 2011.

The average peak cabin altitude was 6,341 ft, which the physicians considered significantly higher than the average peak cabin altitude of 5,673 ft measured during a similar study published in 1988.

The 2013 study found that peak cabin altitudes on commercial airplanes generally were less than 8,000 ft, although on about 10 percent of flights, the measurement was more than 8,000 ft.

The study, published in the January issue of *Aviation, Space, and Environmental Medicine*, recommended that physicians consider the likely cabin altitude when determining a patient's need for supplemental oxygen during a flight.

ADS-B Deadline

Australian airlines and business jet operators have been given until December to equip their aircraft with automatic dependent surveillance–broadcast (ADS-B) equipment to allow for satellite-based aircraft tracking.

The Australian Civil Aviation Safety Authority (CASA) has set Dec. 12 as the deadline for ADS-B equipment installation for “domestic and foreign operators of business jet and airline aircraft flying at and above FL 290 [Flight Level 290, or approximately 29,000 ft].”

CASA said that, according to an Airservices Australia estimate, more than 80 percent of Australian-registered aircraft operating at and above FL 290 are ready for ADS-B surveillance. Only 8 percent of Australian-registered business jet aircraft are equipped with ADS-B, however.

Aircraft that are not equipped with ADS-B by the December deadline will not be permitted to operate above FL 290, “resulting in less operational flexibility and the potential for delays due to the procedural separation standards that will be applied outside radar airspace,” CASA said.



Australian Civil Aviation Safety Authority

Updated Roadmap

The European Aviation Safety Agency (EASA) has revised its plan for tackling major aviation safety risks, identifying 86 actions to be implemented by 2016.

The European Aviation Safety Plan (EASp) is intended to establish “a common focus for the entire European aviation community” and “a practical link between high-level safety issues and actions to be implemented by states, partner organisations, the aviation industry and EASA itself,” EASA said.

The agency said one recently completed initiative of the EASp was the European Action Plan for the Prevention of Runway Excursions — a product of the efforts of a number of aviation industry organizations.

The action plan includes a series of recommendations to aircraft operators, air navigation service providers, airports and regulatory authorities.

The International Air Transport Association (IATA), one of the organizations involved in the plan’s development, said that in 2011, 13 percent of all accidents in European airspace were runway excursions, compared with 19 percent worldwide.

“The action plan is the latest element in our global effort, complementing the Runway Excursion Risk Reduction Toolkit, which was revised in 2011,” said Guenther Matschnigg, IATA senior vice president for safety, operations and infrastructure. “Together they build a common awareness of the issue among the key players, and that will allow us to continue to reduce the risks and the occurrences.”

The action plan “ensures that all the players in Europe are aligned and focused on a common set of tools to improve runway safety,” Matschnigg added. “Along with making European aviation even safer, it sets a good example of cooperation that could be taken up in other regions.”

Boeing, Embraer Developing Excursion Toolkit

Boeing and Embraer are working together to develop a set of Runway Situation Awareness Tools to reduce runway excursions, the two manufacturers announced. In the near-term, Boeing and Embraer will provide customers with new pilot procedures and a training video on landing performance. “In the longer term, the companies also will develop joint technology and systems for the flight deck to improve pilot information about approach and landing,” they said in a joint statement.

The new pilot procedures have been developed and are in the process of being disseminated, which is expected to be completed within the next few months, according to a Boeing executive. The training video also is expected to be released this year. As of mid-December, there were no specific timelines on the implementation of the flight deck technology and systems, although the technology design has been completed, according to Corky Townsend, director of aviation safety for Boeing Commercial Airplanes. She also said some, but not all, of the features will be available for retrofit on existing aircraft.

The two companies also said their broad strategy to reduce runway excursions could be used by pilots flying other commercial aircraft, “supporting overall industry safety.”

Frank Jackman



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Wider SMS Use Urged

The Transportation Safety Board of Canada (TSB) has produced a video to encourage small commuter and air taxi operators to adopt safety management systems (SMS) to help identify hazards, assess risks and develop mitigation strategies.

Larger operators have been required since 2005 to have an SMS in place.

Bryce Fisher of TSB said in the video that 91 percent of commercial aviation accidents in Canada and 93 percent of the resulting fatalities involve commuter and air taxi operations.

Many of these operations are associated with flights to remote areas with limited infrastructure, older aircraft with less sophisticated navigational warning systems, and crews with less experience, in comparison with larger operations.

"SMS is a tool that can help small operators find trouble before trouble finds them," Fisher said, noting that Transport Canada is considering making SMS mandatory for these operators and the TSB hopes that "they'll get a head start and begin to integrate SMS into their day-to-day operations."

The TSB added, "An effective safety management system can help reduce accidents and save lives."



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Pilot Rest Rules Challenged

The labor union representing pilots for cargo carrier UPS is challenging the U.S. government's exclusion of cargo pilots from duty and rest rules that will apply to pilots of passenger aircraft and has produced a benefit cost analysis (BCA) that it says "demonstrates the value of including cargo pilots in the new rule."

The Independent Pilots Association (IPA) offered the BCA as an alternative to an analysis issued by the U.S. Federal Aviation Administration (FAA) in support of its decision not to extend the rules to cargo pilots.

The IPA said its analysis found that the FAA "substantially overstated the costs and understated the benefits" of including both passenger and cargo pilots under the rules, which will take effect in 2014.

The IPA's comments were submitted in response to the FAA's supplemental regulatory impact analysis on the cargo pilot exclusion.

The FAA issued revised flight and rest requirements for pilots of commercial passenger airliners in January 2012, about 15 years after an earlier effort at rule-making had collapsed, primarily because of airline opposition. The IPA filed suit, asking a federal appeals court to extend the rules to cargo pilots. The court case is pending.

Under the rule, the passenger airline pilots will be required to have at least a 10-hour rest period before reporting for duty — two hours longer than now required. In addition, the limit on flight time will be eight or nine hours, and the limit on duty time will be between nine and 14 hours, depending on a number of factors, including the pilot's starting time.

More Help Urged for Small Carriers

The U.S. Federal Aviation Administration (FAA) has not provided enough assistance to smaller air carriers that must meet new safety standards and has not followed through on plans to help the carriers develop safety programs, a government watchdog agency says.

The Department of Transportation's Office of Inspector General (OIG) said in a January report that 12 percent of small carriers — those with 15 aircraft or fewer — have flight data monitor-

ing programs to track aircraft crew performance. In comparison, more than 90 percent of large carriers have implemented these programs.

"Until FAA takes a more focused approach, working with and assisting smaller carriers, the full safety benefits associated with these programs will not be realized," the OIG report said.

The flight data monitoring programs were required under legislation passed by Congress in 2010, in the aftermath of the Feb. 12, 2009, crash of a Colgan Air Bombardier Q400 during approach to Buffalo Niagara (New York, U.S.) International Airport. All 49 people in the airplane and one person on the ground were killed in the accident and the airplane was destroyed.

The U.S. National Transportation Safety Board said the probable cause of the accident was the captain's "inappropriate response to the activation of the stick shaker, which led to an aerodynamic stall from which the airplane did not recover."

The OIG report credited the FAA with prompt attention to many elements of the legislation, including voluntary safety programs, pilot rest requirements and risk management. However, the agency has encountered industry opposition and delays in several areas, including the development of small carrier safety programs and rules on pilot qualification and training, the report said.



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In Other News ...

Data compiled by the U.S. National Transportation Safety Board (NTSB) show that there were no **fatalities** resulting from airline crashes in 2011 and that air taxi fatalities increased to 41, up from 17 in 2010. About 90 percent of the 494 deaths in aviation in 2011 involved fatalities in general aviation. ... The International Civil Aviation Organization and the Civil Air Navigation Services Organisation have signed an agreement intended to improve the exchange of **air navigation safety information** between the two organizations. ... The Performance Review Body of the **Single European Sky** has developed an online interactive tool to show actual performance and performance goals. The e-Dashboard is available at <prdata.webfactional.com/Dashboard/eur_view.html>.

Compiled and edited by Linda Werfelman.

The crew ignored several terrain warnings as the unguided Superjet departed from the intended flight path and headed toward a mountain.



Circle of Confusion

BY MARK LACAGNINA

The flight crew's lack of familiarity with nearby mountainous terrain, prolonged nonpertinent conversations that distracted them from monitoring the aircraft's flight path and the pilots' disregard of several terrain awareness and warning system (TAWS) warnings were factors that contributed to a controlled-flight-into-terrain (CFIT) accident that destroyed a Sukhoi RRJ-95B (Superjet) and killed all 45 occupants the afternoon of May 9, 2012, according to the National Transportation Safety Committee of Indonesia (NTSC).

The NTSC's final report on the accident also cited the absence of minimum vectoring altitudes and a minimum safe altitude warning (MSAW) system for air traffic controllers handling flights in the area of West Java where the accident occurred. "The objective of the MSAW function is to assist in the prevention of CFIT accidents by generating, in a timely manner, a warning of the possible infringement of a minimum safe altitude," the report said.

Demonstration Flight

The crew of the newly introduced regional jet was conducting a demonstration tour and making its second flight of the day from Jakarta's Halim Perdanakusuma International Airport.

The pilot-in-command (PIC), the pilot flying, had 10,347 flight hours, including 1,347

hours in type. The 57-year-old pilot had experience in several military fighters and civilian cargo and passenger aircraft. The report noted that he had served as lead test pilot during the certification of the Superjet's terrain and traffic collision avoidance system (T²CAS), which includes both terrain- and traffic-avoidance equipment.

The second-in-command (SIC), 44, had 3,318 flight hours, including 625 hours in type. He, too, had experience in several military and civilian aircraft.

The Superjet departed from Jakarta for the second 30-minute demonstration flight at 1420 local time. Aboard the aircraft were 40 passengers, the two pilots, a navigator, a test flight engineer and a steward. One of the passengers, representing a potential customer for the aircraft, was in the cockpit jump seat.

The crew conducted the takeoff from Runway 06, made a right turn at 2,000 ft and, per the flight plan, established the aircraft on the 200-degree radial of the VOR/DME (VHF omnidirectional radio/distance measuring equipment) located on the airport. The report noted that the radial was not a published airway.

The demonstration flight was planned to be conducted under instrument flight rules (IFR) at 10,000 ft southwest of Jakarta and within 50 nm (93 km) of the airport.



Unplanned Descent

The aircraft was southwest-bound at 10,000 ft when the SIC requested clearance from Jakarta Approach to descend to 6,000 ft. The controller asked the SIC to repeat the request. “The SIC repeated the request for descent to 6,000 feet,” the report said. “Subsequently, the Jakarta Approach controller responded and acknowledged the request by replying, ‘6,000 copied.’ The SIC then said, ‘Descending to 6,000 feet.’”

The course flown was different from that of the demonstration flight conducted earlier that day. The aircraft was at 20 nm DME on the 200-degree VOR radial when the crew began the descent; at this point on the previous flight, they had turned left at 10,000 ft to return to the airport and land on Runway 24, the runway on which they had departed.

The cockpit voice recording indicated that a passenger, a Sukhoi employee, apparently came to the cockpit and asked the PIC why he had decided to descend. The PIC explained that they were descending in preparation to land on Runway 06, rather than on Runway 24, as during the earlier demonstration flight. He said that the descent was necessary because, otherwise, “the altitude would be too high.”

The SIC requested and received clearance from the Jakarta Approach controller to conduct a “right orbit,” or circling right turn, at 6,000 ft. This was the last radio communication between the crew and air traffic control (ATC).

Tagged as a Fighter

The Jakarta Approach controller’s radar display showed that the aircraft was descending toward a restricted military training area that extends from the ground to 6,000 ft. The training area

was not depicted on the navigation chart that the crew was using.

The report noted that although the Superjet was in radar contact, ATC authorities had not established minimum vectoring altitudes for the area; the minimum sector altitude was 6,900 ft.

Moreover, because the approach facility’s database did not contain the identification code for the new aircraft, the Superjet had been entered manually as a Sukhoi Su-30. Thus, the approach controller believed that he was handling a fighter. “The controller assumed that a military aircraft was eligible to fly in this area [and] approved the aircraft to descend to 6,000 feet,” the report said.

The controller’s workload was high; he was handling 13 other aircraft and his “communications were performed continuously, one after another, practically without pause,” the report said.

Cloud-Covered Terrain

Comments captured by the cockpit voice recorder during the descent indicated that the ground in the area was mostly covered by low cloud. The SIC said, “Dark cloud ahead,” and later remarked that he could occasionally see the ground through the clouds.

The crew was using an area navigation chart that included limited terrain information, according to the report. A different instrument chart with pronounced terrain contours and an even more terrain-descriptive visual flight rules navigation chart were available but were not carried aboard the aircraft.

The PIC used the autopilot’s heading mode to initiate and continue the turn. He initially selected a heading of 333 degrees and then made three more adjustments before selecting a heading of 150 degrees as the aircraft began tracking northbound.

The PIC began discussing features of the aircraft with the jump-seat passenger. He was demonstrating the terrain display provided by the electronic flight information system (EFIS) when he remarked, “But no problem with terrain at this moment.” The passenger said, “Ya, it’s flat.”

The report said that these comments likely were based on the EFIS terrain display that appeared during the PIC’s demonstration. At the time, the aircraft was headed northeast, toward the Java Sea, and the display likely did “not indicate any terrain information due to the flat area ahead,” the report said, noting that this might have “affected the PIC’s perception that the whole area surrounding the flight path was flat,” a perception that was reinforced by the passenger’s comment about the flat terrain.

Out of Orbit

The PIC and the jump-seat passenger were discussing the aircraft’s fuel consumption when the Superjet rolled out on the selected 150-degree heading. The aircraft then continued tracking southeast while the pilots discussed the heading required to return to Jakarta.

The aircraft was nearing the point at which it had begun the circling maneuver when the PIC selected a heading of 174 degrees. As the Superjet rolled out on this heading, the PIC told the SIC to request clearance from ATC for a right turn.

The SIC asked the PIC if he intended to make another orbit or to return to the airport. The PIC did not reply. The SIC repeated the question twice before the PIC said, “We will make approach.”

Both pilots then were distracted from monitoring the aircraft’s flight path. The PIC became engaged in

another nonpertinent conversation with the jump-seat passenger, and the SIC was concentrating on determining the course to return to the airport. “The pilots may not have noticed that the aircraft had exited the orbit and assumed that it was still continuing to turn,” the report said.

The pilots then continued their discussion of the heading required to return to the airport and agreed on 020 degrees. The PIC told the SIC to ask Jakarta Approach for clearance to turn to 020 degrees and to descend to 1,600 ft for the VOR/DME approach to the airport. “The PIC’s intention to descend indicated that he was not aware of the mountainous area surrounding the flight path,” the report said.

The SIC did not respond to the PIC’s instructions to request clearance to return to the airport. The PIC repeated the instruction: “Just request quickly.” The SIC replied, “OK.”

‘Terrain Ahead, Pull Up’

The PIC then selected a heading of 325 degrees, and the autopilot commanded a right, 20-degree-banked turn. Four seconds later, the TAWS generated a “TERRAIN AHEAD, PULL UP” warning, followed by six “AVOID TERRAIN” warnings. (The report noted that the latter warning is generated when a climb, alone, is not sufficient to avoid terrain and a turn also might be necessary.)

The TAWS warnings caused the pilots’ navigation displays to change to the terrain mode. During post-accident simulations conducted by investigators, the displays showed “a solid red cell with black cross-hatches ... at a distance of 1 to 3 nm [1.9 km to 5.6 km]” and a flashing red “TERR AHEAD” message, the report said.

The SIC apparently was surprised by the terrain warnings. “What is that?” he asked. This question also indicated that he, too, “was not aware of the mountainous area surrounding the flight path,” the report said.

The PIC deactivated the TAWS, causing the EFIS terrain displays to vanish, and replied, “May be ... database.” This statement indicated

Sukhoi Superjet 100



© Sergey Kustov/Wikimedia CC-BY-SA-3.0

Sukhoi Civil Aircraft Co., with consultation by Boeing, began the development of the Superjet 100 in 2000. The fly-by-wire regional jet made its first flight in 2008 and entered commercial service in 2011.

Two basic models are manufactured: the 75-passenger SSJ100/75 and the 95-passenger SSJ100/95; Sukhoi also offers long-range versions of each. The aircraft are powered by SaM146 turbofan engines produced by PowerJet, a joint venture of France’s Snecma and Russia’s NPO Saturn.

Maximum takeoff weights are 85,585 lb (38,821 kg) for the SSJ100/75 and 93,740 lb (42,520 kg) for the SSJ100/95. Maximum landing weights are 77,160 lb (35,000 kg) and 86,860 lb (39,400 kg), respectively. Long-range cruise speed is 0.78 Mach, and maximum altitude is 40,000 ft. Maximum ranges with full payloads are 1,590 nm (2,945 km) for the 75-seat model, 1,570 nm (2,908 km) for the 95-seat model, and 2,460 (4,556 km) and 2,390 nm (4,426 km), respectively, for the long-range versions.

Sources: Sukhoi Civil Aircraft Co. and the National Transportation Safety Committee of Indonesia

that the PIC believed that the TAWS warnings had been triggered by a database problem, the report said. There was no communication between the pilots for the next 20 seconds.

Shortly after the TAWS was disengaged, the aircraft’s crew alerting system generated an aural “GEAR NOT DOWN” warning. Although this warning is designed as a landing advisory when the landing gear is not extended below 800 ft above ground level, it would have provided an additional indication of the aircraft’s proximity to terrain, the report said.

Recorded flight data indicated that the PIC made a brief sidestick input corresponding to a



The Superjet struck a nearly vertical ridge near the top of Mount Salak at 6,000 ft.

5-degree nose-up change in the aircraft's pitch attitude. This caused the autopilot to disengage and the associated chime to sound.

The SIC again asked, "What's that?" The PIC replied, "Autopilot off."

Investigators were not able to determine why the PIC made the sidestick input. "The action of the PIC to manually fly by operating the sidestick to pitch up at 5 degrees could not be an indication of an attempted escape action," the report said. "The investigation could not determine the reason of the PIC's action." The report also noted that at this point, the accident could not have been avoided.

Radar Contact Lost

The MSAW system at Jakarta Approach provided no terrain conflict alerts before radar contact with the aircraft was lost. Likely due to his heavy workload, the controller did not notice the disappearance of the aircraft's radar target until 24 minutes later, the report said. The controller attempted to hail the crew, but there was no reply.

The Superjet struck a nearly vertical ridge near the top of Mount Salak at 6,000 ft and 28 nm (52 km) southwest of the airport. "The terrain information surrounding Mount Salak had not been inserted into the [MSAW] system," the report said. Investigators also found that

although the system was functioning properly, its aural warning mode had been disabled.

The antenna on the aircraft's emergency locator beacon had detached on impact, and no distress signal was transmitted. The search for the aircraft was hampered by bad weather. Using recorded radar data, a search-and-rescue helicopter pilot located the wreckage the next day.

"The wreckage was spread over a wide area," the report said. "Most of the wreckage — such as the landing gear, engines and vertical stabilizer — was found at the bottom of the valley at approximately 500 m [1,640 ft] below the impact point."

The accident occurred at 1432, or 12 minutes after takeoff from Jakarta and 38 seconds after the first TAWS warning was generated. Analysis of recorded flight data showed no evidence of a pre-impact aircraft malfunction.

Training Recommended

The report said that post-accident flight simulations indicated that the TAWS aboard the Superjet was functioning properly and that the CFIT accident might have been avoided up to 24 seconds after the first terrain warning if the crew had taken appropriate action in response to the warning.

The NTSC issued several recommendations based on the findings of the accident investigation. Among the recommendations to Indonesian and Russian aviation authorities were to provide adequate training of pilots to respond properly to aircraft systems warnings and to ensure that all IFR flights are conducted in accordance with published minimum safe flight altitudes.

The committee also recommended that Russian authorities "review the current procedures for the preparation and conduct of demonstration flights and, if needed, introduce appropriate amendments." ➔

This article is based on NTSC Aircraft Accident Investigation Report KNKT.12.05.09.04, "Sukhoi Civil Aircraft Company Sukhoi RRJ-95B, 97004; Mount Salak, West Java, Republic of Indonesia; 9 May 2012." The report is available at <dephub.go.id/knkt/ntsc_aviation/aaic.htm>.



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After a string of deadly accidents, HEMS operators are seeing better days.

On the Rebound

BY LINDA WERFELMAN

Fatal accidents involving helicopter emergency medical services (HEMS) flights in the United States have declined dramatically since 2008 — the deadliest year on record, when nine fatal crashes claimed 29 lives.

The next nine fatal accidents were spread over a period of more than four years — two in 2009, four in 2010, one each in 2011 and 2012, and one in the early days of 2013. Together, those crashes killed 28 people (see Table 1, p. 24).

Industry representatives credit the decline to HEMS operators' voluntary adoption — in

advance of anticipated new regulatory requirements from the U.S. Federal Aviation Administration (FAA) — of a range of safety initiatives, including safety management systems (SMS), flight operational quality assurance (FOQA), improved education and training, helicopter terrain awareness and warning systems (HTAWS) and, perhaps most importantly, night vision goggles (NVGs).

“There’s no other single advancement that’s had such an immediate impact,” said Christopher Eastlee, president of the Air Medical Operators Association (AMOA). “We don’t run into stuff we don’t see anymore.”



Increasing numbers of EMS helicopters have been equipped with sophisticated safety devices in recent years, including NVGs and HTAWS.

NVGs are in use today by at least 90 percent of U.S. HEMS operators, up from only 2 to 5 percent in 2006, Eastlee said. Among those using NVGs are all major operators, each of which has installed the systems in all, or nearly all, of its helicopters.

AMOA, established in 2008 to respond to the surge in fatal HEMS crashes, represents operators of more than 730 of the country's approximately 800 EMS aircraft, including all major operators.

Industry representatives, including AMOA and the Association of Air Medical Services (AAMS), noted, however, that appropriate training in the use of NVGs is essential if the devices are to be effective in helping to avoid collisions with terrain and obstacles.

Unfamiliarity with Hazards

Training also was emphasized in an accident report by the U.S. National Transportation Safety Board (NTSB), which cited "the pilot's unfamiliarity with the hazards of a low-contrast area while using night vision goggles" as a contributing factor in the Feb. 5, 2010, crash of a Eurocopter AS350 in El Paso, Texas.

While maneuvering to land in the desert for a simulated patient pick-up, the helicopter orbited the landing site, using a non-NVG-compatible spotlight, then made a wide orbit, banked 45 degrees, "entered a steep nose-down attitude and impacted the ground," the NTSB report said. The probable cause was the pilot's loss of situational awareness, which resulted in controlled flight into terrain.

The 17,600-hour pilot and two paramedics — the only people in the helicopter — were killed, and the NTSB said the helicopter was substantially damaged in the crash, which occurred during the pilot's second flight with the company, and his first "uninstructed ... NVG flight since his recent company training," which he had completed Jan. 29, after 7.5 hours using NVGs.¹

The accident occurred in a remote area with no light from the moon and little cultural lighting (that is, man-made lighting, such as the lights of a town), and the pilot's NVG training "had all been conducted on nights with high moon illumination and in populated areas with

high amounts of cultural lighting and did not prepare the pilot for flight in the conditions encountered on the night of the accident," the report said. "The low visual contrast conditions, combined with the narrow field of view of the NVGs, reduced the pilot's ability to maintain situational awareness. The lack of attempted recovery prior to ground impact suggests that the pilot did not recognize the helicopter's descent rate and bank angle."

NVGs are known for their "tendency to distort depth perception and distance estimation, with the quality of depth perception being dependent on ambient light, terrain surface conditions, the ability of the NVG device and the pilot's experience in flying in those conditions," the report added.

Vigilance and Caution

Bill Winn, general manager of the National EMS Pilots Association (NEMSPA), said that, in addition to NVGs, increased vigilance and caution by pilots has helped reduce the number of accidents.

The surge in crashes in 2008 led to heightened management scrutiny and actions to "promote conservative decision making on the part of their pilots," said Winn, a pilot for Inter-mountain Life Flight in Salt Lake City.

In addition, medical crewmembers have been encouraged to take a more active role in questioning pilots about the continuing safety of flight, and the en route decision point (EDP) process promoted by NEMSPA has emphasized that pilots should never deviate from safe air-speed and altitude, Winn said. EDP guidelines specify that airspeed should never be less than 30 kt below normal cruise airspeed and altitude should never be less than the FAA's specified minimum en route altitude for uncontrolled airspace — no lower than 300 ft during the day (or 500 ft at night) above the highest obstacle along the route of flight.

Multi-Layered Approach

Blair Marie Beggan, director of communications for AAMS, which represents providers of air

U.S. HEMS Crashes, January 2009–January 2013

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Jan. 2, 2013	Clear Lake, Iowa	Bell 407	Destroyed	3 fatal
Night visual meteorological conditions prevailed for the Med-Trans positioning flight, which left Mercy Medical Center in Mason City at 2049 local time for Palo Alto County Hospital in Emmetsburg. A witness saw the helicopter approach from the east, slow and turn north before descending and striking the ground at 2057. The investigation by the U.S. National Transportation Safety Board (NTSB) is continuing.				
Dec. 10, 2012	Compton, Illinois	MBB BK117 A-3	Substantial	3 fatal
The pilot told a dispatcher at 2106 local time that he was ending the positioning flight from Rockford Memorial Hospital in Rockford, Illinois, to Mendota Community Hospital in Mendota because of weather conditions. No further communications were received from the helicopter, operated by Air Methods. Visual meteorological conditions had been reported before the crash, and at 2105, weather conditions 10 mi (16 km) north of the accident site included 7 mi (11 km) visibility in light snow, an overcast at 3,300 ft above ground level, a temperature of 1 degree C (34 degrees F) and a dew point of 2 degrees C (36 degrees F). The NTSB investigation is continuing.				
Aug. 26, 2011	Mosby, Missouri	Eurocopter AS350 B2	Substantial	4 fatal
The Air Methods LifeNet helicopter struck the ground during an autorotation after it lost power during what was to have been a patient-transport flight in visual meteorological conditions from Bethany, Missouri, to Liberty. Before takeoff, the pilot said he had 45 minutes of fuel aboard — less fuel than he originally thought — and therefore would stop in Mosby for refueling. The helicopter crashed in a farm field about 1.7 nm (3.1 km) north-northeast of the planned fuel stop; there was no post-impact fire. The NTSB investigation is continuing.				
Aug. 31, 2010	Walnut Grove, Arkansas	Bell 206L-1	Substantial	3 fatal
Dark night instrument meteorological conditions prevailed as the Air Evac EMS helicopter reversed course several times en route to a landing zone where it was to have picked up a patient. The NTSB said the flight path was “consistent with spatial disorientation and subsequent loss of control due to an inadvertent encounter with instrument meteorological conditions.” The agency said the probable cause of the accident was the pilot’s loss of control, caused by spatial disorientation, which led to the in-flight separation of the main rotor and tail boom (ASW, 12/11–1/12, p. 40).				
July 28, 2010	Tucson, Arizona	Eurocopter AS350 B3	Substantial	3 fatal
The Air Methods LifeNet helicopter lost engine power during a repositioning flight from Tucson, Arizona, where it had undergone engine maintenance, to the company base in Douglas. Descent rates during the last 10 seconds of the flight were consistent with an autorotation, the NTSB accident report said, noting that the pilot had no recent autorotation training or practice. The NTSB said the probable causes of the accident included a maintenance technician’s improper installation of the fuel inlet union during engine reassembly, the failure of the operator’s maintenance personnel to adequately inspect the technician’s work, the failure of the pilot who conducted the post-maintenance check flight to follow the manufacturer’s procedures, and the lack of requirements for an independent inspection of the technician’s work (ASW, 6/12, p. 34).				
Mar. 25, 2010	Brownsville, Tennessee	Eurocopter AS350 B3	Substantial	3 fatal
The pilot was nearing the end of a 12-hour overnight shift when he told another pilot that he hoped to beat an approaching storm and return the helicopter from Jackson, Tennessee, to his home base in Brownsville. The helicopter — operated by Memphis Medical Center Air Ambulance Service, doing business as Hospital Wing — crashed about 2.5 mi (4 km) east of the base, shortly after one of the flight nurses aboard told another pilot in a telephone conversation that they expected to land at the heliport in about 30 seconds. The NTSB said the probable cause of the crash was the pilot’s decision to fly into approaching adverse weather (ASW, 3/12, p. 45).				
Feb. 5, 2010	El Paso, Texas	Eurocopter AS350	Substantial	3 fatal
On a mission described as his first uninstructed flight with night vision goggles since his company training, the Southwest Med Evac (Enchantment Aviation) pilot was conducting a simulated patient pick-up in a remote desert area. He flew the helicopter in a wide orbit before “it banked about 45 degrees, entered a steep nose-down attitude and impacted the ground,” the NTSB said. There was little light in the area, compared with conditions during the pilot’s training flights. The NTSB said the probable cause of the accident was the pilot’s loss of situational awareness, which led to controlled flight into terrain. A contributing factor was his “unfamiliarity with the hazards of a low-contrast area while using night vision goggles,” the NTSB said.				
Nov. 14, 2009	Doyle, California	Eurocopter AS350 BA	Destroyed	3 fatal
About 0201 local time, a dispatcher received “a garbled call” from the pilot of the Mountain Lifeflight helicopter “indicating that the helicopter was going down” during a positioning flight from Reno, Nevada, to Susanville, California, in visual meteorological conditions, the NTSB said. A witness saw the helicopter leave straight and level flight, enter a rapid vertical descent to the ground and burst into flames. The investigation is continuing.				
Sept. 25, 2009	Georgetown, South Carolina	Eurocopter AS350	Substantial	3 fatal
The Omniflight helicopter departed in visual meteorological conditions for a positioning flight from Charleston, South Carolina, to Conway, but weather conditions deteriorated en route. The last segment of the flight was flown below 800 ft, and witnesses observed the searchlight turning on and off in heavy rain. The NTSB cited as probable causes of the crash the pilot’s continuation of the visual flight rules flight into instrument meteorological conditions and his resulting spatial disorientation and loss of control of the helicopter (ASW, 3/12, p. 45).				

HEMS = helicopter emergency medical services; MBB = Messerschmitt Bolkow-Blom (now Eurocopter)

Source: U.S. National Transportation Safety Board

Table 1

and ground medical transport systems, said the HEMS industry has worked hard “to achieve a steadily declining accident rate, through a multi-layered approach.”

Enhanced education and training are essential not only in the use of NVGs but also in recurrent training in simulators and aircraft, Beggan and Eastlee agreed.

“While there are other safety objectives ... none of them can provide a level of risk mitigation equal to that of a frequent training program that makes use of available flight training devices, simulators or operational aircraft with instructors providing simulated scenarios including inadvertent [entry into] instrument meteorological conditions (IMC) on at least a semiannual recurrent basis,” Eastlee said.

AMOA member operators also provide recurrent air medical resource management training for medical crewmembers “to ensure a positive crew resource environment,” he said.

Safety Management

Continuing education and training, in combination with SMS, are intended to “combat complacency and increase personal accountability” and to improve the safety culture throughout the HEMS industry, Beggan said.

Nearly all AMOA members have implemented SMS, the organization said, adding that SMS is an essential, collective approach that combines all safety objectives into one system.

Oversight

Data collection and analysis is a key ingredient in safety oversight, another element of SMS, and industry representatives have advocated one form of oversight through FOQA or similar flight data monitoring programs.

A number of HEMS operators have begun using FOQA, and “some individual operators have learned quite a bit from their own systems,” Eastlee said. Eventually, those using FOQA hope to coordinate their efforts to improve prospects for inter-company data sharing and analysis, he said.



Winn said that, in addition to helping identify and correct procedural errors, FOQA also has served as a deterrent for pilots tempted to depart from standard operating procedures.

“Any pilot who knows big brother is there watching and who might have been tempted to cowboy the aircraft or push weather won’t do it,” he said.

Eastlee said that, in recent years, the industry also has emphasized various other forms of oversight, through enhanced regulations and procedures, management monitoring of those enhancements, and guidance on risk assessment and mitigation. Another element of oversight comes in the form of operational control centers, which the FAA said already were in place at nearly 90 percent of HEMS operations in 2009. The FAA has proposed, in rules changes expected to be made final in late March, that control centers be required for any operator with 10 or more helicopters.

Changes

The industry also is “fully supportive of heightened FAA regulations for helicopter air medical services,” Beggan said.

Those regulatory changes, which were first proposed in 2010, are expected to be issued in final form in late March.

The 2010 proposals call for all HEMS flights with medical personnel aboard to be conducted under U.S. Federal Aviation Regulations (FARs) Part 135, which governs commuter and on-demand operations and imposes stricter limits for weather minimums and flight crew duty and flight time limitations and rest requirements.

Recurrent training for HEMS medical crewmembers is designed to enhance crew resource management.

Under current requirements, those flights may be conducted under the less stringent rules of FARs Part 91.

Despite industry support for NVGs, the proposed changes would not require their use; the FAA said in introducing the proposed rules changes that more research was needed on their effectiveness before such a requirement would be considered. Instead, the proposed changes called for installation of HTAWS equipment within three years after issuance of a final rule.

At the time, many industry groups asked the FAA to consider allowing operators to install HTAWS or NVGs or both, arguing that each technology has unique safety benefits.

In addition to the large numbers of HEMS aircraft equipped with NVGs, about two-thirds now have HTAWS, Eastlee said.

Data Monitoring

In its proposed rules changes, the FAA had asked for comments on a possible future requirement for the installation of lightweight aircraft recording systems in EMS helicopters. The devices would not only enable participation in FOQA programs but also allow the NTSB to collect data in case of an accident.

The NTSB has for several years urged the FAA to require the collection and analysis of safety data by these operators through flight data monitoring programs. In a package of HEMS safety recommendations issued in 2009, the NTSB noted the development of flight data recording devices that were low cost, lightweight and compact enough to enable even small operators to implement flight data monitoring.

“Such data would be particularly useful in evaluating pilot performance in daily operations according to specific parametric operational standards, such

as altitude, bank angle, pitch attitude and airspeed limitations,” the NTSB said. “Frequent downloading and analysis of these data can aid operators in implementing an SMS by identifying exceedances that occur during operations in order to implement corrective actions. In addition, periodic review of flight data from HEMS flights would provide information on aircraft proximity to terrain and weather that could assist in evaluating pilot performance to determine if pilots are conducting HEMS flights in accordance with company operating practices.”

In issuing the recommendations, the NTSB said a flight data monitoring program might have helped prevent the June 29, 2008, collision of two Bell 407 EMS helicopters in Flagstaff, Arizona (ASW, 7/09, p. 32). All seven occupants were killed in the crash, which destroyed both helicopters. The NTSB said the probable cause of the accident was each pilot’s failure to see and avoid the other helicopter as both aircraft approached the Flagstaff Medical Center helipad.

“The systematic monitoring of data from HEMS flights could provide operators with objective information regarding the manner in which their pilots conduct HEMS flights and ... a periodic review of such information, along with other available information such as pilot reports and medical crew feedback, could assist operators in detecting and correcting unsafe deviations from company operating practices,” the NTSB said.

Little Infrastructure

Among the areas in need of more attention is the infrastructure in place for the low-level altitudes where EMS helicopters operate, Beggan said.

“The FAA has invested billions of dollars over the last several decades into a strong infrastructure for commercial air

carriers,” she said. “By comparison, HEMS providers operate at low-level altitudes for which there is little infrastructure in place, including a scarcity of accurate weather reporting and ... in some areas, no radar-based air traffic control.”

A recurring theme in fatal HEMS crashes has been bad weather, and especially inadvertent entry into IMC, which often is cited in HEMS accident reports.

For example, an Aug. 31, 2010, crash in Walnut Grove, Arkansas, that killed the pilot, flight nurse and flight paramedic, was attributed by the NTSB to the pilot’s loss of control of the helicopter following several minutes of multiple course reversals considered “consistent with spatial disorientation and subsequent loss of control due to an inadvertent encounter with [IMC].”²

In some cases, the absence of accurate weather reporting has factored in a crash, Beggan said.

Eastlee agreed that many of the difficulties that have plagued HEMS operations are associated with the low-altitude operations that are a necessary part of their mission.

“Large airplanes can fly over bad weather, but ... everything for us involves flying through it,” he said.

Overall, EMS helicopters transport patients on 400,000 flights every year, and another 400,000 operations are conducted without patients aboard.

“That’s a tremendous volume of very successful flying,” Eastlee said, adding, however, that the accidents of recent months demonstrate that some ongoing safety enhancements must be strengthened. ➡

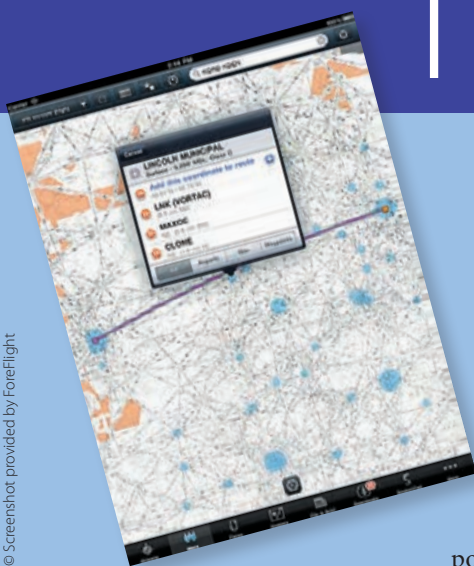
Notes

1. NTSB. Accident Report no. CEN10FA113. Feb. 5, 2010.
2. NTSB. Accident Report no. CEN10FA509. Aug. 31, 2010.

BY WAYNE ROSENKRANS

Predictable issues involving portable EFBs sometimes catch business aircraft pilots by surprise.

The Fine Print



© Screenshot provided by ForeFlight

Some business aviation operators, like airlines and private pilots, are highly motivated to introduce or update installed or portable electronic flight bags (EFBs) in their flight decks. If they proceed, their large multi-engine, turbine-powered aircraft or other applicable regulatory factors may dictate they must comply with comprehensive airline-level requirements — with the built-in benefit of the latest expertise of aviation safety and human factors specialists. Others have latitude to use EFBs under self-compliance guidelines and to voluntarily adopt best practices in risk mitigation through hardware/software choices, policies, procedures, training and other considerations.

Those with latitude may benefit from a working familiarity with the airline-level requirements, and resources such as publicly available, pilot-generated safety reports. In the evolution of this technology, users first welcomed EFBs as a way to reduce or

eliminate the need for paper aeronautical charts, diagrams and other reference materials. At airlines, EFB aircraft performance computers have been used for decades. Currently, business aircraft operators also can contemplate adding advanced functions, features such as own-ship display and hosted applications as these become approved/approvable by civil aviation authorities (ASW, 5/12, p.19).

Operators in the United States can find safety-relevant explanatory background in the Federal Aviation Administration's (FAA's) Advisory Circular (AC) 120-76B, "Guidelines for the Certification, Airworthiness, and Operational Use of Electronic Flight Bags," which took effect June 1, 2012. News about the final AC often focused on standards and requirements for using acceptable devices and software. However, business aircraft operators also can consult this AC to gauge what the FAA considers optimal safety choices.

Known Risk Factors

In 2010, researchers at the U.S. Department of Transportation (DOT) reported on subject matter experts' analysis of observed outcomes and anomalies in

EFB-related voluntary safety reports from pilots.¹ They selected and studied 67 pilot reports collected in August 2009 from the Aviation Safety Reporting System (ASRS) database maintained by the U.S. National Aeronautics and Space Administration. Although EFB-related errors and problems were reported by all types of pilots, the researchers differentiated anomalies among pilots operating under general aviation regulations and those of airline flight crews operating under Federal Aviation Regulations (FARs) Part 121, noting, "Part 91 operators are not required to follow this guidance, and it is therefore possible that they receive less training on EFBs than the Part 121 flight crews."

Essentially, they broke down safety-relevant findings into those involving procedures for interaction between pilots while using EFBs, such as when sharing or cross-checking information; situations requiring pilots to alter how information is presented, such as zooming or panning displays without missing critical data temporarily hidden off-screen; inadequate training of crewmembers who initially were entirely unfamiliar with the EFB; failing to resolve difficulties that pilots reported about using the EFB, including data entry, legibility of display elements, suspected software malfunctions or selecting required navigation charts while needing to access more than one display of information under abnormal conditions; preventing and responding to an outdated EFB database; preflight or in-flight recovery/backup in case of an inoperative EFB; confusion about interpreting information "due to inconsistencies between expected and actual format"; and reliably powering the EFB to prevent interruptions.

Among the most serious situations in the report were the pilot monitoring

becoming "preoccupied" with the EFB during taxi, as the pilot flying missed a taxi clearance restriction or hold short line, and "company policy deviations, expired databases, incorrect computations, altitude confusion, an aborted takeoff and a tail strike upon rotation." They characterized the significant risk areas for operators as heading/altitude/speed deviation, runway incursion, noncompliance with company policy, expired database, incorrect weight and balance for takeoff (including tail strike), erroneous airplane performance data unrecognized when it caused no adverse effects, altitude deviation during a declared emergency, rejected takeoff, confusion about altitude, near-deviation from assigned altitude, and "taxi-route confusion without an airport diagram."

DOT has not repeated this analysis for post-2010 safety reports involving EFB chart applications (apps); its data query had covered 1995 to 2009. Business aviation operators' interest, however, has expanded now to include observed anomalies and risks involved in transitioning to the capabilities and interfaces of consumer tablet-based EFBs — such as the Apple iPad² and its iOS operating system interface (ASW, 10/12, p. 43). The 2010 analysis nevertheless provides context and points of comparison, for example, of business aviation pilots' post-2010 safety reports to ASRS involving EFBs (see "Safety Reports From Pilots Using Tablet EFBs in Business Aviation," p. 29).

Insights From AC 120-76B

Used with other official documents that it references for EFB technical standards, selection, testing, installation and any required approvals, this AC provides comprehensive, practical recommendations to reduce the known



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Safety Reports From Pilots Using Tablet EFBs in Business Aviation

In the years after publication of results from a U.S. Department of Transportation analysis¹ of 67 safety reports from pilots about their regulatory violations and other anomalies involving electronic flight bags (EFBs), more than 100 such reports have been added to the Aviation Safety Reporting System (ASRS) online database administered by the U.S. National Aeronautics and Space Administration.²

The following excerpts from 2012 ASRS reports, selected by ASW, reflect comparable pilot experiences specifically involving business aviation and tablet EFBs — including relatively recent use of EFB apps on the Apple iPad and its iOS operating system.

A flight crew operating a corporate Cessna Citation C650 prepared to depart from Teterboro (New Jersey, U.S.) Airport on the assigned route of TEB RUUDY FOUR LANNA J48. The second-in-command pilot monitoring later explained how they had used the ForeFlight [Mobile] app on an iPad. "For a backup and great situational awareness in case the FMS [flight management system] malfunctions during the initial climb, I manually entered the RUUDY FOUR [departure procedure] waypoints. With an external GPS [global positioning system receiver connected to the iPad], I am able to view the aircraft's position in real time on a map. ... After entering the flight plan into our FMS, I expressed concern that we were unable to view the RUUDY FOUR departure procedure waypoints in the FMS even though we had selected the RUUDY FOUR departure procedure when the unit prompted us. After departure, the captain began to execute the RUUDY FOUR departure procedure. Upon reaching TASCA and climbing through about 3,000 MSL [mean sea level], I noticed on the FMS the current waypoints in progress [indication] was RUNWAY 24

LANNA. This was not correct; the FMS had dropped the departure procedure and had the flight director tracking a course from the runway to LANNA [intersection,] which was further southwest on our route. Meanwhile, I [was] watching our aircraft's position parallel and drift further south and southeast of our required course on my iPad.

I encouraged the captain to fly heading 280 for a longer period of time to prevent drifting and reach RUUDY before turning southwest to LANNA, but he was confused and continued to fly about a 240-degree heading towards LANNA. ... New York Center [asked us] to state our heading and if we were flying the RUUDY FOUR [departure]. ATC [air traffic control] then issued us a heading of 280 to fly and began questioning what procedure we were flying and [told me] when I have time, to study the RUUDY FOUR [procedure]." (ASRS no. 991216, January 2012)

A fractional operator's flight crew departed in a Cessna Citation X from San Francisco International Airport flying the OFFSH5 departure. ATC observed the aircraft make an incorrect turn and intervened by issuing vectors to rejoin the charted course. The captain, the pilot monitoring, later said, "Because the course needed to be defined with a VOR [very high frequency omnidirectional range station] that was not depicted on the FMS [flight management system] flight plan page (PYE VOR), I opted to step down the automation and type PYE into my green needles and join the appropriate radial. I was not aware I must have hit the chart number at the bottom of the iPad with my hand or arm, and switched from the OFFSH5 to the PORTE3 departure [and



© Screenshots provided by ForeFlight

then intercepted the PYE VOR 135 radial instead of the correct 151 radial]. In short, I was now looking at the Porte 3 departure, which is a very similar visual depiction. ... I noticed our mistake within a couple of minutes, but by the time we were correcting, we were given direct to another fix. I noticed the wrong departure on the iPad. We must be very aware that the iPad can change pages without the pilot knowing." (ASRS no. 1022749, July 2012)

The flight crew of a corporate Raytheon Super King Air 200 preparing to depart from Phoenix Sky Harbor International Airport was cleared by ATC for the Stanfield 3 departure with OLIIN transition J2 ALIBY. The pilot monitoring later said, "I was talking to clearance [delivery] and referencing an iPad with freshly downloaded government charts: Hi, Low and approach plates. I was not able to find OLIIN [intersection] on either Hi or Low IFR [instrument flight rules] en route charts, so I asked clearance for a clarification on how to transition from OLIIN to J2. OLIIN was shown on the Stanfield 3 departure but not shown on J2." ATC amended the clearance to omit these fixes, and the aircraft departed uneventfully. During cruise, however, the crew noticed that — unlike the charts on their first iPad consulted — their second iPad with the same government

Continued on p. 30

risks. It addresses how to follow the guidance from the manufacturer, FAA and operator, as well as establishing pilot training, checking and currency requirements for specific aircraft implementations and for normal/non-normal operational scenarios, in which human factors can be as important as EFB integrity and reliability.

AC 120-76B reminds the pilot community, “The intention of this AC is not to supersede existing operational guidance material. Do not use this AC by itself to add own-ship position on Class 1 and Class 2 EFBs. ... Class 1 or Class 2 EFBs must not display own-ship position

while in flight. ... For guidance on the display of own-ship position, refer to Technical Standard Order (TSO)-C165, ‘Electronic Map Display Equipment for Graphical Depiction of Aircraft Position.’ ... All information contained in the EFB intended for operational use must be current and up-to-date.”

The AC cautions about own-ship position because of technical standards and the need to address human factors with approved pilot training for its safe use. Otherwise, operators/users familiar with FAA-approved EFBs that do include own-ship position on aircraft moving map displays — which may be hosted on

portable EFBs per associated standards and approvals — might assume that for operational use, safety involves little more than connecting, for example, a consumer tablet with EFB apps to peripheral devices such as portable global positioning system (GPS) receivers and automatic dependent surveillance–broadcast (ADS-B) receivers.

Technically, parts of the AC’s content do not apply to some business aviation operations, but principles involved are valuable to know. For example, details of the user/operator operational test evaluation for FARs Part 121/135–certificated operations and Part 91K [fractional]

Safety Reports From Pilots Using Tablet EFBs in Business Aviation *(continued)*

data downloaded from a different source *did* depict OLIIN intersection. (ASRS no. 1036925, September 2012)

During arrival for the Runway 6 ILS approach to Teterboro (New Jersey, U.S.) Airport, the flight crew of a corporate medium-transport turbojet received a TCAS [traffic-alert and collision avoidance system] “TRAFFIC” alert just prior to DANDY intersection. “I looked to my right and saw an aircraft climbing out of [Newark Liberty International Airport],” the reporting pilot said. “TCAS showed he was about 1,000 ft above our altitude and was not a factor. My attention went back to the PFD [primary flight display on] which I noticed we would be crossing DANDY on the glideslope. At that point, I remembered from previous trips to Teterboro the mandatory 1,500 ft [crossing altitude restriction] at DANDY. We had not briefed this crossing in our approach briefing. I believe this occurred because of a lack of proficiency using the EFB in the aircraft. I have been using my iPad for commercial charts on the other aircraft I fly. I chose to use the EFB installed in this aircraft so as not to add more distractions in the cockpit.

The EFB was left in the segmented view by the previous crewmember, and I failed to change the view. In this case, the profile segment was set to the briefing strip and not the profile view of the approach plate. Not seeing the profile view, I failed to notice the mandatory crossing at DANDY intersection.” (ASRS no. 1043846, October 2012)

The flight crew of a corporate Cessna Citation C560 was using the flight management system (FMS) to conduct the JHAWK6 standard terminal arrival route into Charles B. Wheeler Downtown Airport (Kansas City, Missouri, U.S.) when the approach controller observed a noncompliant turn toward Kansas City International Airport and instructed them to turn to heading 010. The captain later recalled, “I had the arrival [chart] displayed on my iPad, and the other pilot had the ILS displayed on his iPad. As we approached the NOAHS intersection, my iPad battery went dead. By the time the other pilot switched his iPad to the arrival [chart], our FMS started turning [the airplane] to the airport rather than [the crew] switching to heading mode and flying a heading

of 010. [The controller] noticed the turn in progress and gave a correctional turn, and the flight continued with vectors to a visual approach. ... The time of battery life is not good on long trips, so we will charge up the battery on our iPads en route.” The first officer flying added, “We now have chargers in the cockpit to ensure battery performance of both iPads.” (ASRS no. 1043606, October 2012)

— WR

Notes

1. Chandra, Divya C.; Kendra, Andrew. “Review of Safety Reports Involving Electronic Flight Bags.” John A. Volpe National Transportation Systems Center, U.S. Department of Transportation. DOT/FAA/AR-10/5 DOT-VNTSC-FAA-10-08. April 2010.
2. Reports in this publicly accessible database are a small vetted fraction of all reports received, selected based on expert opinion of the potential value of reporters’ narratives for safety education in the aviation community. ASRS website guidance states limitations of this database, such as its unsuitability for statistical analysis, counting occurrences or calculating rates (ASW, 3/12, p. 43).

operators may inspire voluntary equivalent actions. Other principles can be deduced from the AC's provision that "operators must determine the usage of hardware and/or software architectural features, people, procedures, and/or equipment to eliminate, reduce, or control risks associated with an identified failure in a system."

Before using a specific EFB, a certificated operator also must document things like training effectiveness, operational effectiveness and reliability of the EFB. This includes modifying policies and procedures affected by introducing EFBs into line operations, such as those for normal, abnormal and emergency use in all flight conditions. "Flight crew procedures will ensure that the flight crew knows what aircraft system to use for a given purpose, especially when both the aircraft and EFB are providing similar information," the AC says. "Procedures should also be designed to define the actions to be taken when information provided by an EFB does not agree with that from other flight deck sources or when one EFB disagrees with another."

Such guidance accounts for lessons learned from scientific research, expert opinion and pilot experiences such as those in the ASRS reports. "It is necessary [for operators] to evaluate the human factors/pilot interface characteristics of the EFB system," the AC says. "Special attention should be paid to new or unique features that may affect pilot performance."

In another example, pilots appreciate how well EFBs legibly display one-page instrument approach charts under all flight deck lighting conditions. "This requirement is not meant to preclude panning and zooming features, but is intended to prevent a workload increase during the approach phase of flight," the AC notes, adding that "a moving map centering feature (not own-ship position

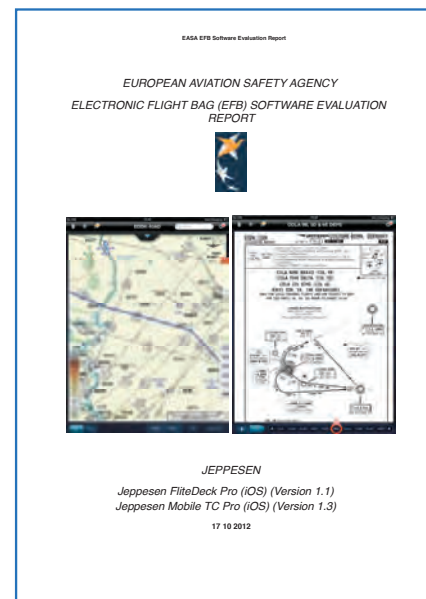
depiction or aircraft symbol) may be desirable [for certain aerodrome charts]. ... Any active manipulation (e.g., zooming, panning, or decluttering) should be easily returned to the default position. ... If the document segment is not visible in its entirety in the available display area, such as during 'zoom' or 'pan' operations, the existence of off-screen content should be clearly indicated in a consistent way."

EASA's EFB Cautions

Like FAA AC 120-76B, the European Aviation Safety Agency's (EASA's) December 2012 report³ on its assessment of two versions of an iPad EFB app contains technically specific approvals plus observations potentially relevant to other EFB apps. In harmony with FAA policy, EASA's report notes that, "Activating the own-ship position option may define an application as ... requiring an EASA airworthiness approval." Moreover, EASA pointed out how this app generates a crew-alert message if own-ship position inadvertently becomes enabled, and therefore advised operators to ensure pilots learn of this alert's significance in their training and manuals.

The report also contained observations such as, "An operator's EFB administrator should ensure that non-EFB software applications do not adversely impact the operation of the EFB. ... Non-Jeppesen applications providing an indication of current position (e.g., Apple's 'Maps' application) should be considered to be non-approved [airworthiness approval-required] applications if the present position function is not inhibited and locked by the administrator. ... There is no way to ensure at the applications level that [interactions] (visual and auditory) coming from non-EFB applications are disabled. Pop-ups, notifications and alarm sounds may be

EASA's assessment of an iPad app also offers generic safety recommendations.



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triggered unexpectedly depending on the configuration."

EASA's general recommendations to operators include performing formal operational risk analysis of EFBs, line-oriented flight training in a simulator that includes items such as a late runway change and diversion to an alternate airport, and observation by a civil aviation authority inspector of initial line flights on which the flight crew uses EFBs. ➔

Notes

1. Chandra, Divya C.; Kendra, Andrew. "Review of Safety Reports Involving Electronic Flight Bags." John A. Volpe National Transportation Systems Center, U.S. Department of Transportation. DOT/FAA/AR-10/5 DOT-VNTSC-FAA-10-08. April 2010.
2. FAA. "The Apple iPad and Other Suitable Tablet Computing Devices as Electronic Flight Bags (EFB)." *Information for Operators*, InFO 1101, May 13, 2011.
3. EASA. "Electronic Flight Bag (EFB) Software Evaluation: Jeppesen FliteDeck Pro (iOS) (Version 1.1) [and] Jeppesen Mobile TC Pro (iOS) (Version 1.3)." Oct. 17, 2012.



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Flare-Ups

BY LINDA WERFELMAN

Pilots are being advised to take precautions against this year's expected increase in solar radiation.

With forecasts of an increase in sunspots and solar flares in the coming months, pilots are being cautioned about a corresponding increase in the sun's contribution to cosmic radiation, which some aeromedical specialists believe may be associated with skin cancers and breast cancer in crewmembers whose flights typically are conducted at higher altitudes.

The International Federation of Air Line Pilots' Associations (IFALPA) approved a

policy in late 2012 calling for some aircraft that operate above 26,000 ft in polar and sub-polar regions to be equipped with warning devices to inform pilots of sudden increases in the rate of radiation exposure.

The policy also said that flight personnel who receive an effective dose of more than 1 millisievert (mSv) of radiation per year (the equivalent of 100 tooth X-rays; Table 1, p. 34) "should be recognized as occupationally exposed to ionizing radiation. Those who

Radiation Doses	
Radiation Source	Radiation Dose
Tooth X-ray	0.01 mSv
Chest X-ray	0.1 mSv
250 hours of flight at 36,000 ft at 60 degrees north latitude	1 mSv
1,330 hours of flight at 27,000 ft at the equator	1 mSv
Radiation limits	
Annual dose limit	1 mSv ¹
Annual cosmic radiation dose for flight personnel	2–5 mSv
Annual limit on effective dose for occupationally exposed workers averaged over five years ²	20 mSv
Dose associated with acute radiation illness	500–1,000 mSv
Lethal dose ³	4,000 mSv
Notes	
1. The unit for measuring radiation doses is the millisievert (mSv).	
2. No annual dose should exceed 50 mSv.	
3. When received at once.	
Source: International Federation of Air Line Pilots' Associations, European Joint Aviation Authorities	

Table 1

are liable to receive an effective dose greater than 6 mSv per year should be [classified as among those exposed to the highest doses].”

In addition, IFALPA recommended that a task force sponsored by the International Civil Aviation Organization (ICAO) be established to address issues associated with any ionizing radiation event “and the possible subsequent emergency descent of a large number of aircraft.”

“Radiation has been, and will be, affecting pilots always,” IFALPA added. “It is one occupational risk factor among others, but fortunately the risk for health effects, with our current knowledge, is very low.”¹

Numerous studies of crewmembers’ cancer risks have concluded that, although the overall cancer risk is not elevated, the risks are higher for malignant melanoma and other skin cancers, as well as breast cancer for female crewmembers, IFALPA said.

Summarizing the findings of more than 65 studies in the past 20 years, IFALPA added that some studies also showed a higher risk of brain cancer.

“Overall, aircrew are a highly selected group with many specific characteristics and exposures that might also influence cancers or other health outcomes,” IFALPA said. “Radiation-associated health effects have not been clearly established in the studies available so far. However, it is certainly worth noting that whilst the annual exposure of other radiation workers (e.g., nuclear workers, medical and industrial radiographers) is decreasing following the introduction of the principle to reduce doses as low as reasonably achievable, radiation doses of airline flight crew do continue to increase, as advances in aerospace technology permit longer duration, higher altitude and higher latitude flights.”

U.S. Federal Aviation Administration (FAA) aeromedical researchers

said in a 2003 report that the primary concern for crewmembers (and unborn children who are exposed to cosmic radiation during their mothers’ pregnancies) is a “small increase in the lifetime risk of fatal cancer” and a risk of genetic defects for future generations.²

Origins

Earth and everything on it are constantly subjected to cosmic radiation, which originates both in deep space — known as background cosmic radiation or galactic cosmic radiation — and in the sun — called solar radiation.

Solar radiation, which is generated when disturbances on the sun’s surface release high-energy solar protons, increases in intensity as solar flare activity increases, which it does in cycles that vary in length but typically last between nine and 14 years.

The current cycle, which began in 2008, is expected to last 11 years, with the so-called solar maximum — the period when sunspots and solar flares are most frequent — likely to occur later in 2013, according to experts in solar weather forecasting, including the U.S. National Aeronautics and Space Administration (NASA).³ The solar storms that occur, especially during the solar maximum, can lead to short-term increases in radiation levels — increases that can prompt airlines to reroute some flights, primarily to avoid a radiation increase that could place crewmembers at risk of exceeding the maximum recommended exposure and could interfere with high frequency (HF) radio transmissions.

The flights that most frequently are subject to rerouting are those at higher altitudes and higher latitudes — in polar areas — where cosmic radiation levels are relatively high. This is because at high altitudes, there is less

air above an airplane to shield it from radiation, and in polar areas, Earth's magnetic field offers less protection against radiation.

A large-scale rerouting occurred in February 2011, forcing airlines to re-book passengers and pay increased fuel costs related to the longer routes that took the place of the planned polar flight paths.

IFALPA says that five solar storms in the past 60 years have had radiation levels so high that individuals on a single trans-Atlantic flight would have exceeded the recommended 1 mSv annual radiation limit for members of the public. For crewmembers, a trans-Atlantic flight during one of those severe solar storms would have provided exposure to the same amount of radiation received during three months of typical airline flying.

Calculations

Several computer programs have been developed to provide estimates of the radiation exposure on a given flight. For example, the European Program Package for the Calculation of Aviation

Route Doses (EPCARD) calculates radiation exposure by taking into account the departure airport, duration of climb, flight altitude, duration of descent, destination airport and number of flight levels.⁴

The CARI-6 computer program, developed by the FAA Civil Aerospace Medical Institute (CAMI), works in a similar fashion, calculating radiation exposure by considering the shortest route between any two airports. The FAA says the program also takes into account the date of the flight to determine changes in Earth's magnetic field and current solar activity that may affect levels of cosmic radiation penetrating the atmosphere. The program also calculates the dose rate at any geographic location or altitude up to 60,000 ft.⁵

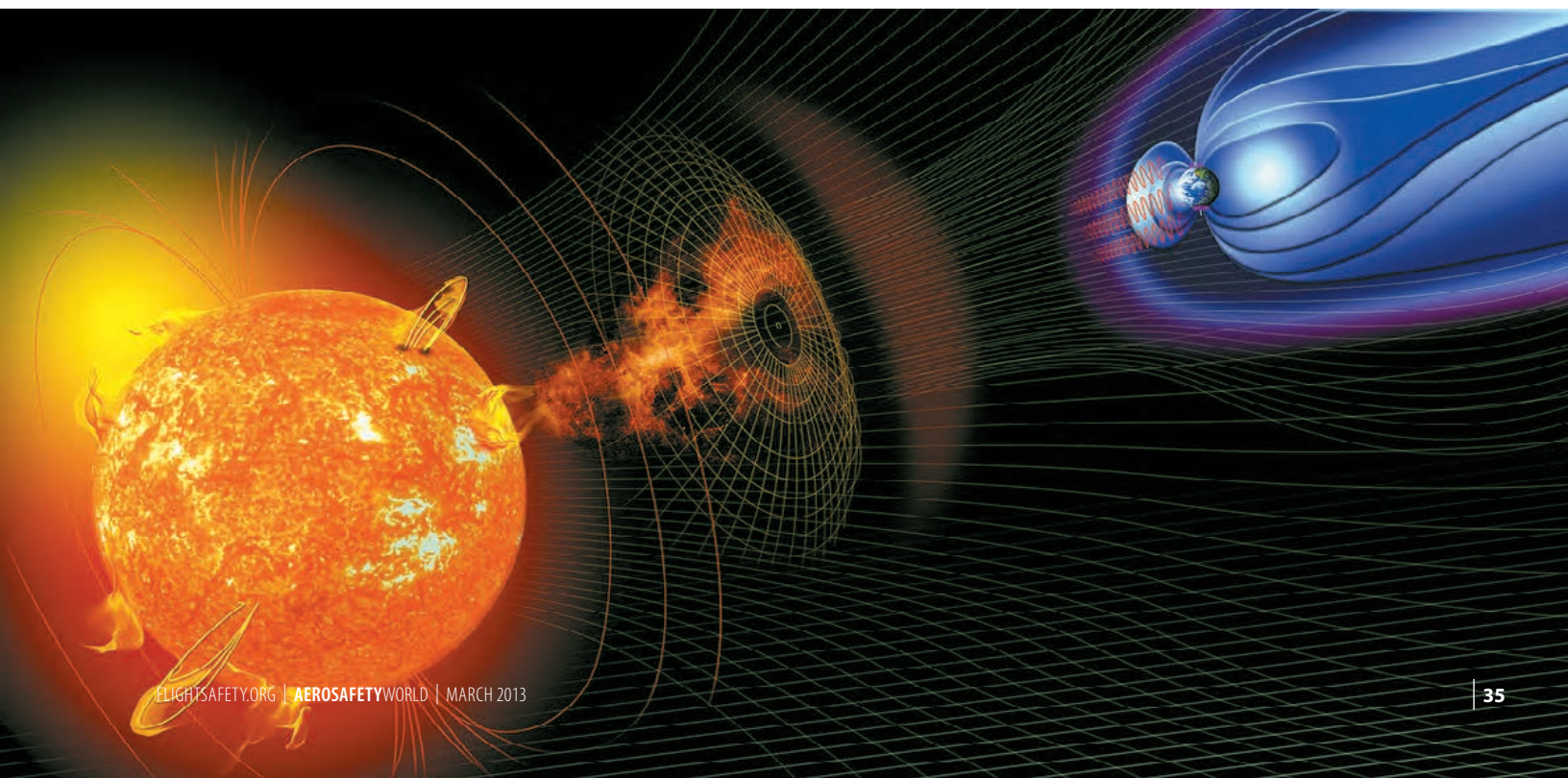
PCAire says it laid the groundwork for its web-based program by having its researchers carry "a large radiation detector, sensitive to cosmic rays, on hundreds of flights. The radiation field was recorded every minute along each of these flights. Analysis of this data led to the development of

mathematical functions that matched the measurements for any flight, at any altitude and anywhere in the world. The PCAire code uses these mathematical functions to calculate the dose to a person on a given flight. For each flight that is entered, the code takes into account the date, time and flight path and recomputes the radiation field during that flight."⁶

Forecasts

In the United States, a solar radiation alert system continuously analyzes satellite measurements of high-energy solar protons to determine whether the effective dose rates are elevated at aircraft flight altitudes.

If a substantial elevation is detected, an alert is issued by the CAMI via the National Oceanic and Atmospheric Administration (NOAA) and a global network of agency counterparts. The alert includes an estimate of radiation levels at altitudes from 20,000 ft to 80,000 ft at specified latitudes, and a recommended maximum flight altitude at those latitudes. For air carriers, the recommended



response to a solar radiation alert is to “minimize flight time at altitudes that exceed the recommended maximum flight altitude,” the CAMI report said.⁷

As noted earlier, when scientists have determined that elevated dose rates are expected, airlines have rerouted polar flights to avoid exposure to increased cosmic radiation — and to avoid the possibility of interference with HF radios. When the large-scale reroutings occurred in 2011, airline flights from the United States to Asia were forced to detour south over Alaska (ASW, 11/11, p. 40).

Chris Mertens, senior scientist at the NASA Langley Research Center in Hampton, Virginia, said, however, that the current system does not monitor aviation occupational radiation exposure.⁸

A report quoted Mertens as saying that the average commercial airline pilot receives “more radiation exposure than a fuel-cycle worker in a nuclear power plant.”

Mertens said he and other NASA scientists are working with NOAA and

the National Institute of Occupational Safety and Health to better understand the effects of radiation on aircraft crewmembers and incorporate radiation predictions into National Weather Service forecasts.

Protection

IFALPA identified two methods of providing in-flight protection against cosmic radiation — radiation shielding or imposing limits on exposure.

“It is impractical to shield aircraft effectively from cosmic radiation,” IFALPA said. “Therefore, the most viable option for flight crew is dose constraints/limits.”

The International Commission on Radiological Protection (ICRP), an independent, non-government organization that provides guidance on protection against the radiation risks, says — and most civil aviation authorities agree — that the recommended effective dose limit for airplane crewmembers is 20 mSv per year, averaged over five-year periods, or 100 mSv per five years, and that exposure in any one year should not exceed 50 mSv.

Accompanying ICRP recommendations are that pregnant crewmembers should not be exposed to more than 1 mSv “from declaration of pregnancy for the remainder of the pregnancy” and that passengers should be exposed to no more than 1 mSv per year.

In the United States, the FAA has no binding radiation-related regulations but recommends that operators comply with the ICRP’s recommended limitations, including the annual dose limit of 20 mSv.

In Europe, many individual nations have stricter limits; typically, they set a 6 mSv limit on the allowable dose from

occupational exposure to cosmic radiation, IFALPA said.

ICAO Requirements

ICAO requires that all airplanes that are intended to be operated above 49,000 ft carry equipment “to measure and indicate continuously the dose rate of total cosmic radiation being received ... and the cumulative dose on each flight.”⁹

Other requirements call for the equipment’s display unit to be visible to a flight crewmember and for the operator to maintain records of the relevant flights “so that the total cosmic radiation dose received by each crewmember over a period of 12 consecutive months can be determined.” ➔

Notes

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U.S. National Aeronautics and Space Administration; Photo Illustration: Susan Reed

In an era of razor thin airline profit margins and bloated fuel prices, a data-driven, safety-sensitive fuel management program is increasingly essential to efficient operations. Fuel now accounts for 33 percent of airline operating costs, up from 14 percent in 2003, according to the International Air Transport Association (IATA). At most airlines, fuel is more expensive than labor, which traditionally had been the largest single operating cost item.

The fuel-induced pressure on profitability has some in the industry concerned that carriers could opt to carry less fuel on some flights to reduce aircraft weight and decrease fuel burn, but a properly run fuel management program can positively impact safety performance. IATA, in

its *Guidance Material and Best Practices for Fuel and Environmental Management* (the 5th edition of which was released in 2011), said that “managing fuel accurately and efficiently improves safety through additional attention to planning, high accuracy of the flight planning system and precise execution of the flights, increased situational awareness, operational discipline to follow the flight plan, availability of appropriate analytical tools and statistics, adequate training for pilots and other operational personnel, a feedback mechanism to inform employees of airline policy, efficiency targets, and performance data within specified timelines.”

BY MARIO PIEROBON

Managing for Safety

An effective fuel management program can enhance safety and efficiency.

According to IATA, additional safety benefits include the opportunity to “exercise proper risk management by ensuring that sufficient fuel is carried to high-risk airports and less fuel to airports where it is not necessary; minimize the risk of unplanned diversions; ensure that flight crews and dispatchers maintain a safe and efficient approach to fuel management; monitor the use of fuel reserves for purposes other than intended, such as the improper use of alternate fuel while an alternate airport is still required; [and] develop a fuel management information system, which permits the tracking of fuel usage and the monitoring of deviations of flight plan fuel.”

Data-Driven Approach

To derive safety benefits from a fuel management program, it is important that the program be based on safety principles and be data driven. Accurate and reliable data have to be available to understand the status quo, to establish the saving targets and to continuously assess the safety implications. “You simply need to have accurate data to monitor [whether] your flights are really happening as you think they are happening,” said Rudolf Christen, CEO of Aviaso, a fuel management software provider. “Three examples illustrate what type of information can be relevant: compare the planned versus actual trip times, compare the planned versus actual lateral and vertical departure/arrival tracks, and compare the planned versus actual weights. Ideally, you have this information in correlation to the time of the day, weekday and further criteria such as weather, since, obviously, an arrival into a busy commercial airport looks different on a foggy early Monday morning compared to a sunny Sunday afternoon,” he said.

The availability of data means an opportunity for better decisions, said Christen, who advocates providing fuel efficiency information to flight crews as part of their briefing process. He said that during the preflight briefing, pilots should get fuel efficiency information on the upcoming sector to be flown. “Such information is coming from the fuel efficiency data warehouse and is based on information collected in [for

example] the previous 12 months on the respective sector. This approach improves the pilots’ knowledge of the upcoming flight and allows for better decisions. Obviously it is important to not only present average figures but also highlight the deviations from the average figures.”

In addition, it is important that the data coming from a variety of sources be properly integrated, and that pilots and other operational personnel be familiar with the principles of statistical analysis, according to Christen. Collected data parameters can relate not only to actual fuel consumption, but also to parameters that affect consumption, such as weight, distance, time, engine, flight planning and weather information, he said.

Important fuel consumption data can be derived from flight data monitoring (FDM) systems and aircraft performance monitoring (APM). APM is important because “while FDM records data at certain preselected time intervals, like once per second or every two seconds, and then feeds the flight data recorder, APM allows the calculation of the deterioration of aircraft performance over time,” said Philipp Reichen, an aviation and aerospace consultant and contractor. “APM records very specific data to calculate aircraft performance, whereas FDM records a vast quantity of data, including flight control positions, which are intended to show excursion of values compared to limits. The APM and FDM systems share some of the same sensors; therefore, the accuracy of the acquired data should be the same,” Reichen said.

Neither system, however, will provide a complete understanding of how fuel consumption is affected on its own, said Reichen. “The risks of just using one or the other system are that decisions and results will be based on incomplete data and might, therefore, be inaccurate or even faulty. This, in turn, might lead to not being able to meet ROI [return on investment] goals in fuel savings and to introducing procedures that do not address the potential savings correctly. In order to have the best understanding of fuel consumption and reasons for maybe excessive use of it as well as potential savings, APM

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systems should be used together with FDM and even engine condition trend monitoring. Best practices would include a long-term data and trend view, as well as the short-term view for the more immediate decisions,” said Reichen.

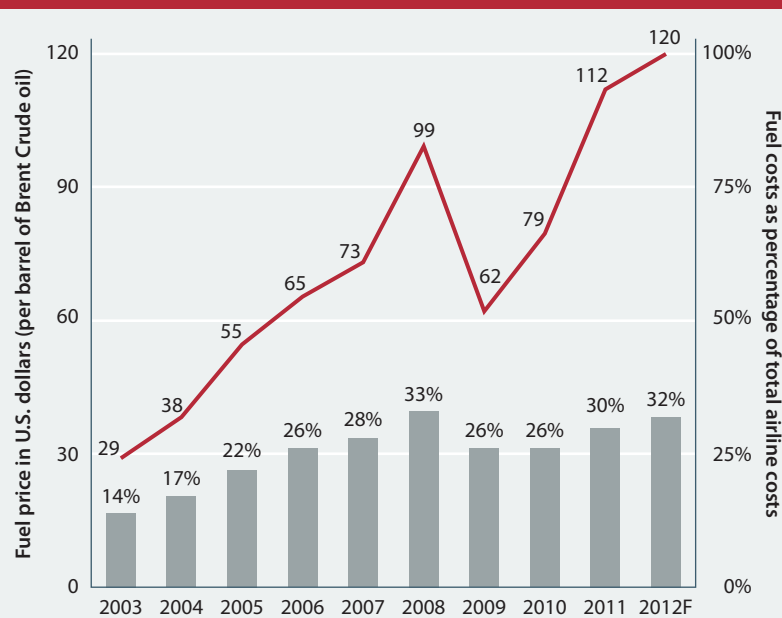
Fuel Management on the Flight Deck

Even if other functions also have an important role to play in fuel management — for example the engineering function can prescribe aircraft drag and weight reduction efforts and support the collection of APM data — because the operational domain is the main target for fuel efficiency improvements, pilots and dispatchers tend to be the main recipients of safety recommendations. “Lately, there has been more and more emphasis on carrying the correct amount of fuel, no more, no less. It is critical that pilots do a very thorough analysis of the fuel requirements, perform risk management (using appropriate tools such as analyzed contingency fuel), learn how to check their fuel using advanced flight management systems [FMS] and properly manage their fuel during flight,” said Marcel Martineau, a former Airbus A330/A340 captain, manager of Air Canada’s fuel program and currently the owner of Total Fuel Management, a consulting firm.

Flight Planning Systems

Some airlines still use legacy flight planning systems despite having invested heavily in modern aircraft. Upgrading the flight planning to support to more efficient fuel management offers several safety benefits. “There is a large variation regarding the optimization of various flight planning systems,” said Martineau. “Most flight planning systems on the market are reasonably accurate calculators, but often not great optimizers. In addition, many dispatchers are not well trained on their flight planning systems. The best systems will calculate fuel more accurately as they will consider the planned departure runway with appropriate SID [standard instrument departure route] and the planned landing runway with the correct STAR [standard terminal arrival route]. This eliminates a lot of guessing work as to how

Development of Fuel Price and Fuel Costs as Percentage of Total Airline Costs



F = forecast

Note: As crude oil and thus fuel prices have increased, fuel costs as a percentage of total airline costs have risen dramatically.

Source: Aviasco/Fuel Efficiency, Aviasco Inc.

Figure 1

much fuel is required to compensate for inaccuracies. In addition, having runway-specific flight planning system capabilities is excellent to assist the pilots in programming the FMS so as to check the accuracy of the fuel requirements before departure. This will improve safety due to the fact that pilots will have a clear idea of their fuel and what it is used for,” he said.

Another driver of a good fuel management program is the cost index, which “provides a flexible tool to control fuel burn and trip time to get the best overall economics.”¹ Some techniques for reducing fuel burn, such as cruising at a lower speed, often result in more trip time. In such a situation, fuel savings could be offset by increased time-related costs, such as crew-related costs or the expenses associated with passengers missing connections. The cost index is the cost of time compared with the cost of fuel and is used to obtain the best economics. If fuel costs are the main priority, then the cost index is

low. With zero cost of time, the cost index would be zero and the FMS would fly the aircraft at maximum range cruise (MRC) speed. If the cost of fuel instead is cheap compared to the cost of time, then speed is important and the cost index is high. For zero cost of fuel, the cost index would be 999, and the flight management system would fly the aircraft just below Mach maximum operating (MMO). The best economics are between these two speeds and depend on the operator's cost structure and operating priorities.²

Put another way, suppose crew costs work out to \$10 per minute, maintenance is \$10 per minute, the delay cost is \$50 per minute and fuel is \$1 per kg (or about \$3.25 per gal). As long as an aircraft is burning less than 70 kg of fuel to save a minute of time, the airline comes out ahead, according to Martineau.

Flight Planning and Operations Control

"As the flight dispatch or flight planning function is integrated into the operations control process, one major aspect of improving the business decisions within operations control has been the provision of improved situational awareness tools that provide a variety of functions including flight watch," reported IATA.³ According to Martineau, "This process can greatly enhance flight safety, and will ultimately produce the safest and most cost-effective operation, as the flight crew cannot adequately analyze the significant amount of data and factors involved in planning a flight without experienced, knowledgeable assistance from the ground."

Flight dispatchers typically play a larger operational role in regulatory regimes like those of the United States and Canada than elsewhere in the world. "It is unfortunate that most

dispatchers outside North America are relegated to a clerical function, leaving the [airplane] commander alone to determine fuel requirements often based on a seat-of-the-pants process," said Martineau. "In an increasingly complex environment, dispatchers must be better trained and must not only participate in the fuel requirement risk analysis, but must provide proper flight following after the flight gets airborne. Many conditions can change during the flight, and dispatchers are in a better position to monitor and assess changes that can affect the safety of flight. Things such as volcanic ash, NOTAMs [notices to airmen], wind updates, turbulence reports, ETOPS [extended twin-engine operations] support, etc., can be better done from the ground with proper systems."

Alternate Airport Selection

Selection of an alternate airport also is an important element of a safe and effective fuel management program. "All alternates shown on the operational flight plan must be in compliance with applicable regulatory and company policies. The following guidelines should be considered during the alternate selection process: Diversions very rarely occur, and when they do, the aircraft often does not proceed to the flight planned alternate. The cost of carrying the fuel for an alternate is high, [and] in business case terms, an occasional diversion is much cheaper than always carrying extra fuel as part of a 'prevent a diversion' strategy," reported IATA. In explaining the "prevent a diversion" strategy, Martineau said that some airports present particular operational risks, such as unpredictable weather, heavy traffic or limited approach facilities that might prevent a flight from landing. To minimize the chances of having to divert, it is

sometimes necessary to carry extra fuel to enable additional holding time or the ability for the flight to attempt more than one approach in cases when the weather is variable. If the flight carries the minimum amount of fuel, it might have to divert to the alternate airport as a result once its holding time is over.

According to Martineau, "The likelihood of going to an alternate when the weather is bad will contribute to the choice of the alternate. The flight planning system must calculate realistic fuel requirements to the alternate. For instance, if Newark [Liberty International] Airport is used as an alternate while going to [John F. Kennedy International Airport] (which is about 12 nm [22 km] away), there will be a requirement for about 80 nm [148 km] of travel to fly to the alternate airport. Pilots must be careful to plan the proper routing to the alternate in the FMS to ensure accurate alternate fuel prediction. In addition, in the likelihood of a diversion, pilots must ensure they have some fuel reserve available above the final 30 minutes fuel, as many other flights might be diverting at the same time and there might be a need for some holding capability. Also, one must know how this 30 minutes holding is calculated by the flight planning system and how much of it is usable, along with the flight maneuvering restrictions if using fuel from the final holding fuel."

Center of Gravity

"Depending on the aircraft type, drag created by loading an aircraft to the forward limit of its forward center of gravity can increase drag by as much as 3 percent compared to loading the aircraft at its most rearward center of gravity limit. Mismanaging an aircraft's center of gravity can have a significant impact on fuel efficiency. The actual center of

gravity plays a significant role in aircraft en route performance; the more aft the center of gravity can be placed, the less induced drag will be produced, which, in turn, improves the specific range of the aircraft. This reduction in induced drag results in reduced fuel consumption,” reported IATA.

Accuracy in managing aircraft center of gravity is thus very important. Unfortunately, most flight planning systems do not consider the variation of fuel burn caused by the variation of the center of gravity, Martineau said, “The variation can go from plus or minus 2 percent, depending on the aircraft type. Consequently, on long flights, a 2 percent error can eat up the contingency fuel. If the flight plan fuel biases are not accurate, pilots can end up arriving at the destination with less of the required fuel.”

Reduced Fuel Consumption Procedures

An approach based on risk analysis should also lead to the adoption of reduced fuel consumption procedures. A wide range of flight operations procedures reduce fuel consumption, are safety sensitive and need appropriate control actions: engine-out taxi-out, reduced takeoff flaps, reduced acceleration altitudes on takeoff, continuous climb operation, constant descent operation, low noise–low drag approach, reduced flaps landing, idle reverse on landing, and engine out–taxi in.

“Many of these procedures are used safely by many airlines,” said Martineau. “The idea is having good guidelines, training and awareness for each initiative. Landing on a 10,000-ft (3,048-m) runway where the airplane must exit at the end of the runway certainly does not require the use of full reversers and maximum brake on landing. All of these procedures are a question of

airmanship and common sense. Regular line pilots who are well trained with proper guidelines are quite capable of judging when such procedures should be applied. All of these initiatives should be recommended procedures and not standard procedures, as they should only be applied when the conditions are appropriate.”

Risk-Based Approach and Regulatory Compliance

The key to a data-driven fuel program is to follow a risk-based approach. The question may arise of how it is possible to manage fuel performance in a risk-based mode, that is, based on the particular operational history of the airline, while remaining compliant with applicable regulations, which are, of course, prescriptive, regardless of the peculiarities of a specific operator.

Risk-based fuel management does not imply going against regulatory requirements or manufacturer’s recommendations. A risk-based approach allows for pushing the envelope wherever there is a margin of safety and for making more conservative decisions where the risks are known to be higher. “The several actions implemented by a fuel management system in flight certainly have a financial motivation,” said Luigi Bellini, an airline training captain. “The need is for a functional safety risk management effort which counterbalances the strictly financial motivation.”

A risk-based approach can also be applied in updating relevant regulations on fuel reserves. “In the European regulatory environment, there has been a lot of work in clarifying the process of fuel planning and how fuel should be managed during flight,” said Martineau. ICAO [the International Civil Aviation Organization] has been doing a lot of work trying to catch up with Europe,

and its *Flight Planning and Fuel Management Manual* is expected to become an ICAO Annex shortly, Martineau said. In the United States, if an operator wants to use a risk-based approach to managing contingency fuel, it needs to request a special exemption to the FARs from FAA, he said. “Needless to say, all of the changes are causing some problems of interpretation of the rules,” he noted. “Often, the government agencies from many countries introduce various regulations without proper consideration of the effect of such rules. So you end up with flights landing at the same airport at the same time with completely disparate fuel requirements. This shows that there is a lot of room for improvement in the area of training and achieving commonality in regulations on fuel reserves. The adoption of a risk-based approach in the rulemaking process is certainly a priority.”

To summarize, fuel management serves to increase operating efficiencies, resulting in reduced fuel bills, and at the same time, it improves flight safety by enabling better front-line decision making. A data-driven and risk-based fuel management program based on a combination, as applicable, of the above best industry practices for optimized fuel consumption will also reduce the risk of systemic errors. ➤

Mario Pierobon works in business development and project support at Great Circle Services in Lucerne, Switzerland, and was formerly with the International Air Transport Association in Montreal.

Notes

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MULTIPLE AVIATION INDUSTRY SEGMENTS. ONE MESSAGE: SAFETY.

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Predictive tools hold promise for investigative authorities expanding their time-honored niche.



BY WAYNE ROSENKRANS

Beyond Forensics

Stereotyping the work of aviation accident investigation boards (AIBs) may become impossible in light of presentations by several of their leaders at a recent global conference. More openness to data-mining methods pioneered by airlines and civil aviation authorities (CAAs) is apparent, and some AIBs already have extensive experience conducting analyses of their own safety data for predictive purposes. Leaders and investigators who had been reluctant to move in this direction now point to the influence of non-AIB initiatives with international reach, such as the Aviation Safety Information Analysis and Sharing program in the United States.

A few AIBs envision complementing their own safety-intelligence resources by partnering with CAAs for access to aggregated, de-identified airline data from voluntary reporting systems and/or flight data monitoring, although such data formerly had been considered incompatible with AIB methods and missions (ASW, 5/11, p. 18; ASW, 11/12, p. 31).

Completing accident investigations while venturing into predictive data analysis and risk mitigation was the theme of the joint International Investigative Issues Conference of state AIB leaders and the International Society of Air Safety Investigators ISASI 2012 seminar in August.

Diversity of Aviation Accident Investigation Boards

Name of AIB	Staffing, Budget and Caseload	Interesting Facts
AAIB U.K. Air Accidents Investigation Branch	50 total staff including 30 investigators; investigators include operations inspectors, engineering inspectors, recording inspectors and six principal inspectors who act as IICs	AAIB routinely is involved in large international investigations, sometimes as state of manufacture for aerospace companies such as BAE Systems and Rolls-Royce.
AAIU Air Accident Investigation Unit, Ireland	7 total staff including 5 investigators	A substantial portion of activity involves interface with non-Irish aviation authorities; AAIU sometimes is assisted in technical and non-technical problems by the European Union's network of investigators.
ASC Aviation Safety Council, Taiwan	27 total staff, including 17 technical staff; \$1.8 million annual budget; 80 occurrence notifications and 68 cases annually	About 10 cases annually are serious incidents or accidents; national sponsoring agencies/institutions fund \$2 million in ASC safety studies and other research projects annually.
BEA Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civil, France ¹	100 total staff including 50 investigators; 250 accident or incident investigations annually; \$40 million annual budget	BEA annually leads about 50 public transport investigations, mainly incidents and serious incidents; in 2011, BEA analyzed 112 flight recorders and 33 avionics units, 6 videos, 37 ATC radar cases, 25 wreckage sites and 26 metallurgic/failure cases.
BFU Bundesstelle für Flugunfalluntersuchung, Germany ²	35 total staff including 18 investigators; 60 external experts on call for minor GA accidents	Sometimes interfaces with other AIBs as state of manufacture of products from companies such as the Airbus A318, A319, A321 and some A320s; some Dornier aircraft; Rolls-Royce; and Eurocopter EC135 and EC145 helicopters.
NTSB U.S. National Transportation Safety Board	400 total staff including 104 aviation accident investigators; \$100 million annual budget; 1,500 aviation accidents investigated annually inform/enable objective data queries	NTSB annually sends investigators as accredited representatives to about 8 international accidents; 10 electrical and aerospace engineers in the recorders lab annually analyze 500 devices, and only about 150 are aircraft FDRs or CVRs and the rest consumer devices.
TSB Transportation Safety Board of Canada	220 total staff include 20 engineering and laboratory staff; \$30 million annual budget; 65 accident/incident cases annually	TSB addresses events in aviation, marine, rail and pipeline transportation modes; 170 laboratory projects annually in all modes may involve 11 human factors and microanalysis specialists.

AIB = aviation accident investigation board; ATC = air traffic control; BEA (1) = Bureau of Inquiry and Analysis for Civil Aviation Safety; BFU (2) = German Federal Bureau of Aircraft Accident Investigation; CVR = cockpit voice recorder; FDR = flight data recorder; GA = general aviation; IIC = investigator-in-charge; ISASI = International Society of Air Safety Investigators

Note: These AIBs are a subset of ISASI 2012 presentations, and facts disclosed varied. All numbers are approximate.

Source: AIB presentations at ISASI 2012 conference (August 2012) by Sylvie Dionne, TSB; Jens Friedemann, BFU; Wen Lin (Michael) Guan, ASC; Paddy Judge, AAIU; Joseph Kolly, NTSB; Christophe Menez, BEA; and Philip Sleight, AAIB.

Table 1

Deborah A.P. Hersman, chairman of the U.S. National Transportation Safety Board (NTSB), opened the conference saying: “Now I know that this might be hard for you all to hear, but some even suggest that with today’s sophisticated data and tools, accident investigations may become a thing of the past. However, I would propose that the reality is that forensic investigation is the foundational tool not only to be reactive, but to be more predictive. ... In almost every accident, we do see

precursors, data that could have been used to understand breakdowns in safety margins and predict accidents. But in real time, with thousands of flights, figuring out what the data can tell you, and how it might combine with other factors in the operating environment ... can be as much of an art as science. ... [AIBs] must use all the tools available — retaining the ‘tin-kicking,’ but also enhancing laboratory equipment and taking advantage of tools that mine data to map trends and hot

spots — so we can move from reactive to predictive.”

Comparing data even from minor incidents to the experience of entire fleets enables AIBs to include predictive elements when issuing safety recommendations, she said.

“It’s not beneficial for any AIB to look at a single accident now in a vacuum,” Hersman said. “We have tremendous data sources out there waiting to be mined. ... If we’re not understanding how this [accident] relates in

the context, we're not really helping to advance things. ... And so [AIBs] have to be part of that feedback loop. Sometimes one of the challenges ... is not just siloing within organizations, but it's siloing organizations within the [safety management system] process."

NTSB by law conducts special studies and investigations apart from investigating aircraft accidents, added Joseph Kolly, director, and Loren Groff, national resource specialist, both in NTSB's Office of Research and Engineering. These have similarities to the newer interest in predictive data analysis. Data sources have comprised existing databases and targeted collection of new data, including aggregate data from nominal/non-accident flight operations for understanding safety issues, for comparisons to accidents and for predictive uses. "Independent investigation authorities typically have access to a wealth of detailed information regarding the circumstances surrounding safety management failures and hazardous events," they said.

Facing Canadian Realities

Noting the latest 10-year record of one fatal accident in Canada involving large commercial jets, Wendy Tadros, chair of the Transportation Safety Board (TSB) of Canada, rhetorically asked, "With the numbers in decline, where does that leave us — where does that leave you, as investigators? Will the numbers ever reach and stay at zero? Will we have to close up shop and go home? The reality is, in this complex world ... many of you will be investigating large aircraft accidents in the developing world as accredited representatives."

Inside Canada, one of TSB's most important tasks is to prudently invest resources only in investigations of accidents that promise to yield valuable

knowledge, and then multiply the value of results by finding patterns through predictive analysis of data. When it comes to providing the hard evidence required to push government and industry toward AIB-recommended changes, statistics are the most persuasive, Tadros said, noting, "What can start off as a 'weak signal' in one occurrence, or in several occurrences ... may be a symptom — a sign of greater trouble — down the road. ... I am not trying to talk about predicting the future; rather I'm talking about studying the details, recognizing those underlying factors, the ones that maybe haven't become full-fledged causes yet, but which are nonetheless important."

Canada's smaller turboprop and piston-engine aircraft — widely used in commercial operations such as on-demand flights, as well as private flying — today are involved in more than 90 percent of accidents and 90 percent of fatalities, she said. TSB has concluded, given their predictive value, that safety management systems (SMS) and flight data recorders should be implemented by small operators in addition to large operators.

"Aircraft accident safety boards have a very important role to play in the evolution of safety management from reactive to predictive," said Michael Cunningham, Air Branch Atlantic regional manager, TSB. "Some systems may even be capable of evolving from reactive to predictive abilities as a result of research and development by experts in organizational management, fueled with the results of comprehensive safety board investigations."

Therefore, TSB has placed major emphasis on developing investigators' expertise in SMS through the study of Transport Canada regulations and guidance; a TSB course and annual

workshops; a TSB on-site SMS review guide; presentations by industry SMS managers; and sharing examples of problems identified by TSB, such as airline management taking inappropriate punitive actions against employees.

Australian Shift

AIBs play a key role in objectively informing governments about the current and future risks to the nation's aviation industry, said Stuart Godley, manager, research investigations and data analysis, Australian Transport Safety Bureau (ATSB). "Like airlines, nations rely on the collective wisdom of a combination of proactive initiatives, in addition to the reactive investigations that we do," he said. ATSB integrates predictive research primarily by using its internally generated data. Specifically, ATSB has been performing quarterly trend analysis for about two years, comparing current findings to five-year averages.

Predictive analysis has become "an integral way of conducting business as an investigator [agency] by guiding the best way that we can use our limited resources," Godley said. "Importantly, another driver is the prospect of discovering ... data that could have been used to highlight an emerging risk before a catastrophic accident happened. But we haven't actually used that data to do that."

AIBs often keep a nation's official accident and incident database and also may have a non-public database of details from accident/incident investigations, enabling trend monitoring, decision making, risk rating of occurrences, analysis of findings across investigations, and proactive analysis of safety deficiencies.

"Looking [annually at about 7,400] non-investigated occurrences provides a very valuable ... visibility of safety not always available in that small subset [of

about 100 in aviation] that we investigate,” Godley said. “We’re looking at everything to see if there’s any subtle changes that may point to something bigger.

“[We’re] then using statistics, seeing if the last quarter is greater than or less than, say, two standard deviations. ... When that happens, you can call that a ‘hard alert.’ ... Sometimes there’s no real trend or just a bit of random noise, and sometimes [it’s] quite clearly coming from one area.” The ATSB response to a hard alert may include designating one investigator to closely monitor all related occurrences day by day and to develop sensitivity to the details of each.

An event risk classification system published for airlines by Aviation Risk Management Solutions — and free for anyone to adopt, Godley said — helps AIBs to make one-time investigation decisions and to analyze multiple related occurrences. This results in a risk score rating matrix (Figure 1).

The system has been used, for example, to establish ratings for the risk

of bird strikes based on factors such as actual strike history, whether increases in data reflect changes in strikes or changes in reporting, and the types and number of birds involved in strikes.

Sorting the risk matrix by airports has influenced the government to act by showing that “the airports with the greatest risk, such as Townsville and Alice Springs, [have a higher risk] because aircraft are actually having bird strikes of multiple ... medium- and large-sized birds as opposed to just having [strikes involving] one bird or smaller birds,” he said.

AIB Nigeria’s FOQA Focus

Muhtar Usman, commissioner/CEO of Accident Investigation Bureau Nigeria and a captain, and Mike Poole, director, safety and strategy, CAE Flight-scape, told the conference that in many states, neither AIBs nor CAAs “have embraced the use of flight data for proactive safety measures.” However, a strong motivation for such programs is

the International Civil Aviation Organization’s (ICAO’s) latest emphasis for states to investigate serious incidents and also to collect data under state safety programs.

Usman said that the Nigerian government, for example, in late 2012 was scheduled to establish its own flight data analysis capability under a plan to require operators of Nigerian-registered aircraft to provide flight data to AIB Nigeria for the state safety program. He said that “the data will be kept confidential and used to develop safety action in the form of safety recommendations; it will not be used for punitive measures and it is not intended in any way to replace an operator’s internal FOQA [flight operational quality assurance] program.” The objectives include focusing on broad issues that transcend airline boundaries and/or aircraft type, and identifying the most problematic airports and events nationwide.

Other AIBs also have been adding infrastructure that enables broader

and deeper safety data analysis suitable for predictive purposes. For example, memorandums of understanding and cooperation agreements that include provisions for safety data exchange have been signed by Aviation Safety Council (ASC) Taiwan with other AIBs, government agencies and the academic research community, said Wen Lin (Michael) Guan, director of the investigation laboratory at ASC.

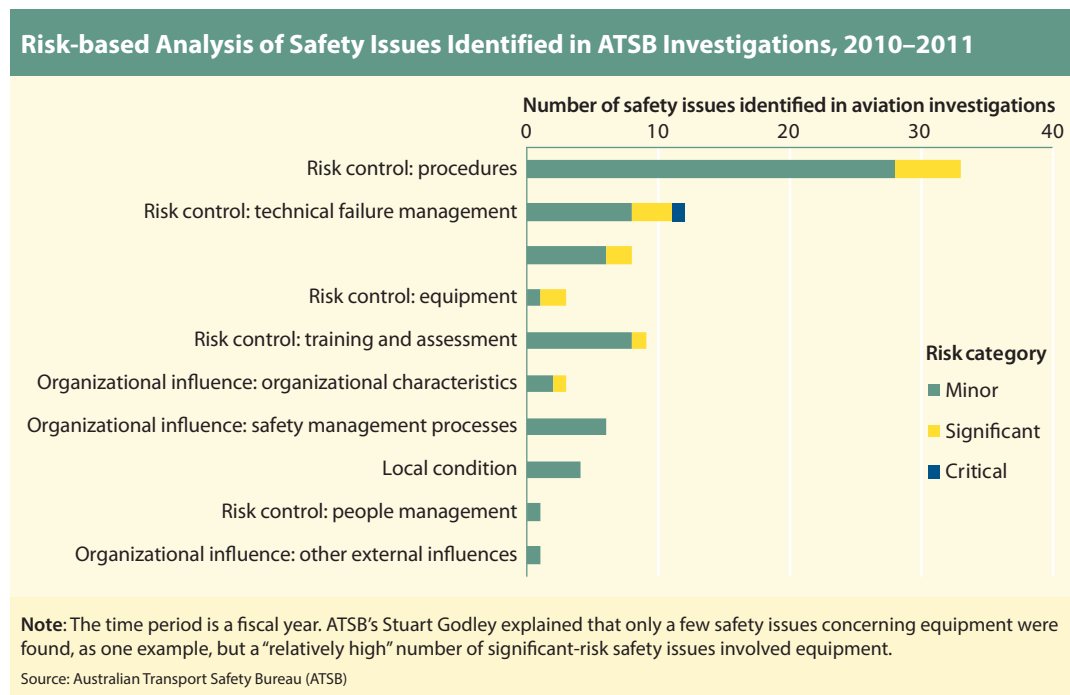


Figure 1

“At ASC, we have built up an occurrence information management system,” Guan said. “We know [beforehand even] the type of recorder installed on the aircraft. We also know the number of [flight data recorder parameters].” The system also organizes nearly all resources and information during an investigation and remains a resource for subsequent larger-scale safety analyses.

AIB laboratories today must capture and manage data associated with accidents in more sophisticated ways than before, agreed Sylvie Dionne, manager, materials analysis and structures operational services branch, TSB. “You’re going to learn a lot from previous cases and from ongoing monitoring of what’s going on, so you need to have some kind of database, I would say,” she said.

In Japan, the independence of the Japan Transport Safety Board (JTSB) from the Japan Civil Aviation Bureau, the nation’s regulator and air traffic service provider, preserves neutrality and transparency in investigations but also may affect efforts to adopt predictive safety analysis, according to Yuji Yanagisawa, deputy investigator general for aircraft accidents at JTSB. “These two organizations have a different role to play, but are working toward the same goal of improving the air safety — especially now, shifting to the state safety program and SMS environment, where aircraft accident investigation and regulatory enforcement are parts of the component elements,” he said.

Europe Settles AIB Debate

Europe largely has resolved complex disputes over relationships between the European Aviation Safety Agency (EASA) and the region’s AIBs, said John Vincent, deputy director for strategic safety, EASA. How to aggregate and use

the region’s newest data source, airlines’ voluntary safety reporting systems, is still under discussion.

“We had a long period of debate as to what EASA’s role was in relation to accident investigation,” Vincent said. “We hope that’s resolved now because we have ... Regulation 996,¹ which came into being in 2010 and establishes in European law the position that EASA has relative to the air accident investigators. I’m very glad to say that we work together [with AIBs and CAAs] as a team, the objective being the continuous improvement of aviation safety. It’s taken some time to build and develop that relationship; in some quarters, it’s still growing and developing and maturing.” A high level of interaction and interdependency, including for data uses, is expected, he said. In 2012, EASA also began a process under Regulation 996 to establish one central European database for AIB and CAA safety recommendations.

In Brazil, after a period of SMS-related adjustments to their relationship, the AIB — Centro de Investigação e Prevenção de Acidentes (CENIPA) — and the CAA have begun a new phase in which CENIPA is the national center for SMS training and also sees opportunities to pursue predictive data analysis, said Col. Fernando Camargo, former deputy chief of CENIPA. He described the adjustments as a positive step in resolving difficulties of interagency cooperation during investigations and in CAA acceptance of its safety recommendations.

Expectations of ICAO’s Universal Safety Oversight Audit Program also have motivated sharing of one database by the CAA and CENIPA for information such as final reports of accident/incident investigations and voluntary non-punitive reports from airline personnel, Camargo said.

U.K. Iterative Investigations

Philip Sleight, principal inspector, U.K. Air Accidents Investigation Branch (AAIB), asked, “What is the goal of ... a no-blame accident investigation? I would say actually the goal is to identify the safety issues early so that actions can take place to prevent recurrence.” The agency’s holistic model — essentially, iterative methods and free-flowing, cross-domain communication among individuals and groups participating in an investigation — has proved to be consistent with this goal, effective for safety mitigations prior to issuance of an accident report, and compatible with current proactive/predictive concepts of safety data analysis, he said.

Yet one challenge AAIB has recognized is that, whatever proactive/predictive initiatives may be desirable, the data demands of accident investigations alone become extremely difficult as complexity of aircraft and methods continue to increase. “Certainly at the AAIB, we would actually struggle with storing all of this information [and] in such a way that it is easily retrieved,” Sleight said. “As we were doing the investigation of the [British Airways Boeing 777 runway undershoot accident <www.aaib.gov.uk/cms_resources.cfm?file=/1-2010%20G-YMMM.pdf>] at Heathrow — with vast amounts of information that were coming in at a very rapid rate — we were still exploring solutions to enable all parties to the investigation to have secure access to the information, but also in a timely manner without compromising confidentiality.”

Note

1. The title is *Regulation (EU) No 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and repealing Directive 94/56/EC*.

BY RICHARD L. NEWMAN

Recovery Program

More-realistic simulators, angle-of-attack displays, flight envelope protection and improved training could reduce upset aircraft accident risk.

Loss of control (LOC), also known as upset aircraft (ASW, 2/13, p. 18) was the leading cause of large commercial jet accidents worldwide in the 2001–2010 decade. According to the Boeing *Statistical Summary*,¹ 20 fatal accidents of 87 reported in the period were caused by LOC. These LOC accidents resulted in 1,756 onboard fatalities as well as 231 external fatalities.

Following several high-profile upset accidents, colleagues and I reviewed airline LOC accidents and published a report on the findings in 2008.² That review included transport category and commuter airline operations during the 15 years from 1993 through 2007. The period was chosen to provide a reasonable statistical sample while avoiding a possible discontinuity caused by the introduction of fly-by-wire (FBW) technology. There were 75 accidents in that study period, with 3,261 fatalities. Major areas of concern included 27 stalls, 20 upsets caused by ice-contaminated airfoils and eight spatial disorientation (SDO) upsets. Eleven of the 75 accidents were exacerbated by faulty recovery techniques used by pilots.

New Upset Review

Our updated review, the subject of this article, analyzed all air carrier upset

events for the period 1981 through 2010. All U.S. Federal Aviation Regulations (FARs) Part 121 and scheduled Part 135 (commuter) revenue operations were covered. Equivalent non-U.S. events were included. We considered only transport and commuter categories. Transport category airplanes eligible for operation under Part 135 were classed as “commuters” regardless of the actual operating rule. Single-engine airplanes used in scheduled Part 135 operations were excluded.

This review used data from the Australian Transport Safety Bureau (ATSB), Transportation Safety Board of Canada (TSB), French Bureau d’Enquêtes et d’Analyses pour la Sécurité de l’Aviation Civile (BEA), U.S. National Transportation Safety Board (NTSB) and Aviation Safety Network (ASN) databases.

We also reviewed a database³ that includes accidents from many countries. Search keywords were “loss of control,” “upset,” “unusual attitude” and “stall.” Following identification from the databases, the accident reports were reviewed. Accidents resulting from midair collisions, criminal or deliberate activities, in-flight fire or pilot incapacitation were culled from the list.

There were minor differences in event filtering between the 2008 study

and this one. We only considered revenue Part 121 and scheduled Part 135 flights (and non-U.S. equivalents), whereas the earlier study included non-revenue flights, excluding only engine-out ferry flights and maintenance test flights.

Results

We identified 207 events (32 incidents and 175 accidents)⁴ resulting in 8,610 onboard fatalities with an additional 217 ground fatalities (Table 1). There were 554 serious injuries to airplane occupants and an additional 19 on the ground. It is likely that the

Primary Causes of Aircraft Upsets, 1981–2010		
Primary Cause	Number of Upsets	Fatalities
Aerodynamic stall	48	1,505
Spatial disorientation (SDO)	27	1,463
Pilot involvement	26	1,149
Atmospheric disturbances	20	1,141
Flight controls	33	739
Airframe ice	18	651
Other	23	1,469
Undetermined	12	493
Total	207	8,610

Source: Richard L. Newman

Table 1

incident data are underreported.

Events were classified according to causal factors involved (Table 2). The primary cause was gleaned from investigating authorities' accident reports where available and otherwise inferred from the ASN database. Forty-five percent of events happened at night and 56 percent occurred during instrument meteorological conditions.

Aerodynamic Stalls

There were 64 events (2,589 fatalities) involving stalls, either as the primary cause or as a consequence of the upset (Table 3). Twelve of these stalls involved contaminated airfoils.

Only one stall was in an FBW aircraft. The envelope protection was disabled by sensor failure in that event.

Twelve events, resulting in 336 fatalities, involved the autopilot flying the airplane at the time of the stall (Table 4, p. 50). Six airplane types were involved. A single aircraft type accounted for five autopilot-induced stalls. Two other types each had two autopilot-induced stalls.

Spatial Disorientation

In 37 events, resulting in 1,931 fatalities, SDO played a role. They included 18 cases of primary spatial disorientation, eight instrument failures, four events that occurred during or following a stall, two events that occurred when a pilot attempted to override the autopilot and six instances of somatogravic illusion, when rapid acceleration gives the false impression that the airplane is nose-up, or rapid deceleration mistakenly suggests that the aircraft is nose-down.

Causal Factors in Aircraft Upsets, 1981–2010

Causal Factor	Number of Upsets	Fatalities
Aerodynamic stall	64	2,589
Spatial disorientation (SDO)	35	1,738
Faulty recoveries	20	1,557
Takeoff (ice or flaps)	18	920
Airframe ice	34	706
Flight control problems	21	567

Note: Totals in Table 2 do not add to 207 upsets as shown in Table 1 because most upsets involved multiple causal factors. Faulty recoveries included such pilot actions as failure to immediately reduce angle-of-attack in an upset and applying rapid rudder reversals. Takeoff (ice or flaps) included takeoffs when the wings were contaminated with ice or the flaps were incorrectly set.

Source: Richard L. Newman

Table 2

Fourteen SDO events resulted in classic spiral dives. Nine aircraft types — none involving FBW aircraft — were represented. Five somatogravic illusion cases were found. These involved a takeoff or go-around. One additional “undetermined cause” accident has the earmarks of this illusion. Eight events were associated with distractions while troubleshooting.

Faulty Recoveries

Faulty airplane recovery techniques by pilots were involved in 20 events, resulting in 1,557 fatalities. Among those events were seven stalls, eight SDO encounters, two wake vortex encounters and three “other.”

The most common theme identified was failure to immediately reduce angle-of-attack (AoA). It appears that many pilots responded

Aerodynamic Stalls, 1981–2010

Aircraft Type	Number of Stalls	Fatalities
All widebody turbojets		
Airbus A300/A310	5	365
Airbus A330	1	228
<i>Subtotal</i>	6	593
All narrowbody turbojets		
Boeing 737	6	343
Boeing 757	2	189
British Aircraft Corp. BAC-111	1	71
Bombardier CL-600	1	53
Douglas DC-8	3	258
McDonnell Douglas DC-9/MD-80	4	191
Fokker F-28	1	27
Learjet 35	1	4
Sud Aviation SE-210	2	13
Tupolev Tu-154	3	515
Yakovlev Yak 40	1	9
<i>Subtotal</i>	25	1,673
All turboprop transports (no commuters)		
Antonov An-12	2	45
ATR 42/72	2	2
Convair CV-580	1	2
De Havilland DHC-8	2	49
Fokker F27	1	45
Lockheed L-188	2	73
<i>Subtotal</i>	10	216
All reciprocating transports		
Howard 500	1	3
<i>Subtotal</i>	1	3
All commuters		
Beechcraft BE-99	2	13
Britten-Norman Islander BN-2	2	16
De Havilland DHC-6	3	4
Embraer E110	1	17
Embraer E120	3	29
British Aerospace Jetstream JS31/41	2	11
Let L-410	2	14
Saab SF340	7	0
<i>Subtotal</i>	22	104
Total	64	2,589

Source: Richard L. Newman

Table 3

Autopilot-Induced Stalls, 1981–2010		
Model	Number of Stalls	Fatalities
All narrowbody turbojets		
McDonnell Douglas DC-9/MD-80	2	160
Tupolev Tu-154	1	145
Subtotal	3	305
All turboprop transports (no commuters)		
ATR 42/72	1	2
De Havilland DHC-8	1	0
Subtotal	2	2
All commuters		
Embraer E120	2	29
Saab SF340	5	0
Subtotal	7	29
Total	12	336

Source: Richard L. Newman

Table 4

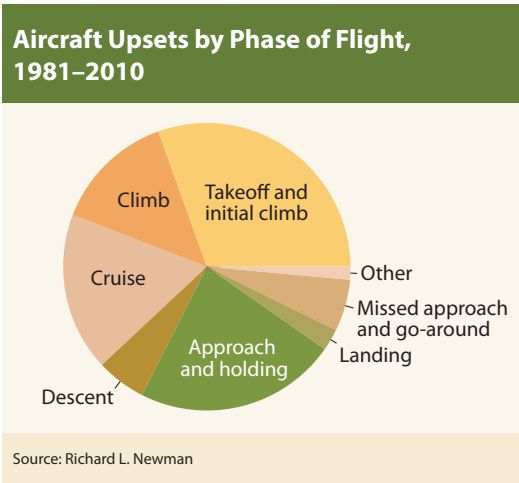


Figure 1

to upsets by pulling back on the stick.⁵ A second theme was applying rapid rudder reversals. This appears to be much more common than previously thought.^{6,7}

Takeoff Accidents

Eighteen events causing 920 fatalities happened during takeoff, when either the configuration was improperly set (five accidents with 374 fatalities) or the wings were contaminated with ice or frost (13 accidents with 546 fatalities). Distribution of upsets by phase of flight is shown in Figure 1.

Airframe Ice

Thirty-four icing-related events resulted in 706 fatalities. Thirteen of those involved stalls. In particular, eight of the 10 autopilot-induced stalls occurred

with ice-contaminated airfoils. Airframe icing events involved one heated-wing airplane, 17 pneumatic-boot airplanes and two airplanes with unprotected flap vanes.

There were 22 in-flight events, involving one heated-wing airplane (two fatalities), 17 boot-equipped airplanes (seven types — 158 fatalities) and two unprotected flap surfaces (single airplane type — no fatalities).

Among the 17 events involving booted airplanes, one turboprop type had eight events and two turboprop types had three events each.

Perhaps we should ask why we are still designing boot-equipped transport airplanes in the 21st century. Only one tailplane stall was identified during this period.

There were 13 attempted takeoffs with contaminated wings, resulting in most of the 546 icing-related fatalities.

Flight Control Malfunctions

Twenty-six events, responsible for 594 fatalities, were caused by flight control system failures. There was an additional accident involving a structural failure that led to loss of control.

Most of the events involved familiar components — actuator or autopilot hardovers, actuator or linkage jams, disconnected control cables and similar malfunctions. In one accident there was a complete hydraulic failure.

Pilot-induced oscillations (PIOs) are thought to be a flight control problem. They are not caused by the pilot, but may involve excessively sensitive controls.

FBW airplanes showed three new categories of software problems. The upsets studied resulted from inappropriate software control gains which led to an overcontrol tendency. Many of these could have been classed as PIOs, but have been listed in this analysis as “control gains” if the accident report recommended changes in the gains to prevent future accidents. In three cases, the flight control software logic was flawed — usually causing inappropriate flight mode changes.

Ten autopilot-induced stalls were not counted in this category but were included under “stalls.”

Pilot Experience

Pilot flight hours from 1981 through 2010 were examined. The data are sparse. While there was a downward trend in flight hours since 1980, low flight time of accident pilots does not appear to stand out as a factor. No difference between U.S. and non-U.S. carriers was evident, although commuter pilots have less flight time, and there were fewer commuter operations in the 1980s.

Training for Upset Prevention and Recovery

Many upsets were identified in which manual instrument flying proficiency appeared to be lacking. Airline flying has changed during the author's career, from emphasis on "stick and rudder" skills to "system management." This begins with initial pilot training. Many upsets begin with autopilot disconnection, degraded handling and systems faults. When coupled with reduced instrument skills from lack of use, it shouldn't surprise us when the crew has difficulty in regaining control.

The loss of pilots' instrument proficiency needs to be addressed. This must take into account the minimal amount of hand flying typical in airline operations today. In addition, many of these upsets result from automation failure, with the pilot being given manual control of the airplane in difficult circumstances.

The primary problem found in upset prevention and recovery techniques was the failure of many pilots to aggressively reduce the AoA. This very likely is a result of overemphasis on minimizing loss of altitude. Pilots have been trained incorrectly to "power out" of approaches to stalls, rather than actually recover from a stall. The U.S. Federal Aviation Administration (FAA) has published an advisory circular (AC)⁸ that changes the FAA's criteria for air carrier stall training to emphasize AoA reduction over minimizing altitude loss. This AC is a step in the right direction.

However, some existing simulators cannot be reliably used for stall training, particularly in high altitude, out-of-trim conditions, or during steep turns. While simulators might be used in these flight regimes, such use requires flight test and wind tunnel data that are not always available.⁹

The AC stresses the need for motion cues to allow the pilot trainee to recognize and feel the differences as the airplane approaches the stall. These differences are subtle. Training simulators, at this stage of their development, do not provide fully realistic motion cues. Motion cues can help, but misleading motion cues can provide negative transfer of training.

From my perspective, stall training must be in a fully validated simulator using data throughout the possible flight envelope, not just the normal flight envelope. If such a simulator is not available, then at least initial stall training must be accomplished in flight in the actual airplane.

Envelope Protection

The data clearly show that FBW airplanes equipped with envelope protection have been effective in preventing stall accidents. There were no in-service stall accidents in an airplane with a functional envelope protection system. Currently the Cirrus SR-20 and King Air 200, 200 and 350 are certificated with retrofit envelope protection systems.

Reducing Spatial Disorientation

The problem of SDO follows from the deterioration of instrument skills. However, simply improving pilot instrument skills may not be sufficient. Pilot training should include specific SDO training on upset prevention, recognition and recovery. This should include specific illusions, such as the somatogravic illusion, which can lead a pilot into perceiving pitch attitude to be much higher than it really is during a go-around.

There was some indication in our study that standby attitude instruments may not be providing adequate cues. The approval process for standby indicators should include enabling upset recognition and recovery from both pilot seats. Both primary and standby attitude indicators should provide visual cues to clearly show the pilot the angular relationship of AoA. This would help prevent the situation in which the airplane descends into the ground with the stick pulled back. An air-mass flight path angle, such as demonstrated in the variable-stability VISTA NF-16D, operated by the U.S. Air Force test pilot training school in conjunction with Calspan, should be evaluated.¹⁰ A scalar AoA tape or dial-pointer is not compelling enough.

Many SDO upsets involve pilots distracted by cascading failures or common-cause

The data clearly show that fly-by-wire airplanes equipped with envelope protection have been effective in preventing stall accidents.

failures in which the pilots discern no obvious pattern from the caution or warning displays.

Takeoff Accidents

There were five takeoff accidents in which the configuration was improperly set. This suggests that the certification requirement for a takeoff warning system may be inadequate. Perhaps FARs Part 25.703 should be amended to require that takeoff be prevented with an improper configuration. This would be similar to Part 25.670(a) for flight control gust locks.

There were 13 takeoff accidents in which the wings were contaminated with ice or frost (546 fatalities). No explanation was evident for why these accidents keep happening.

Concerns and Recommendations

The study suggests that deterioration in the basic manual flying skills of airline pilots today should be addressed. The industry must take a long, hard look at the past trends in pilot training emphasizing “management skills” and deemphasizing basic flying skills. Every now and then, the pilot has to abandon management skills and revert to simply flying the airplane.

This study suggests the following recommendations:

- Expand the proposed air carrier training advisory circular to the entire aviation community, including general aviation and primary flight training.
- Continue the development of simulators with sufficient data to cover the high-AoA regime with adequate motion cues. Until such simulators are in place, stall training must be conducted in the airplane.

- Develop displays to graphically present AoA information in high-AoA situations to aid upset prevention and recovery. The air-mass flight path display flown in the VISTA would be a start.
- Develop displays to cue the pilot to developing SDO scenarios and to provide guidance for recovery.
- Develop and install retrofit and forward-fit envelope protection as a mitigation technique.
- Amend the takeoff warning systems requirement (Part 25.703) to require a means of preventing takeoff with an improper configuration, similar to Part 25.670(a) for flight control gust locks.
- Amend the ice protection requirements (Part 25.1419) to require prevention of ice accretion on critical airfoils instead of allowing accretion followed by removal.
- Develop and install retrofit and forward-fit of autopilots incorporating cabin altitude monitoring and automatic descent profiles.
- Ensure that pilot experience (including second-pilot data) is documented during accident investigation. A return to the NTSB *Factual Report–Aviation* form would help. ➡

The help of Dennis Crider and Loren Groff of the NTSB in obtaining accident data and the help of Madeleine Kolb in reviewing the manuscript and other editorial assistance are gratefully appreciated.

Richard L. (Dick) Newman, Ph.D., is an engineer and test pilot with more than 25 years of experience in the development, testing and certification of aircraft systems.

Newman retired from the FAA Aircraft Certification Service in 2009 and then spent three

years with the Human Performance Department of the Naval Air Systems Command. He was a faculty member at Embry-Riddle Aeronautical University, a pilot for a major airline and has 7,000 hours of flight time.

Notes

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Exploiting Runway Excursion Precursors

The challenge is finding the most important pilot deviations in voluminous flight data.

BY RICK DARBY

REPORTS

Event Limits

Flight Data Monitoring Based Precursors Project: Part 1 — Runway Excursions

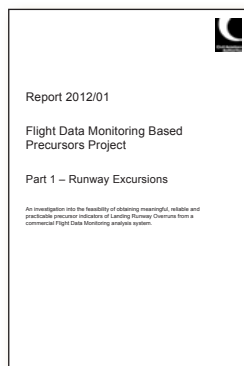
U.K. Civil Aviation Authority (CAA) Safety Regulation Group. Report 2012/01. 28 pp. December 2012. <bit.ly/XdP03x>.

Flight data monitoring (FDM), known as flight operational quality assurance (FOQA) in some countries, is one of the pillars of modern aviation risk reduction. It first came to prominence as a key element of airlines' growing analysis of routine flights in the 1990s. Today it is also part of the foundation of safety management systems.

The concept — although not necessarily the practice — of FDM is simple enough. It requires aircraft equipped to access and record selected parameters of flight data, which can then be downloaded via quick access recorders (QARs) or wireless real-time transmission. The data can be analyzed from individual flights and aggregated from numerous flights, usually in a deidentified form, to give an overview of exposure to risk. That, in turn, gives operators a handle on mitigating identified risks.

The report describes a project undertaken by the CAA to determine the effectiveness of FDM in helping operators monitor and reduce the risk of landing runway excursions, identified by the CAA and the industry as one of “seven significant safety issues.”¹ Flight Safety Foundation has also emphasized the importance of minimizing runway excursions, collaborating with the industry in a Runway Safety Initiative that resulted in the production of the *Runway Excursion Risk Reduction (RERR) Toolkit* <bit.ly/XjDwGU>.

The CAA project was developed in connection with Aerobytes, a supplier of FDM software, and an unidentified airline referred to only as the operator. In the report's preface, Aerobytes comments: “As any experienced user of an FDM/FOQA system will tell you, developing theoretical high-level/low-detail ‘concept’ analysis solutions is easy. The challenge is to translate those ‘concepts’ into reliable and practical methods that will work across a range of aircraft — aircraft which won't necessarily all record the ‘perfect’ set of parameters.” The company says that its programming philosophy is to simplify the combination of parameters selected for analysis, consistent



with utility, and minimize dependency on what it calls “exotic” parameters that many aircraft types are not equipped to provide.

The operator, in turn, says that “it has been challenging to translate safety data into consistent measures against specific risks. We experienced that monitoring hundreds of FDM events and event descriptors from the safety reporting database can be a very time-consuming exercise and may produce varied analysis.”

For the project, the operator says, “Variables and event logics were modified to confirm consistency and accuracy of the data. The sole aim of the project was to identify FDM-based precursors which could easily be adopted into any FDM system, but will provide sufficient information to assess the exposure to the runway excursion risk. Although our FDM vendor (Aerobytes) had provided us with some very useful algorithms to monitor key values and events, this project helped in identifying some finer improvements which could further enhance the analysis of the data.”

The FDM data were obtained from the QARs of several of the operator’s Airbus A320s, based on 587 flights during summer and 250 flights in one winter month. In the trial, the approach and landing phases (what Aerobytes calls “states”) of flight were studied. The report says, “The [Aerobytes FDM] program sets an end point at touchdown and then looks backwards through the data until the gear and flaps are up, which is set as the start of the approach state. ... The landing state is the period between touchdown until the end of rollout. This is defined as after 90 seconds, or [when] groundspeed is less than 50 kt or there is a heading change of more than 20 degrees.”

Twenty values were selected for analysis. For approach, they included height above airfield (AAL) at various stages, such as becoming established on the glideslope and gear selected down, and airspeed versus the aircraft-computed reference landing approach speed. Landing values included data such as airspeed at touchdown and time from touchdown to reverse thrust application.

Experience with the early data analysis led researchers to modify some of the criteria for a stabilized approach during the study. For example, the CAA noted that precision approaches and non-precision approaches² are so different that “it is important to determine the type of approach being flown and obtain comparable metrics from both types of approach.”

Based on the project’s FDM data, the report identified “significant” events considered potential precursors to a runway excursion and recommended that operators use those event limits in determining stable approach criteria. It warned, however, that extreme outliers in calculated data distributions are suspect, and that “each of these significant events must be fully validated so as to remove false ‘events.’ In this way the workload associated with each measure will be minimized, whilst assuring data quality.”

The recommended precursor event limits are as follows:

- Unstable approach: Below 1,000 ft AAL or below 500 ft AAL — the lowest height AAL at which the approach was unstable in instrument meteorological conditions or visual meteorological conditions, respectively.
- Long flare: Distance greater than 2,000 ft (610 m) from reaching flare height to touchdown.
- Long landing: Distance greater than 2,500 ft (762 m) from runway threshold to touchdown.
- Fast landing: Airspeed at threshold greater than V_{APP} (final approach speed calculated by Airbus aircraft) or V_{REF} (reference landing speed for non-Airbus aircraft).
- Runway remaining at touchdown: Less than 4,000 ft (1,219 m).

“Once the standardised precursor measures have been implemented, thought must be given to the aggregation, analysis and presentation of the results,” the report says. “For example:

- “Measures of exposure by airfield, runway, fleet.

**‘It has been
challenging to
translate safety
data into consistent
measures against
specific risks.’**

- “Frequencies/probabilities of events by airfield and runway.
- “Values and context data (e.g., airfield, runway, type of approach) for each event.

“[These] data should be output in a standard database/spreadsheet format to allow further analysis and also aggregation with other operators’ data, if agreed.”

Weighed on the Bioscale

Development, Validation, and Fairness of a Biographical Data Questionnaire for the Air Traffic Control Specialist Application

Dean, Michelle; Broach, Dana. U.S. Federal Aviation Administration (FAA) Civil Aerospace Medical Institute (CAMI). DOT/FAA/AM-12/19. 20 pp. December 2012. <1.usa.gov/TaP2qb>.

“Validity,” in connection with scientific testing, means that the test accurately measures what it is supposed to measure. You could ask applicants for training as an air traffic control specialist (ATCS) for biographical information, such as what they ate for breakfast, and theoretically have a database of completely accurate answers. There is no reason to assume, however, that the information would have any bearing on the applicants’ potential for being good ATCSs.

As it happens, the FAA has long included biographical data, or “biodata,” in its assessment of applicants. “The Federal Aviation Administration (FAA) has conducted [biodata] investigations of the ATCS occupation,” the report says. “Following the 1981 controller strike, the FAA faced an enormous organizational challenge in rebuilding this highly technical workforce. While the core of the post-strike ATCS selection process from 1981 through the mid-1990s was a cognitive aptitude test battery, researchers at CAMI investigated alternative assessments, including biodata. Two instruments in particular were administered to several thousand newly hired air traffic controllers for research purposes between 1981 and 1992: the Applicant Background Assessment (ABA) and the Biographical Questionnaire (BQ). Research with these instruments indicated that biodata had promise as a personnel selection tool for the ATCS occupation.”

The FAA developed three versions of the “biodata scale”: with 80 items, 100 items or 120 items.

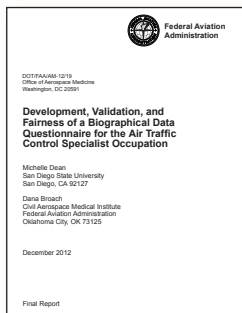
As the report points out, the stakes are high for both applicants and the FAA. Many applicants spend thousands of dollars for tuition and fees in the FAA’s Air Traffic Control Collegiate Training Initiative, hoping to be hired by the FAA. For the agency, the report says, “ATCS training is intensive, extensive and expensive. Completion of all training phases takes an average of two to three years, depending on facility assignment. Failures waste FAA training dollars and personnel resources. They also result in fewer people becoming controllers, a critical concern for the agency as the post-strike generation of controllers reaches retirement age.”

Researchers used several techniques to rate the validity of the biodata questionnaires, such as looking for correlations among the ABA, the BQ and average supervisory ratings. The biodata questionnaires also were measured against the computerized Air Traffic Selection and Training (AT-SAT) aptitude test battery composite score in predicting the supervisory ratings.

The report concludes that “each version of the biodata scale had significant incremental validity over the AT-SAT composite score, accounting for 29 percent to 32 percent additional variance in average job performance ratings.” Second, “the 80-item version was more efficient (fewer questions for about the same statistical gain) than either the 100- or 120-item versions of the biodata scale.”

Notes

1. The other “significant seven” safety issues were airborne conflict, airborne and post-crash fire, controlled flight into terrain, loss of control, ground handling and runway incursion/ground handling.
2. A non-precision approach was defined, adopting International Civil Aviation Organization Annex 6 criteria, as “an instrument approach and landing which utilizes lateral guidance but does not utilize vertical guidance.” A precision approach was defined as “an instrument approach and landing using precision lateral and vertical guidance with minima as determined by the category of operation.”



Sidestick Standoff

Airbus pilots made opposite flight control inputs while initiating a go-around.

BY MARK LACAGNINA

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

JETS

Hard Touchdown on Runway

Airbus A319-111. Substantial damage. No injuries.

A hard touchdown that destroyed the A319's landing gear resulted in part from an initial nose-down sidestick input by the pilot flying (PF) that was not countermanded by the commander's application of nose-up sidestick during the initiation of a go-around at London Luton Airport the afternoon of Feb. 14, 2012, said the U.K. Air Accidents Investigation Branch (AAIB).

The aircraft became airborne after the brief touchdown, and the flight crew completed the go-around and landed without further incident. There were no injuries among the 142 passengers and six crewmembers, but the force of the hard landing exceeded the maximum certified loads on the aircraft's main landing gear, and the gear had to be replaced.

The A319 was inbound from Faro, Portugal. A captain-under-training was flying the aircraft from the left seat. He had 3,998 flight hours, including 672 hours in type. The report noted that he had completed "nine sectors of command training without notable incident, and the training reports prior to the event had all been positive." His command training had included practice in the "TOGA 10" go-around

procedure, which includes takeoff/go-around (TOGA) power and a 10-degree pitch attitude, in flight simulators, but he had not conducted the procedure in an A319.

The commander, a training captain, had 10,700 flight hours, including 500 hours in type. "The commander had previous experience of line training on another aircraft type but was relatively inexperienced in this capacity on the Airbus 320-series aircraft," the report said. Like the trainee captain, the commander had practiced the TOGA 10 procedure in simulators but had not conducted the procedure in an A319.

Luton had clear weather and surface winds from 320 degrees at 16 kt. The crew flew a standard arrival procedure that took the aircraft north of the airport and then received radar vectors from air traffic control (ATC) to position the aircraft for the instrument landing system (ILS) approach to Runway 26. "The crew were aware that some turbulence can be expected on the final approach to Runway 26 when the wind is from the northwest," the report said.

Nearing the airport from the north, "the aircraft was given an early radar vector towards the final approach track, and the PF increased the rate of descent," the AAIB report said. "The aircraft was then allocated a heading of 220 degrees, cleared to intercept the localiser and, once established, to descend on the glidepath."

Preparing to capture the ILS glideslope from above, the PF called for the "flap 2" setting and for extension of the landing gear. He armed the electronic flight control system's localizer mode and then inadvertently selected the expedite mode rather than the approach mode. "The expedite



'If the commander had used the sidestick takeover pushbutton, the severe hard landing may have been prevented.'

mode is used in climb or descent to reach the desired altitude with the maximum vertical gradient," the report said. "The expedite climb mode engaged, but, to prevent a climb or any mode confusion and to regain the correct profile, the PF disconnected the autopilot and the autothrust."

During this time, the A319 had flown through the localizer course. ATC issued a heading to enable the crew to re-intercept the localizer.

The PF elected to continue hand flying the approach. The aircraft was established on the localizer course about 6 nm (11 km) from the runway. "The wind conditions were gusty and gave rise to some turbulence on the approach," the report said.

Recorded flight data showed that the approach remained stabilized until the aircraft was close to the runway. "Below 30 ft over the runway, both pilots sensed that the aircraft was sinking rapidly, and both initiated a TOGA 10 go-around," the report said. "The PF momentarily retarded the thrust levers to idle before advancing them to the TOGA position. At the same time, he made a full-forward sidestick input, within one second, which was then rapidly reversed to full-aft sidestick."

The report said that a possible explanation for the PF's initial aft movement of the thrust levers and forward input on the sidestick was "momentary confusion between the actions of his left and right hands."

As the PF made the forward sidestick input, the commander made a full-aft input, pushed the thrust levers full-forward and announced, "I have control." However, the commander had not engaged the "takeover" pushbutton on his sidestick. Thus, flight-control priority remained with the PF, and the commander's nose-up sidestick input only reduced the magnitude of the nose-down input made by the PF.

"If the commander had used the sidestick takeover pushbutton, the severe hard landing may have been prevented," the report said.

The report noted that Airbus sidesticks move independently, "so one pilot may not be aware of a control input being made by the other." A small green light illuminates on the glareshield in front of the pilot who has priority control. If both

sidesticks are moved at the same time, without activation of the takeover pushbutton by the other pilot, both green lights illuminate and an aural "dual input" message is generated.

The report noted that although "a pilot can deactivate the other stick and take full control by pressing and keeping pressed his priority takeover pushbutton ... the use of the takeover pushbutton has been shown from previous incidents not to be instinctive."

The simultaneous sidestick inputs of 15 degrees forward by the PF and 8 degrees aft by the commander had resulted in a momentary net input of 7 degrees forward before both pilots applied full-aft inputs. The A319 touched down on all three landing gear a half second later.

A "load report" generated automatically by the aircraft after the hard, three-point touchdown showed that the rate of descent was 12.5 ft/second and that vertical acceleration was 2.99 g (2.99 times standard gravitational acceleration). Because of these parameters, the event was classified as a "severe hard landing," the report said. Analysis of the recorded data by Airbus indicated that several components of the landing gear had exceeded design load limits and required replacement. No other aircraft damage was found.

Early Rotation Damages Tail

Boeing 737-800. Substantial damage. No injuries.

Performance data for a takeoff from Runway 25R, the runway in use at Los Angeles International Airport (LAX) the morning of Jan. 3, 2011, had been loaded automatically into the 737's flight management system (FMS) via the aircraft communications addressing and reporting system. However, shortly before leaving the gate, the flight crew was told that the departure runway had been changed to Runway 07L.

The airplane's takeoff performance system enables data to be automatically loaded for the first four runways listed in the database for a particular airport. Because Runway 07L was not among the first four listed for LAX, the first officer had to manually enter the takeoff data, using information in the preflight paperwork,

said the report by the U.S. National Transportation Safety Board (NTSB).

Among the parameters appropriate for the conditions, the “takeoff decision speed” (V_1) and the rotation speed (V_R) were both 153 kt. However, the first officer inadvertently entered 123 kt for V_1 and 153 kt for V_R into the FMS. “The most likely reason for the inappropriate V_1 value was determined to be a keystroke entry error by the first officer when manually entering data,” the report said.

When airspeed reached 123 kt on takeoff, an automated callout of V_1 was generated and the captain began to rotate the airplane. “ V_1 and V_R are typically close in value for a 737, so the captain may have reacted to the erroneous V_1 callout, expecting that the airplane was also at V_R ,” the report said. “Had the captain waited for a ‘ V_R ’ callout by the first officer, the erroneous V_1 entry would have had no effect.”

The first officer told investigators he had noticed that the automated V_1 callout had occurred too early and that the captain had begun rotation but said nothing to the captain for fear of causing confusion, the report said.

“The airplane pitched up to about 11 degrees just prior to liftoff at 148 knots,” the report said. “The airplane operating manual specifies that tail contact will occur at 11 degrees of pitch if still on or near the ground.”

Flight attendants notified the flight crew that a tail strike had occurred. The pilots completed the quick reference handbook procedure for a tail strike and decided to continue to flight to the destination, Toronto, where the airplane was landed without further incident.

The 737 was ferried to a maintenance facility, where examination of the airframe revealed substantial damage to the aft pressure bulkhead and the tail skid.

Reversed Off an Embankment

Boeing 737-200. Substantial damage. No injuries.

After deplaning their 97 charter passengers at Hoedspruit (South Africa) Air Force Base the night of Jan. 10, 2011, the flight crew prepared for the return positioning flight to Johannesburg.

The captain told investigators that visibility was poor, with intermittent rain. “Whilst taxiing to the cleared holding point for takeoff, the pilot switched off the landing lights to avoid blinding [the crew of an aircraft on final approach],” said the report by the South African Civil Aviation Authority. “As a result, he overshot the turning point in the darkness and found himself at the end of the taxiway with insufficient space to turn around.”

The captain explained the situation to ATC and requested ground assistance but was told that no equipment was available to tow the 737. He decided to turn onto a perpendicular taxiway leading to military aircraft hangars, stop and then use reverse thrust to back the 737 onto the main taxiway, facing the other way.

“This was done without external guidance,” the report said. “Whilst reversing the aircraft, the pilot failed to stop it in time; the main wheels rolled off the edge of the taxiway, and the aircraft slipped down a steep embankment, coming to rest with the nosewheel still on the taxiway. The aeroplane was substantially damaged, but no one was injured.”

Thrust Asymmetry Causes Excursion

Cessna Citation 501. Destroyed. Five fatalities.

The pilot was conducting a private flight with four passengers from Venice, Florida, U.S., to Macon County Airport in Franklin, North Carolina, the afternoon of March 15, 2012. The NTSB report noted that the pilot was not familiar with the airport, which is at 2,020 ft and surrounded by mountains.

The pilot held a private license with multiengine and instrument ratings, and a type rating in the Citation I/SP, which is certified for single-pilot operation. He had about 1,159 flight hours, including about 185 hours flown in the Citation during the previous two years.

The uncontrolled airport had clear skies, with surface winds from 260 degrees at 3 kt. Witnesses said that the Citation was high on approach to Runway 25, which is 5,001 ft (1,524 m) long and 75 ft (23 m) wide. The pilot initiated a go-around and positioned the airplane for another approach.

‘He overshot the turning point in the darkness and found himself at the end of the taxiway with insufficient space to turn around!’

“During the second approach, the airplane was high again, and the approach angle steepened, nose-down toward the runway,” the report said. “The nose gear touched down approximately halfway down the runway, followed by main gear touchdown. The airplane then bounced, and the witnesses heard the engine noise increase. It then banked right, and the right wing contacted the ground. The airplane subsequently flipped over off the right side of the runway, and a post-crash fire ensued.” All five occupants were killed.

Examination of the Citation revealed that the thrust reverser on the right engine was deployed and the thrust reverser on the left engine was stowed on impact. “The airplane had already porpoised and bounced during the landing,” the report said. “The pilot’s subsequent activation of only the right engine’s thrust reverser would have created asymmetric thrust and most likely exacerbated an already uncontrolled touchdown.”

Eight Minutes of Silence

Boeing 757-200. No damage. No injuries.

The flight crew did not activate the 757’s transponder before taking off on Runway 27R at Hartsfield-Jackson Atlanta International Airport the afternoon of March 11, 2011, for a flight to New York with 130 people aboard. About a minute after departure, the airport traffic controller told the crew to establish radio communication with the departure controller. The crew acknowledged the instruction but did not contact the departure controller for eight minutes.

“The airplane flew through one controller’s airspace and entered another controller’s airspace without coordination before radar and radio contact were established,” the NTSB report said, noting that the airport controllers had not verified that there was a radar data tag for the 757 before handing off the flight to the departure controllers. The airplane appeared on radar only as an enhanced primary target, with no identification, altitude or airspeed data.

A review of primary radar data revealed that a loss of required lateral separation had

occurred with three other airplanes: The 757 had passed within 0.8 nm (1.5 km) of a Pilatus PC-12, 1.4 nm (2.6 km) of a Beech Baron and 2.4 nm (4.4 km) of a Bombardier CRJ100.

TURBOPROPS

Ice Suspected in Control Loss

ATR 42-300. No damage. No injuries.

While preparing for the return flight from Bergen to Florø, both on the west coast of Norway, the flight crew noticed that snow was accumulating on the aircraft and that there were remnants of clear ice on the wings, horizontal stabilizer and propeller spinners that had accumulated during the earlier flight in moderate icing conditions that included freezing sleet.

After the 24 passengers were boarded, the ATR 42 was deiced with warm water and sprayed by two vehicles with 69 L (18 gal) of Type 2 anti-icing fluid at 100 percent concentration. In addition, 17 L (4 gal) of Type 1 anti-icing fluid at 28 percent concentration were applied to the bottom of the horizontal tail surfaces.

The holdover time — basically, the time at which the deicing/anti-icing procedure would have to be repeated — was 30 minutes, said a report on the Nov. 9, 2007, incident issued in January 2013 by the Accident Investigation Board Norway (AIBN).

The crew initiated the takeoff eight minutes after the deicing/anti-icing procedure was completed. Airspeed was 10 kt below the calculated rotation speed when the aircraft lifted off the runway without any control inputs by the pilots.

“According to the commander, the aircraft continued the uncontrolled ascent in spite of both control columns being moved to the full-forward position (stop) and engine power being increased,” the report said. “The stick shaker activated and the ‘cricket sound’ [aural stall warning] was heard for a few seconds while the airspeed decreased.

“Eventually, the nose of the aircraft started to come down and speed gradually increased.



While the speed increased, the crew experienced that the control columns oscillated back and forth and were heavy to operate.”

The crew had begun a turn back to Bergen; but, as the flight controls became gradually easier to move, they decided to continue the flight to Florø, hand flying the aircraft rather than engaging the autopilot. The flight was completed without further incident, and an inspection of the flight controls revealed no discrepancies.

Investigators explored several factors that might have contributed to the serious incident, including an aft center of gravity, an incorrect elevator trim setting or jamming of the elevators by ice. The AIBN concluded that the most likely cause was ice contamination of the upper surface of the stabilizer.

The report noted that an analysis of the incident by the aircraft manufacturer concluded that “the event description fully matches with the behavior an ATR would have in case of an improper deicing of the horizontal stabilizer.” The manufacturer also said that the amount of Type 2 anti-icing fluid applied to the aircraft “seems to be low” and that a proper application would consist of about 120 L (32 gal).

The AIBN report noted that the recommended deicing procedure for the ATR 42 and 72 emphasizes the gap between the elevator and horizontal stabilizer. “This is to prevent the elevator from freezing, as has happened several times with this [aircraft] and aircraft types of similar design,” the report said. “The procedure also explicitly states that the upper surface of the tail must be deiced, but the AIBN still questions whether the special focus on clearance between the elevator and stabiliser ... may have caused the deicing personnel to not be sufficiently attentive to the importance of also keeping the upper surface of the stabiliser and elevator completely free of ice and snow.”

Overdelayed Go-Around

Dornier 328-100. No damage. No injuries.

Nearing Norwich, England, the morning of March 22, 2012, the flight crew briefed the NDB/DME (nondirectional beacon/

distance-measuring equipment) approach to Runway 09. The airport was reporting surface winds from 110 degrees at 7 kt and 4.0 km (2.5 mi) visibility in haze.

The company required that the decision to go around or to land be made 20 ft above the minimum descent altitude (MDA) on a nonprecision approach and that a go-around be initiated no later than reaching the MDA.

In this case, the commander, the pilot flying, “could see the ground and was aware of his position due to his local area knowledge” as the aircraft descended to the MDA, the AAIB report said. He did not make the required go-around/landing call before leveling the aircraft at the MDA. The aircraft was about 0.75 nm (1.39 km) south of the extended centerline when the commander gained visual contact with the runway a few seconds later. “The copilot could not see the runway, as it was obscured by the aircraft’s structure,” the report said.

The commander disengaged the autopilot and maneuvered the aircraft to line up with the runway centerline. “The commander later commented that the forward visibility during the approach was reduced as a result of flying towards the sun,” the report said. “He added that it was poor judgment on his part to fly the unstable manoeuvre after he became visual with the runway.

“The copilot [said] that he had been ‘slightly concerned’ during the manoeuvre but had confidence in the commander’s ability and so did not interject.”

The Dornier was banked about 30 degrees right when it crossed the runway threshold. It touched down firmly, and the right main landing gear broke an edge light as the aircraft veered slightly off the right side of the runway. “As the aircraft touched down, or possibly just before, the copilot called ‘go around’; this was flown by the commander without event,” the report said.

The crew then conducted the ILS approach to Runway 27 and landed without further incident. None of the 27 occupants was injured, and there was no damage to the Dornier.

‘He added that it was poor judgment on his part to fly the unstable manoeuvre after he became visual with the runway.’

Excursion on an Icy Runway

Rockwell 690C. Substantial damage. No injuries.

The pilot conducted a global positioning system approach to Runway 24 at Conrad (Montana, U.S.) Airport the morning of March 23, 2012. The uncontrolled airport had a 1,500-ft overcast, 2.0 mi (3.2 km) visibility in light snow and surface winds from 350 degrees at 4 kt.

After breaking out of the overcast, the pilot saw a snowplow on the 4,600- by 75-ft (1,402- by 23-m) runway. “Soon after the pilot spotted the snowplow, it exited the runway, and the pilot continued his approach/landing sequence,” the NTSB report said.

After touchdown, the airplane began to slide on the ice- and slush-covered runway. “The pilot stated that he should have initiated a go-around, but the airplane was never sufficiently realigned with the runway so he could safely apply go-around power,” the report said.

The airplane veered off the runway and struck a warning sign for a natural gas line that caused an 8-in (20-cm) tear in the fuselage skin. The pilot and his four passengers were not hurt.

“The pilot reported that he was unable to maintain altitude with the left engine at full power.”

He reported the engine failure to ATC and diverted the flight to Broken Bow, Nebraska, which was about 20 nm (37 km) away. The Baron was on final approach and in landing configuration when the right engine lost power completely.

“The pilot did not feather the right propeller, thinking he was too close to landing to get the engine secured,” the report said. Nearing the minimum single-engine control speed, the airplane drifted right, and the pilot reduced power from the left engine in an attempt to maintain control.

The Baron descended onto an open field and came to rest inverted. The pilot sustained serious injuries, and his passenger was killed.

Marginal Weather Gets Worse

de Havilland Beaver. Substantial damage. One serious injury, one minor injury.

The pilot said that marginal weather conditions prevailed when he departed from a mining site for a charter flight to Ketchikan, Alaska, U.S., about 25 nm (46 km) northeast, the morning of March 13, 2012. Shortly after departure, visibility decreased nearly to zero in heavy snow.

“He attempted to follow the shoreline at a low altitude but was unable to maintain visual contact with the ground,” the NTSB report said. “He stated that he saw trees immediately in front of the [float-equipped] airplane and attempted a right turn toward what he thought was an open bay.”

During the turn, the right float struck a rock outcrop, and the Beaver descended into the bay. The pilot was seriously injured, and his passenger sustained minor injuries.

Deceptive Fuel Gauge

Aero Commander 500B. Substantial damage. One minor injury.

The fuel gauge indicated 120 gal (454 L) before the pilot departed from Kansas City, Missouri, U.S., for a positioning flight to Cushing, Oklahoma, the evening of Jan. 13, 2012. The airplane was cruising at 8,000 ft about an hour and 20 minutes later when the right engine began to lose power.

PISTON AIRPLANES

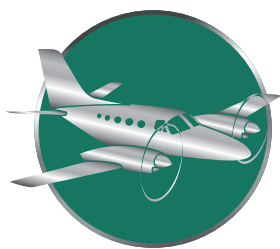
Crossfeed Fuel Starvation

Beech E55 Baron. Substantial damage. One fatality, one serious injury.

The pilot said that the Baron was fully refueled before departing from Dickinson, North Dakota, U.S., for a personal flight to Kansas the afternoon of March 28, 2012. About two hours after takeoff, while cruising at 11,500 ft, he noticed indications of less fuel in the left main tank than in the right main tank.

“He attempted to correct the imbalance by placing the left fuel selector in the crossfeed position so that both engines would receive fuel from the right main fuel tank,” the NTSB report said.

About 15 minutes later, both engines lost power. The pilot repositioned the fuel selectors to the left main tank and the right auxiliary tank. “The left engine regained power, and the right engine began ‘surging,’” the report said.



The pilot was attempting to restore power to the right engine when the left engine began to surge. As he turned toward Bartlesville (Oklahoma) Municipal Airport, both engines lost power. The pilot sustained minor injuries when the Aero Commander struck trees and terrain about 1.5 nm (2.8 km) from the airport.

“The pilot [said] that before he secured the airplane and turned the master battery switch off, the fuel gauge was still indicating 100 gallons [379 L],” the NTSB report said. However, investigators determined that the fuel gauge was faulty and that the airplane actually had only about 50 gal (189 L) of fuel when it departed from Kansas City.

HELICOPTERS



‘Wind-Down’ on Pipeline Patrol

Agusta Bell 206B. Substantial. No injuries.

The pilot and his passenger were conducting a pipeline-patrol flight 600 ft above the ground near Perth, Scotland, the afternoon of Feb. 20, 2012, when they heard a loud bang as the JetRanger yawed left.

“The main rotor rpm decreased, and the engine was seen to ‘wind down,’” the AAIB report said. “The pilot completed a successful autorotation into a field.”

Initial examination of the engine showed that the compressor case had been breached by a failure of the axial compressor. Further examination at an approved engine-overhaul facility revealed that the failure had been initiated by a fatigue crack that caused a blade on the stage-two axial compressor rotor to fracture and separate, resulting in extensive damage to the compressor section.

Fuel Cap Strikes Tail Rotor

Robinson R22 Beta. Substantial damage. No injuries.

The flight instructor refueled the helicopter while his student performed a preflight inspection before departing from Bulverde, Texas, U.S., for an instructional flight the afternoon of March 9, 2011.

They were practicing autorotations when the R22 began to yaw left and right. The instructor took control and landed the helicopter in an orchard. “The helicopter’s main rotor contacted the ground, and the helicopter came to rest on its left side,” the NTSB report said. “During the impact, the tail boom separated into two pieces.”

Investigators determined that the fuel tank cap had not been secured properly before departure and had separated in flight, striking and damaging the tail rotor.

Unqualified for Night Flight

Aerospatiale Gazelle. Destroyed. One fatality.

Before departing from a mining site located in a valley near Keswick, Cumbria, England, the night of March 8, 2011, the pilot telephoned his partner at his home near Cockermouth and informed her that he was returning. He also asked about the weather conditions there and was told that it was “rather blustery” but with good visibility.

“There was no evidence that the pilot obtained any other meteorological briefing before the flight,” said the AAIB report, which noted that reduced visibilities and low clouds prevailed in the area, and that the pilot was not qualified, and had received no training, to fly at night. The report also noted that the flight time between the mining site and the destination was 10 minutes in good conditions; “the journey by car would have taken half an hour or less.”

No one saw the Gazelle depart from the mining site. A search for the helicopter was initiated about three hours later, after it was reported overdue by the pilot’s partner. The wreckage was found at the bottom of the valley, about 330 m (1,083 ft) from the mining site. Investigators determined that the impact had occurred at a high rate of descent.

Noting that “almost no cultural lighting” existed in the valley for some distance from the mining site and that the waning moonlight would have been obscured by cloud, the report concluded that the pilot likely had become disoriented and had lost control of the helicopter. ➔

Preliminary Reports, January 2013

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Jan. 1	Jasper, Alabama, U.S.	Piper Twin Comanche	destroyed	3 fatal
Night instrument meteorological conditions (IMC) prevailed when the airplane crashed out of control during an unauthorized flight by a student pilot.				
Jan. 2	Delano, California, U.S.	Bell 206	destroyed	1 fatal
The pilot discontinued a frost-protection mission when fog began to form over the agricultural field. The helicopter then struck terrain about 4 nm (7 km) from the airport while returning to Delano.				
Jan. 2	Clear Lake, Iowa, U.S.	Bell 407	destroyed	3 fatal
The emergency medical services helicopter was on a positioning flight in night visual meteorological conditions (VMC) when it was observed by a witness to enter a steep descent into a field.				
Jan. 2	Las Vegas, Nevada, U.S.	Piper Aerostar 602P	substantial	2 none
The pilot was practicing single-engine landings with a flight instructor aboard when a main landing gear collapsed on touchdown and the Aerostar veered off the runway.				
Jan. 2	Seminole, Oklahoma, U.S.	Eurocopter EC130-B4	substantial	4 serious
The engine lost power during a positioning flight, and the helicopter touched down hard during an autorotative landing.				
Jan. 4	Los Roques, Venezuela	Britten-Norman Islander	NA	6 NA
Radar contact with the Islander was lost shortly after it entered a rapid descent over the Caribbean Sea during a charter flight from Los Roques to Caracas. At press time, the aircraft had not been located.				
Jan. 5	Saint Pierre de Bressieux, France	Piper Seneca	destroyed	5 fatal
The aircraft struck a hill shortly after departing from Grenoble for a flight to Morocco.				
Jan. 11	Maxwell, Nebraska, U.S.	Beech 58 Baron	destroyed	4 fatal
IMC with freezing rain prevailed when the Baron crashed shortly after departing from North Platte for a business flight to York, both in Nebraska. The pilot had declared an emergency just before radio and radar contact with the airplane were lost.				
Jan. 12	Paris, Texas, U.S.	Piper Malibu Meridian	destroyed	3 fatal
The single-engine turboprop struck terrain in IMC shortly after departing from Paris for a business flight to Austin. Witnesses heard sounds consistent with compressor stalls and a flameout. Distribution of the wreckage indicated that the airplane was in a flat spin when it crashed in a pasture.				
Jan. 13	Manteo, North Carolina, U.S.	Piper Seneca	destroyed	1 fatal, 1 minor
The Seneca struck Croatan Sound during an attempted go-around in IMC.				
Jan. 15	Pellston, Michigan, U.S.	Cessna 208B Cargomaster	destroyed	1 fatal
Night VMC prevailed when the airplane struck trees shortly after taking off for a cargo flight.				
Jan. 16	Burlington, North Carolina, U.S.	Pilatus PC-12/45	substantial	1 fatal
Night IMC prevailed when the PC-12 crashed on an athletic field shortly after departing from Burlington to transport medical specimens to Morristown, New Jersey.				
Jan. 17	Tuxtla Gutiérrez, Mexico	Piper Chieftain	destroyed	8 fatal
The Chieftain stalled during initial climb and crashed near the departure end of the runway.				
Jan. 19	Mangum, Oklahoma, U.S.	Beech B55 Baron	substantial	3 fatal
Witnesses said that the Baron "sputtered" before it pitched nose-down, entered a spin and descended to the ground while departing in VMC. The preliminary report noted that an annual maintenance inspection had just been completed and the pilot had performed a taxi test on the runway before boarding his passengers for takeoff.				
Jan. 23	Queen Alexandra Range, Antarctica	de Havilland Canada Twin Otter	destroyed	3 fatal
The Twin Otter struck a mountain at 13,000 ft during a flight from the South Pole to Terra Nova Bay.				
Jan. 29	Kyzyltu, Kazakhstan	Bombardier CRJ200ER	destroyed	21 fatal
Vertical visibility was 100 ft in freezing fog when the CRJ struck terrain on approach about 5 km (3 nm) from the runway.				

NA = not available

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

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