AeroSafety WORLD

WHAT LIES BELOW
Planning Route Terrain Clearance

STELLAR CAST
Safety Team 10 Years On

BETTER BUSINESS
Benefits of Precision-Like Approaches

CAUSAL FACTORS
UA Crash Precedent

BEYOND TECHNICAL
FLIGHT SAFETY FOUNDATION SHIFTS FOCUS

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

DECEMBER 2007


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SHIFTING Focus

As 2007 finishes up its run, we are celebrating the 60th anniversary of Flight Safety Foundation. Born as the aviation industry — fueled by recovering economies as a healthy dose of new technology was ramping up its postwar growth — the Foundation has kept itself positioned to provide critical help, developing safety solutions and information for the rapidly expanding community.

I'm still relatively new with the Foundation, but it quickly became clear that this organization is as forward-looking as most for-profit operations: In order to remain relevant, we must keep shifting our focus to the next biggest safety target.

Despite all of the good work that has been done reducing the risk of having an accident, and our satisfaction in a job well done, problems that have been with the industry since its inception remain unsolved.

Case in point is the FSF Runway Safety Initiative. Going into the effort, it seemed obvious that runway incursions would be the major focus. However, hiding in plain sight was a problem that day after day damages more aircraft and, in most years, inflicts more death and injury than incursions — the problem of runway excursions.

From the dawn of flight, aircraft have been departing runways in undesirable ways, and usually it's no big deal; jack up the airplane, change a tire or two and drag it back to the ramp. However, the large number of these events constitute, we now understand, a warning of a larger problem that can, and does, produce real accidents, sometimes fatal.

Some elements of the FSF *Approach and Landing Accident Reduction Tool Kit* also are useful in reducing excursions — a stabilized approach, for example — but the complete issue of figuring out how to stay on the runway, or even being able to calculate with confidence your chances of staying on a runway, has not been addressed as a coherent whole. And that is why the Foundation, with enthusiastic contributions from many major players in the aviation community, continues this obviously important effort.

While we remain engaged in developing risk reduction strategies for "traditional" types of problems like excursions, we also must address a whole new class of emerging threats that require different approaches, different tactics and a different organization.

How Flight Safety Foundation proposes to deal with these emerging threats can be found in the story by FSF President and CEO William R. Voss, on p. 16.

The source of many of these new threats is, ironically, growth and prosperity. More and more airplanes are flying throughout the world, and the pains of rapid growth have been clearly defined by multiple fatal accidents in certain regions.

When Flight Safety Foundation was created, it focused its limited assets on reducing the risk of an accident in areas of the world where most aviation activity existed — North America and Europe. While the largest part of world aviation continues to occur on those continents, accidents there are now rare. It is time to devote more attention to those areas that need the most help, developing what is intended to be a worldwide network of people and associated organizations to achieve and maintain high safety standards.

William R. Voss's President's Message*, usually seen on this page, will return next month.*

J.A. Donoghue

J.A. Donoghue
Editor-in-Chief
AeroSafety World

AeroSafetyWORLD

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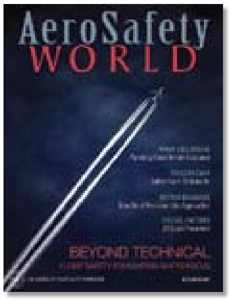

About the Cover
New safety challenges require new responses as Flight Safety Foundation celebrates its 60th year.
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If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about aviation safety, we will be glad to consider it. Send it to Director of Publications J.A. Donoghue, 601 Madison St., Suite 300, Alexandria, VA 22314-1756 USA or donoghue@flightsafety.org.

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Serving Aviation Safety Interests for 60 Years

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 1,140 individuals and member organizations in 142 countries.

MemberGuide

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Exhibit and Sponsorship Opportunities Available

EASS 2008

March 10–12, 2008

Flight Safety Foundation and European Regions Airline Association
20th annual European Aviation Safety Seminar

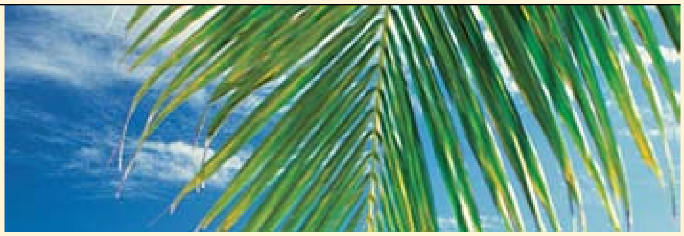
JW Marriott Bucharest Grand Hotel, Bucharest, Romania

CASS 2008

April 29–May 1, 2008

Flight Safety Foundation and National Business Aviation Association
53rd annual Corporate Aviation Safety Seminar

The Innisbrook Resort and Golf Club, Palm Harbor, Florida

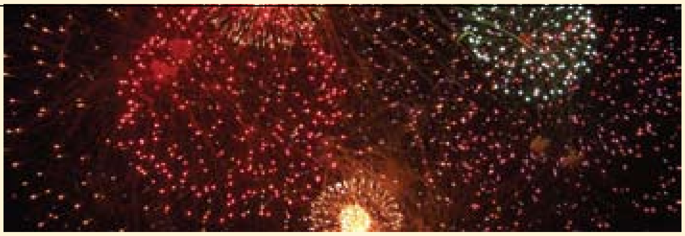


CASS 2009

April 21–23, 2009

Flight Safety Foundation and National Business Aviation Association
54th annual Corporate Aviation Safety Seminar

Hilton Walt Disney World, Orlando, Florida



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DEC. 3–4 ➤ LIMA 2007 International Aerospace & Aviation Conference. Langkawi, Malaysia. World Aerospace, <www.lima2007.com>, +603-2691-2484.

DEC. 5–6 ➤ Crew Management Conference 2007. Brussels. Flight International. Cathy Fuller, <cathy.fuller@rbi.co.uk>, +44 208 652 3749.

JAN. 6–9 ➤ SMS in Aviation Conference. Embry-Riddle Aeronautical University and Saint Louis University. Daytona Beach, Florida, U.S. Mark Friend, <mark.friend@erau.edu>, <www.eruniversity.com/sms.htm>, +1 386.226.6842.

JAN. 23 ➤ JAR-OPS 1 vs. EU OPS Difference Course. European Joint Aviation Authorities. Hoofdorp, Netherlands. <training@jaat.eu>, +31 (0)23 567 9790.

JAN. 29–FEB. 1 ➤ NBAA 19th Annual Schedulers & Dispatchers Conference. National Business Aviation Association. Savannah, Georgia, U.S. Dina Green, <dgreen@nbaa.org>, <web.nbaa.org/public/cs/sdc/2008/index.php>, +1 202.783.9357.

FEB. 5–7 ➤ 16th Annual Safety-critical Systems Symposium. Centre for Software Reliability. Bristol, England. Joan Atkinson, <joan.atkinson@ncl.ac.uk>, <www.csr.ncl.ac.uk/calendar/csrEventView.php?targetId=377>, +44 191 222 7996.

FEB. 11–14 ➤ Annual International Cabin Safety Symposium. Southern California Safety Institute. Montreal. <www.scsi-inc.com/css%2025/CSS%2025%20Program.html>.

FEB. 13–17 ➤ Lawyer Pilots Bar Association. Miami. <www.lpba.org>, +1 410.571.1750.

FEB. 14 ➤ Asian Business Aviation Conference and Exhibit (ABACE). National Business Aviation Association. Hong Kong. Donna Raphael, <draphael@nbaa.org>, <www.nbaa.org>, +1 202.783.9000.

FEB. 19–24 ➤ Singapore Airshow. Singapore Airshow & Events. <www.singaporeairshow.com.sg>, +65 6542 8660.

FEB. 24–26 ➤ Heli-Expo 2008. Helicopter Association International. Houston. Marilyn McKinnis, <marilyn.mckinnis@rotor.com>, <www.heliexpo.com>, +1 703.683.4646.

FEB. 25–27 ➤ OPS Forum 2008: Fly Safe, Fly Smart, Fly Green. International Air Transport Association. Madrid, Spain. <www.iata.org/events/ops08/index.htm>.

MARCH 10–12 ➤ 20th annual European Aviation Safety Seminar (EASS). Flight Safety Foundation and European Regions Airline Association. Bucharest, Romania. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org/seminars.html#eass>, +1 703.739.6700, ext. 101.

MARCH 13–15 ➤ ARSA 2008 Annual Repair Symposium. Aeronautical Repair Station Association. Washington, D.C. <arsa@arsa.org>, <www.arsa.org/node/400>, +1 703.739.9543.

MARCH 18–20 ➤ Aviation Industry Expo. National Air Transportation Association. Dallas. Jill Ryan, <jill.ryan@cygnusexpos.com>, <aviationindustryexpo.com/as3gse/index.po>, 800.827.8009, ext. 3349.

MARCH 28 ➤ IS-BAO Implementation Workshop. International Business Aviation Council. San Antonio, Texas, U.S. Katherine Perfetti, <kathyhp@comcast.net>, <www.ibac.org>, +1 540.785.6415.

MARCH 31–APRIL 2 ➤ 15th Annual SAFE (Europe) Symposium. SAFE (Europe). Geneva, Switzerland. <safe.distribution@virgin.net>, <www.safeeurope.co.uk>, +44 (0)7824 303 199.

APRIL 14–17 ➤ 59th Annual Avionics Maintenance Conference. ARINC. Tulsa, Oklahoma, U.S. Samuel Buckwalter, <Samuel.Buckwalter@arinc.com>, <www.aviation-ia.com/amc/upcoming/index.html>, +1 410.266.2008.

APRIL 15–17 ➤ Maintenance Management Conference. National Business Aviation Association. Daytona Beach, Florida, U.S. Dina Green, <dgreen@nbaa.org>, <web.nbaa.org/public/cs/mmc/200804/index.php>, +1 202.783.9357.

APRIL 18–22 ➤ IFALPA 2008: 63rd Conference. International Federation of Air Line Pilots' Associations. Mexico City. <ifalpa@ifalpa.org>, <www.ifalpa.org/conference/index.htm>, +44 1932 571711.

APRIL 23–26 ➤ AEA Convention and Trade Show. Aircraft Electronics Association. Washington, D.C. <info@aea.net>, <www.aea.net/Convention/FutureConventions.asp?Category=6>, +1 816.373.6565.

APRIL 29–MAY 1 ➤ 53rd annual Corporate Aviation Safety Seminar (CASS). Flight Safety Foundation and National Business Aviation Association. Palm Harbor, Florida, U.S. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org/seminars.html#cass>, +1 703.739.6700, ext. 101.

MAY 20–22 ➤ European Business Aviation Convention and Exhibition (EBACE). National Business Aviation Association and European Business Aviation Association. Geneva. <info-eu@ebace.aero>, <www.ebaa.org/content/dsp_page/pagec/ev_ebace>, +32-2-766-0073 (Europe), +1 202.783.9000 (United States and Canada).

MAY 30–JUNE 1 ➤ Australian and New Zealand Societies of Air Safety Investigators Conference. Adelaide, South Australia. <www.asasi.org/anzsasi.htm>.

JUNE 3–5 ➤ 63rd Annual General Meeting and World Air Transport Summit. International Air Transport Association. Vancouver, British Columbia, Canada. <www.iata.org/events/agm/index.htm>, +1 514.874.0202.

JUNE 8–11 ➤ Conference and Exposition. American Association of Airport Executives. New Orleans. Carrie Heiden, <carrie.heiden@aaae.org>, <www.aaae.org/products/_870_Annual_2008>, +1 703.824.0504.

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 — we'll keep it on the calendar through the issue dated the month of the event. Send listings to Rick Darby at Flight Safety Foundation, 601 Madison St., Suite 300, Alexandria, VA 22314-1756 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.

Safety News

GPWS Training Urged

Indonesian airlines should ensure that their flight crews receive training in the proper use of ground-proximity warning systems (GPWSs), the Indonesian National Transportation Safety Committee (NTSC) said, citing the March 7, 2007, crash of a Garuda Indonesia Boeing 737-400 in Yogyakarta.

The Garuda 737 overran the departure end of Runway 9 during landing at Yogyakarta, crossed a road and struck an embankment. The airplane was destroyed; of the 140 people in the airplane, 21 were killed and 12 received serious injuries.

In its final report on the accident, the NTSC said that the captain — who was the pilot flying — had "descended the aircraft steeply in an attempt to reach the runway," and as a result, "the airspeed increased excessively." GPWS alerts and warnings sounded 15 times during the approach, and the first officer called for a go-around but did not take control of the airplane when he realized that the captain was repeatedly ignoring the GPWS alerts. The airplane touched down at 221 kt and with 5 degrees of flaps — landing speed with the recommended 40 degrees of flaps is 134 kt.

The NTSC issued 19 safety recommendations, including one that called on airlines to "ensure that their flight crews are trained and checked in 'GPWS-specific' simulator training sessions" to ensure that they can perform "the vital actions and required responses to" GPWS and enhanced GPWS warnings. A related recommendation said that the Directorate General of Civil Aviation should ensure that airlines provide the required training and checking.

A recommendation to Garuda Indonesia said that the airline should "review its fuel conservation incentive program to ensure that flight crews are in no doubt about its intent and that there is no perception that such a policy could compromise the safe operation of aircraft."

The NTSC also recommended that Indonesian airlines use Flight Safety Foundation training materials on approach and landing accident reduction (ALAR) and the elimination of controlled flight into terrain (CFIT).

Other recommendations called for improvements in flight procedures, training and checking, safety and regulatory oversight, serviceability of flight recorders, and airport emergency planning and emergency equipment.

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Electrical Discharge Damage

The Australian Transport Safety Bureau (ATSB), citing the Feb. 5, 2006, engine failure and forced landing of a Cessna 208 floatplane, has recommended steps it says will prevent similar failures.

The pilot and 10 passengers on the commercial sightseeing flight were not injured in the forced landing on a lake in remote southwestern Tasmania. The ATSB attributed the engine failure to electrical discharge damage (EDD) to the engine during a previous generator failure.

© Cessna Aircraft Co.

Forty-three similar events involving Pratt & Whitney Canada PT6 series turboprop engines on Cessna 208s have been reported worldwide since 1992, the ATSB said.

"As a result of the ATSB investigation into this serious incident, a number of safety actions have been implemented by the aircraft and engine manufacturers, as well as Australia's Civil Aviation Safety Authority," the ATSB said. "While the safety actions of all parties are to be commended, the ATSB remains concerned that there remain safety issues that need to be addressed to eliminate the possibility of EDD events leading to engine failures of this engine type."

As a result, the ATSB issued 10 safety recommendations to the aircraft and engine manufacturers and civil aviation authorities in Canada and the United States. The recommendations involved measures calling for the removal from service of any PT6A series engines that show indications of an EDD event, the use of measures to electrically isolate starter-generators in PT6A engines, the revision of relevant aircraft manual procedures and a review of the continued airworthiness of PT6A engines.

Life Rafts Wanted

Turbine helicopters that are operated in the Gulf of Mexico and have at least five seats should be equipped with externally mounted life rafts large enough for all occupants, the U.S. National Transportation Safety Board (NTSB) says.

The NTSB said that the U.S. Federal Aviation Administration (FAA) should require the life rafts and also should require that all offshore helicopter operators in the Gulf provide their crews with personal flotation devices equipped with a global positioning system–enabled 406-MHz personal locator beacon and a signaling mirror or other signaling device.

"The [NTSB] has investigated several helicopter accidents in which the aircraft crashed or ditched into the Gulf of Mexico," the NTSB said in a letter to FAA Acting Administrator Robert A. Sturgell. "In some cases, helicopter occupants did not survive while awaiting the arrival of search and rescue teams. With better access to life rafts stored on board the aircraft and better signaling devices, these occupants would have had a greater chance of surviving."


© Sikorsky Aircraft

Although helicopters operating in the Gulf are not currently required to carry life rafts, all accidents cited by the NTSB involved helicopters that were equipped with life rafts.

"Even so, none of the rafts were used following the accidents," the NTSB said. "In every case cited, crew and passengers either did not have sufficient time to locate and inflate the rafts once the helicopters were in the water or passengers did not know where life rafts were located. … If the helicopters operating in the Gulf were equipped with life rafts that were easy to locate or designed to automatically deploy outside the aircraft after a ditching, all occupants on board the accident helicopters would have had a greater chance of surviving once they were in the water."

The ditching of several Gulf helicopters has shown that personal flotation devices equipped with rescue tools can dramatically reduce the amount of time that crewmembers must spend in the water awaiting rescuers, the NTSB said.

"The Board sees no reason not to provide as many tools to survive as possible," the NTSB said.

Reducing Runway Incursions

The United States recorded 24 serious runway incursions out of more than 61 million surface movements in fiscal 2007 — or one incursion for every 2.5 million movements, the U.S. Federal Aviation Administration (FAA) says.

That represents a 25 percent reduction for fiscal 2007, which ended Sept. 30, compared with the previous year. The FAA's goal had been to reduce the number of incursions to no more than one for every 2 million surface movements.

Hank Krakowski, chief operating officer for the FAA Air Traffic Organization, attributed the reduction to improved training of airport and airline personnel, clearer airport signs and other new procedures. These actions and other efforts to improve runway safety were intensified after an August meeting of FAA officials and industry representatives. For example, the FAA says that 75 airports have voluntarily accelerated programs to enhance airport markings; of those, 52 airports had completed the work by mid-October, 19 were scheduled to complete the work by the end of 2007, and four planned to complete the work before the original deadline of June 30, 2008.

Long-term efforts to eliminate runway incursions will include flight deck warning systems and several types of ground surveillance systems.


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Looking for Answers

The U.K. Civil Aviation Authority (CAA) wants to know what cabin crewmembers, flight crewmembers and trainers think about current training for dealing with in-flight fires and is conducting an online survey to find out.

"Cabin crews receive extensive training on emergency procedures, including dealing with fires, but a number of training issues have emerged in recent years that have led us to commission the study," said Janice Fisher, head of the CAA Cabin Safety Office.

She said that the survey's results will aid in the evaluation of existing fire response training and help identify improvements.

The survey, being conducted for the CAA by RGW Cherry and Associates, is online at <www.rgwcherry.co.uk/caa_survey.html>.

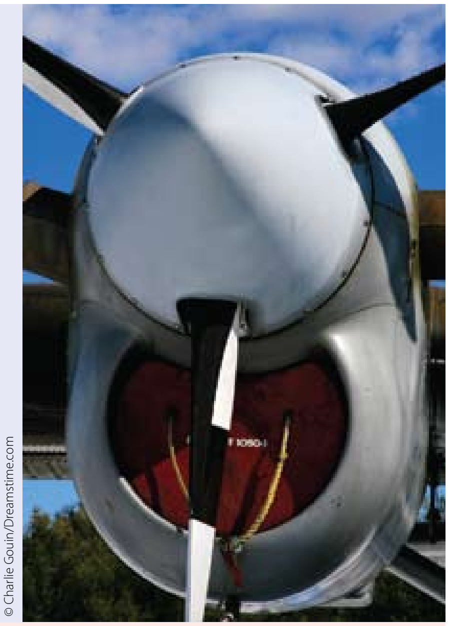
Twin Otter Inspections Ordered

The French Bureau d'Enquêtes et d'Analyses (BEA), citing the fatal August 2007 crash of a de Havilland DHC-6 Twin Otter in French Polynesia, is recommending inspections of stainless steel stabilizer control cables.

The BEA recommended that Transport Canada and the European Aviation Safety Agency "require operators to perform an inspection as soon as possible on stainless steel stabilizer control cables installed on DHC-6 Twin Otter airplanes, with particular attention being paid to chafing areas in contact with cable guides."

A second recommendation said that the two agencies should "consider extending these inspections to carbon steel cables that may also be installed on the stabilizer control system of this airplane."

Twenty people died and the airplane was destroyed in the crash, just after takeoff from Moorea. A preliminary investigation found that sections of the two stainless steel stabilizer control cables were heavily worn because of chafing at positions where they passed through cable guides. The investigation was continuing.



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In Other News …

Patrick Gandil has been designated as the new director general of the French Direction Générale de l'Aviation; he had been secretary general of the Ministry of Infrastructure, Tourism, Transportation and the Sea. … Australian Transport Minister **Mark Vaile** has ordered a review of the relationship between the Australian Transport Safety Bureau and the Civil Aviation Safety Authority to identify actions that would improve aviation safety; lawyer Russell Miller was conducting the review and was scheduled to submit his report in December. … Very light jet manufacturer **Eclipse Aviation** says its flight operational quality assurance (FOQA) program has been approved by the U.S. Federal Aviation Administration (FAA); Eclipse is the first manufacturer to receive FAA approval for its program, which includes flight data monitoring capabilities similar to those used by airlines.

U.S. National Aeronautics and Space Administration

New Rules for Wiring

Aircraft manufacturers will have two years to complete new wiring-related maintenance and inspection tasks that are being required by the U.S. Federal Aviation Administration (FAA) to reduce wire-failure risks in airliners.

The requirements are included in a new rule that increases safety requirements for the design, installation and maintenance of electrical wiring in new airplane designs as well as in existing airplanes. The rule adds new certification standards "to address wire degradation and inadequate design or maintenance," the FAA said.

Manufacturers have 24 months from the effective date of Dec. 8, 2007, to complete the maintenance and inspection requirements in existing airplanes; U.S. scheduled airlines and foreign airlines that operate aircraft registered in the United States have 39 months from the effective date to develop wiring maintenance and inspection programs in accordance with manufacturers' instructions.

"We've gained enormous knowledge about aircraft wiring issues over the last decade," said Nicholas A.

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Sabatini, FAA associate administrator for aviation safety. "With this rule, we are ensuring that wiring systems will be properly designed, installed and manufactured over the life of the airplane."

The new maintenance requirements apply to aircraft that carry more than 30 passengers or maximum payloads of at least 7,500 lb (3,402 kg).

The FAA said that the new rule — developed after an examination of connectors, wiring harnesses and cables to determine how they are installed and how they deteriorate during an aircraft's time in service — is part of an effort to improve the safety not only of wiring but also of a variety of other aircraft systems.

Compiled and edited by Linda Werfelman.

© Eduard Brantjes/Airliners.net

Conclusion of a series focusing on the development and safety benefits of precision-like approaches, a project of the FSF International Advisory Committee.

BY DAVID CARBAUGH

Good for Business

Beyond their safety benefits, precision-like constant descent angle approaches are good for an airline's bottom line. One of the key items in any business case is protection from disaster — insurance to allow the organization's survival. As safety specialists often point out, "If you think safety is expensive, then you should see the cost of an accident." History shows that a controlled flight into terrain (CFIT) accident or an approach-and-landing accident can be devastating to an airline. There have been cases in which such accidents initiated a downward spiral in business and passenger confidence that eventually resulted in the demise of the airlines.

Airline CEOs often point out that safety is their highest priority, and rightly so. They worry about profits and safety, and understand that the absence of the latter could destroy the former. An accident or serious incident imposes many direct costs, and studies have shown that the indirect, or "hidden," costs are generally four times higher and not covered by insurance. Hidden costs accumulate from rescheduling, leasing, lost revenue, investigation and auditing, among many other factors. Another significant hidden cost results from the loss of confidence among potential passengers and investors.

When deciding what to do, CEOs understand what *The Economist* magazine has stated: "An airline's reputation for safety has an economic value." Because the accident rate during nonprecision approaches is four to eight times higher than during precision approaches, it makes business sense — as well as safety sense — for an airline to incorporate precision-like constant descent angle approaches in its standard operating procedures.

Shades of Green

Beyond eliminating or reducing the safety risks of nonprecision approaches, other benefits can be realized from conducting constant descent angle approaches. One is contributing to the protection of the environment. There is tremendous pressure on airlines today to operate "green." Although the overall production of emissions by air carrier aircraft is relatively low, airlines need to be able to show improvement in this area. Regulators and activists are demanding action.

While newer airplanes, new-technology engines, etc., provide obvious levels of improvement, constant descent angle approaches are among new operational strategies that can show very dramatic progress. An example is the implementation by airlines of more efficient required navigation performance (RNP) arrival routes at several airports in Australia. A recent report by Airservices Australia said that the RNP routes substantially reduced emissions of carbon dioxide, a "greenhouse gas." There are other examples of reduced emissions resulting from more efficient arrival routes established by airlines in Canada, the United States and elsewhere. "Greener" operations can be accomplished with the airplanes that airlines operate today by a dedicated transition from traditional approaches to more efficient approaches.

Directly related to emissions improvement is the reduction of fuel consumed during more efficient operations. Most approaches today, even precision approaches, have level segments either during the final approach or associated with the maneuvering required to reach a level segment just prior to the final approach fix. These level segments require relatively higher power settings, especially when operating at slower speeds with the flaps, slats and landing gear extended. Multiple step-down altitudes often are associated with arrival procedures, vectoring by air traffic control (ATC) and with the final approach procedure.

Airlines, manufacturers, regulators, ATC authorities and approach designers should find ways to enable flight crews to conduct descents with power set at idle or near idle to capture a constant descent angle final approach path. With the advent of modern navigation capability, mainly RNP-based, ever-increasing numbers of airlines are finding success and benefits in conducting these approaches routinely. With fuel accounting for one-third of many carriers' expenses, the benefit of saving fuel is obvious. The RNP arrival routes implemented at the Australian airports also have resulted in an average savings of 450 lb (204 kg) of fuel per approach, according to the Airservices Australia report. One airline estimated that this equals the total profit per flight that it previously had achieved. The cumulative effect of such fuel savings over a large fleet is astonishing.

Another direct environmental effect of conducting precision-like constant descent angle approaches is reduced noise levels. For many years, airlines have struggled to be good neighbors to the communities near their airports by implementing noise-reduction procedures such as steeper-than-normal arrivals and reduced-flap approaches, especially for night arrivals at "noise-sensitive" airports. Unfortunately, these attempts have not always resulted in success, and safety risks have to be considered before implementing these procedures. Further improvements can be made with the consistent use of constant descent angle arrivals and approaches. Idle or near-idle descents greatly reduce engine noise. By eliminating level segments, the overall descent gradient of an arrival and approach can be steeper. The overall result is that the crew can fly a long, stabilized, visual-like approach in instrument meteorological conditions; the steeper approach can be flown with idle or near-idle power, delayed flap and gear extension, and power increased only when the airplane is about 2 nm (4 km) from the runway. This is a welcome improvement for those who live under a formerly level segment of an approach to a busy airport.

Focused Training

The business case for training is certainly a powerful one. Today, the airlines must ensure that their flight crews are trained and maintain proficiency in many types of instrument approaches. This is a daunting challenge for many airlines. The costs of implementing and maintaining procedures, publications and training syllabuses, and conducting proficiency checks are substantial. However, many of these traditional instrument approaches can be conducted with a well-planned constant descent angle final approach segment, a common procedure that crews can be trained to conduct.

Using the most modern methods for RNP-based arrivals and descents can greatly reduce training requirements. Essentially, in today's environment, all approach training should focus on instrument landing system (ILS) or RNP-based constant descent angle approaches. The vertical guidance enables crews to conduct consistent and reliable approaches. Reducing the types of approaches that crews are required to conduct also results in briefer and easier transition training to new aircraft types. Figure 1 shows expected progress in reducing approach training requirements.

Another benefit that can be gained is lower approach minimums. For airlines with modern, RNP-based equipment, the consistency of constant descent angle final approaches results in greater obstacle clearance than the traditional "dive-and-drive" nonprecision approaches.

Expected Reduction of Approach Training Requirements

TODAY			FUTURE
ILS	NDB-DME	ILS/GLS (xLS)	Category III RNAV (RNP)
VOR	VOR-ARC	RNAV (RNP)	
NDB	NDB-NDB	Specials	
LOC	RNAV 2-D		
VOR-DME	RNAV-3-D		
LOC-DME	GPS		
BCRS	PAR		
SDF	ASR		
LDA	Specials		

ILS = instrument landing system; VOR = VHF omnidirectional radio; NDB = nondirectional beacon; LOC = localizer; DME = distance measuring equipment; BCRS = back course; SDF = simplified directional facility; LDA = localizer-type directional aid; RNAV = area navigation; 2-D = two dimensional; 3-D = three dimensional; GPS = global positioning system; PAR = precision approach radar; ASR = airport surveillance radar; GLS = global navigation satellite system–based landing system; xLS = ILS or GLS; RNP = required navigation performance

Source: The Boeing Co.

Figure 1

Regulators acknowledge this safety improvement based on their long experience with ILS approaches. With RNP values set, trained, equipped and flown low enough, the results can be outstanding. Operators currently are flying RNP-based constant descent angle area navigation (RNAV) approaches to decision altitudes as low as 250 ft. In many locations, newly implemented RNP approaches have minimums that are lower than those for the pre-existing instrument approaches — in some cases, lower than an ILS approach. Airlines that have been using these procedures have reported numerous diversion "saves," in which the availability of RNP-based constant descent angle approaches has allowed flights to continue in situations that previously would have required expensive diversions. Of course, satisfied customers were on those flights also.

Fans and Ropes

The precise horizontal and vertical navigation that allows flight crews to consistently fly RNP-based constant descent angle approaches also provides airlines the further benefit of increased payload and/or range. With older nonprecision approach methods, the lack of accuracy requires conservative methods of conducting missed approaches. At some airports with large areas of protected airspace for the missed approach procedures, payloads have to be reduced to meet the required climb gradients.

Protected airspace can be visualized as a hand-held fan versus a rope: Because the protected airspace for the older nonprecision approaches depends on the relatively lower accuracy of the navigation aid, its angularity generally increases with distance, like a fan. However, with RNP, the protected airspace is like a rope of consistent width. The rope can be turned and twisted to achieve the optimum path for an arrival, approach or missed approach — for example, the RNAV (RNP) approach to Queenstown, New Zealand (Figure 2). The path can begin or end 50 ft above the runway threshold. This allows for high navigational accuracy during approaches and missed approaches, and allows tailoring of the approaches to optimize the trajectory. As a result, airlines can increase their maximum landing weights at these airports, typically by 5,000 to 13,000 lb (2,268 to 5,897 kg). That can be converted into extra payload, range and revenue.

The business case for RNP-based constant descent angle approaches does not apply only to the airlines. Regulators, airports and ATC achieve benefits also. For regulators, the maintenance and inspection of the many types of navigation aids and approach procedures are quite cumbersome, time-consuming and expensive. Implementation of approach procedures at new airports requires much attention to the development of the regulatory infrastructure. Reducing the types of approaches and navigation aids, and implementing tightly controlled arrival paths provide the potential of reducing the complexity and costs of the airspace system and infrastructure.

Most airports today have multiple navigation aids with high installation and maintenance costs. RNP-based constant descent angle approaches reduce the requirement for such expensive equipage and maintenance. At some airports, terrain — and, at times, weather conditions — preclude implementation of traditional approach procedures to certain runways. This problem can be solved by the use of RNP approaches. New travel destinations can be developed without the need for ground-based navigation aids.

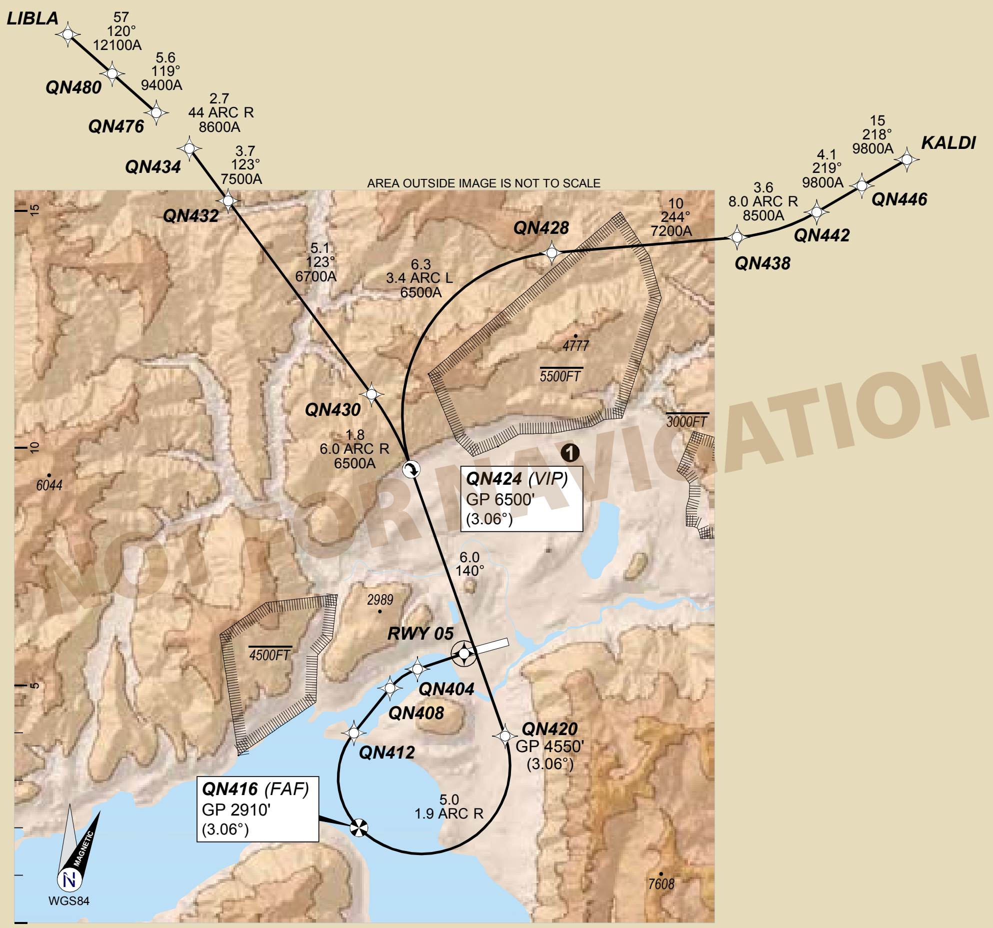
ATC benefits from the predictability of approach paths come rain or shine. Arrivals can be tailored to meet noise, terrain and timing needs, thus reducing direct intervention by controllers. With predictable arrivals and descents, the controller's primary job of maintaining separation becomes easier to manage.

Looking Ahead

Cleaner, quieter, more efficient operation is a worthy goal. Of greater importance, however, is the challenge of further reducing the accident rate despite the projected increase in air traffic. With the advent of the global shortage of qualified pilots, training already has become a burden for airlines and regulators. Cost control is here to stay, and the economics of the airline business will continue to be a challenge

This is the fourth and final article in a series discussing the development and benefits of precision-like constant descent angle approaches. The articles are the products of the Precision-Like Approach Project, launched by the Flight Safety Foundation International Advisory Committee (IAC) three years ago. The first article, by Capt. Tom Imrich, reviews the history of all-weather approach operations, from road maps, pilotage and dead reckoning to RNP and satellite-based approaches (*ASW*, 9/07, p. 22). In the second article, Capt. Etienne Tarnowski describes the recommended methods and operational procedures for conducting traditional nonprecision approaches and constant descent angle approaches (*ASW*, 10/07, p. 12; an enhanced version of the article is available on the FSF Web site, <flightsafety.org>). The third article, by Don Bateman and Capt. Dick McKinney, takes a closer look at the many hazards of nonprecision approaches and provides strategies to reduce the risks (*ASW*, 11/07, p. 13).

RNP-Tailored RNAV Approach



RNP = required navigation performance RNAV = area navigation

Source: Etienne Tarnowski

Figure 2

for many operators. Constant descent angle approaches will help to ensure a bright future.

Some day, we likely will see all approaches conducted as uninterrupted idle or near-idle descents from cruise altitude to short final. The capability exists today to conduct RNP-augmented approaches with consistent precision and on a constant descent angle down to Category III operating minimums. These approach procedures can be implemented at nearly every airport runway end worldwide without the massive investment in infrastructure and navigation aids that is necessary for traditional approaches. Because there will be only one way to fly these approaches, training will be simplified and airplanes will be designed and operated in a simplified manner. Imagine just pushing the "APPROACH" button, watching the course deviation pointers and flying a curved Category III type approach to a runway that previously could not be served by an instrument approach. Idle descents and specific arrival paths will greatly reduce the emissions, noise and fuel penalties we suffer from today. ATC will be able to "modify the rope" and tailor the RNP arrival paths to avoid weather, terrain and other inhibiting factors while maintaining optimum idle-power descents and timing of aircraft arrivals to maximize airport operations.

For many airlines and pilots, the future is now. They are making the changes and investments needed to conduct constant descent angle approaches. They are enjoying the benefits in the many areas we have discussed. And, they are doing it safely, using proven methods and modern tools. We should join them.●

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Flight Safety Foundation realigns priorities to meet emerging threats.

Beyond Technical

BY WILLIAM R. VOSS

For 60 years, Flight Safety Foundation periodically has reinvented itself to meet the demands of the times. After a decade of spectacular reductions in accident rates, once again the time has come to refocus the Foundation on a new crop of emerging threats to aviation safety.

For many years the risk of having an accident was reduced by invention and communication; safer hardware and techniques were developed and information about those developments was disseminated. Lives and aircraft were saved by fostering the open exchange and publication of objective, accurate technical information.

Our orientation toward excellence in the technical aspects of aviation safety — including how to mitigate human error — also carried forward, for example, to the 1990s, when international specialists transformed accident data into credible methods of reducing approach-and-landing accidents, including those involving controlled flight into terrain, and the other dominant accident categories.

The FSF Board of Governors, staff and I recognize that we not only must build on these solid technical underpinnings but also prepare for a new generation of challenges to safe flight. We have begun to reshape our activities into a global system — including establishing a network of FSF Fellows around the world — targeting emerging risks, expanding beyond our legacy of distributing information through informal networks. Flight Safety Foundation of the future will be less about inventing and communicating, more about implementing and enabling.

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We have identified these emerging risks:

- Unprecedented growth
- Lack of qualified personnel
- Lack of political will
- Safety management challenges
- Rise of criminalization
- ATC risks
- Runway safety

Flight Safety Foundation and our industry partners know how to achieve high levels of safety, as proven by the record in North America, Europe and elsewhere. For the most part, this knowledge has reached into the farthest corners of the world. Yet we have found that many safety professionals, while knowing what to do, cannot do it because of issues of political will or failure to commit adequate resources. Good regulatory oversight of civil aviation is not expensive relative to other costs in a state's aviation system, but governments have to be willing to do it and to pay for it. If they can't do it alone, they must partner with neighboring governments. One way or another, the job of safety oversight has got to get done.

This is an example of the emerging challenges already being seen in the aviation system, more strategic and structural than past concerns. The changing nature of the challenges has not diminished the world's need for an objective, independent aviation safety organization. But the organization must evolve. Fewer future challenges will have purely technical solutions. Instead, they will engage us in complex political, social and cultural issues that industry and government bodies are poorly positioned to deal with.

The growth of operations around the world will reflect exploding demand for air travel.

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The Foundation has that important ability to "tell the truth to power" that ensures leaders are aware of the safety consequences of their actions or inaction.

The "new model" Flight Safety Foundation that we begin building in 2008 will carry over our strongest assets but also aim to develop more effective ways of empowering people at all levels of responsibility to apply their knowledge, skills and resources — and to overcome impediments — to consistently achieve the norms of safety performance that the international aviation community expects.

The core mission of the Foundation remains reducing the risk of aviation accidents by ensuring the global dissemination of safety information and interventions to all segments of the aviation industry. We will continue this important mission while working to overcome social, political and economic barriers to the implementation of proven interventions, aligning our work with the *Global Aviation Safety Roadmap,* the international aviation safety plan adopted by ICAO that focuses limited resources on the highest risk areas.

Flight Safety Foundation will work more closely with industry partners, and rely extensively on partnerships such as the Industry Safety Strategy Group, especially on initiatives that require a global safety network and/or assistance networks.

FSF Fellowship Program

Under the new FSF Fellowship Program, experienced safety professionals will be named FSF Fellows and located around the world performing functions that mitigate developing safety risks either in growth "hot spots" within the developing world, such as South Asia, or specializing in important developments in any world region, such as the implementation of new generation air traffic control systems in the

United States and Europe or attacking the problem of criminalization worldwide.

FSF Fellows will develop information sources, personal relationships and safety intelligence insights to help focus global aviation industry resources where they can do the most good in terms of the *Roadmap;* advise the region's regulators and aircraft operators on developing issues; establish high-level government relationships that enable them to "tell the truth to power" and improve transparency of civil aviation activities and safety to the public; and offer an accessible, credible source for news media representatives, improving the accuracy of reporting on aviation safety.

Another role of FSF Fellows will be to develop relevant technical solutions — or help others to develop the solutions — that target problems in various industry segments and geographic regions such as business aviation in Europe, the Middle East and Asia; low-cost carriers in Asia and Europe; or air navigation service providers worldwide. The two-way communications channel that FSF Fellows establish immediately will benefit all sponsoring industry partners, and ultimately will benefit the entire aviation community.

The key advantages of an FSF Fellow working as an employee of Flight Safety Foundation — typically sponsored by a contract of three to five years, funded by grants from coalitions of government or corporate industry partners — are freedom from external ties or obligations, the flexibility to work on the ground in a developing region, and direction solely from the Foundation.

Safely Managing Growth

Current projections show the global airline industry doubling in the next 20 years. Projections recently presented by Alteon Training, a subsidiary of The Boeing Co., show the global airline fleet doubling to more than 35,000 airplanes, with 363,100 new pilots required to support the projected fleet growth and pilot retirements from 2006 to 2026. Boeing also says the fleet size in the Asia Pacific Region will triple in 20 years. The Middle East fleet is expected to grow at an annual rate of 7 percent, doubling in just 10 years.

The demand for air transportation in high-growth regions will not go away. There may be US$100 per barrel oil prices, and strong pressure from environmental concerns, but these factors are overridden by millions of people entering a new global middle class around the world, who insist on traveling. Regulators in developing states are under enormous political and commercial pressures; governments that have waited decades for prosperity are not inclined to say "no" to growth. It is not certain that safety concerns would drive down demand, so it is not safe to assume that economics and market demand will force safety improvements. Demand, and scarce supply, may overwhelm safety considerations. This poses a significant risk to the industry because some of the high-growth regions — now or projected — have had persistently poor safety records. Governments and regulations need the advice and positive reinforcement that Flight Safety Foundation must be positioned to offer.

In responding to emerging safety challenges in the rapidly developing regions of the world, we cannot afford to let down our guard in North America and Europe, where traffic growth will further test an already strained infrastructure. Although growth rates will trail developing areas of the world, the numbers are already large and the influx of needed airplanes and pilots will pose significant challenges. Boeing estimates Europe will need 73,400 pilots over the next 20 years.

It is possible that aviation growth in Europe could be impacted by the public perception that aviation is a major contributor to global warming. While this charge might be greatly overstated, one cannot argue that the conversation has changed regarding aviation in Europe, shifting from safety to carbon, and that in itself is reason for concern.

The important role of safety management systems (SMS) in coping with growth should not be underestimated, yet the SMS template, which represents a fundamental overhaul of the global regulatory system, contains elements that appear threatening to existing holders of authority, such as regulators and labor unions. The Foundation's drive to support SMS proliferation guided by the *Roadmap* is undiminished.

Not Enough People

The availability of skilled personnel poses two threats to global aviation, the most worrisome being the safety of operations, followed by limited growth potential. Lack of qualified pilots and maintenance personnel has become acute in Asia and Africa. The problem has begun to emerge in other states and regions such as Russia, Eastern Europe and the Middle East, and soon will spread to the rest of the world. Programs must be established that can generate qualified professionals to keep up with demand, without compromising safety standards (see "Zero Time to First Officer," p. 38). Some accidents still under investigation look suspiciously like people losing control of aircraft during normal operations, a bad indicator of the level of proficiency of pilots in those airplanes right now.

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Regulators' development of strategies and information needed to ensure controlled safe growth of the industry must consider the danger of bowing to massive economic and political pressures to sustain aviation system growth rates with under-qualified people.

The personnel crisis is a threat that no entity in the airline industry or government can address alone. It requires specialists in many fields to work together to address the problem. The Foundation believes some tools in place now, like flight operational quality assurance, could provide an early warning when an airline's expansion exceeds the capability of its people. Measures will be needed to make sure crews are of the appropriate quality, and airline operations are limited to those that the workforce can support. China has taken such measures, but that is the exception rather than the rule.

Shaky Political Will

Safety oversight in parts of the world has been compromised by economic interests. Unscrupulous aircraft operators exploit weaknesses in the aviation system for profit, and their carelessness causes accidents that kill people. What happens on charters during the *haj*, for example, is a terrifying and blatant disregard for safety standards and regulations, a flagrant end-running of government oversight systems. It is the job of regulators to control these operators, but while some states have taken action, the highest levels of governments in other states have lacked the political will to do so. Safety professionals in these situations — from civil aviation inspectors to directors general of civil aviation — have been left on their own, sometimes in grave personal danger, confronting difficult operators and never knowing when the next enforcement action they take will be their last.

In states with highly developed aviation industries and infrastructure, it is easy to ignore the circumstances of the sudden departure of a developing nation's director of civil aviation and not question the event. It must be appreciated that promoting aviation safety in the developing world will require more effort than shipping training materials. We must help others deal with the really tough political problems. It is worse than useless to tell people how to regulate safety if they are not allowed to act.

Taking ATC for Granted

The United States and Europe with increasing urgency are beginning to implement their next generation ATC systems, while states elsewhere are involved in major upgrades. The United States is driven by significant traffic congestion and flight delays, and Europe, also coping with congestion and delays, needs better ATC efficiency to hit carbon targets under environmental regulations. These systems must meet future demand, redefining ground and airborne separation responsibilities, and predicted performance must match real life experience based on objective assessments; experience has shown that new ATC technology rarely operates as expected.

The coming ATC changes must be revolutionary and will impact the level of safety in ways that will be difficult to predict. These are end-to-end changes that will need an end-to-end safety perspective. The industry cannot allow improvements in one area, such as required navigation performance, to increase the severity of consequences of an ATC error, such as incorrect altitude assignment, or a pilot error, such as an altitude deviation. Safety management systems and continuous feedback from operational experience will need to be applied to this emerging challenge.

Safety programs for the flight deck and ATC have developed over time in separate vertical "silos." In addition, labor-management issues impact the change process. Flight Safety Foundation and industry partners must help specialists within these disciplines and among different air navigation service providers to apply a cross-cutting approach — a perspective of the big picture that bridges the silos — providing a forum that helps them focus on safety dimensions separated from labor-management issues and mitigate tensions. At every level, we have to build mechanisms that allow for the exchange of data and the development of ATC solutions.

To Err Is Criminal?

Flight Safety Foundation will continue to strongly oppose the unwarranted application of criminal laws to aircraft accident investigations. When passengers are killed in an aircraft accident, the public's first reaction is to want to assign blame, identify individuals to hold accountable and punish them with fines or imprisonment. It is difficult for those who are not aviation safety professionals to grasp how criminal investigations interfere with safety investigators' efforts to identify the accident's probable cause and compromise programs that prevent recurrence of accidents.

As a result, legal systems around the world have tried to use criminal charges to obtain justice and, ostensibly, to improve safety. The Foundation's future role will be to educate prosecutors, jurists and the public around the world about the practical safety consequences of their actions. This message must be delivered by an independent safety authority; it cannot be a company or organization that has a monetary or legal stake in the case.

Justice is a matter of balance, balancing the human desire to assign blame and exact retribution versus the proven benefits of unhindered access to the facts of the accident. It is up to the Foundation and our partners in this effort to make that case, not trying to avoid justice, but to restore the balance that lets us save other lives by preventing accidents in the future.

If the global movement towards criminalizing accidents and abusing safety data goes unchecked, the proactive safety approach that depends on trust, openness and innovation — which has driven the recent dramatic improvements in the accident rate — will be compromised irreparably. The free flow of confidential data that can warn us of an impending accident will be lost, and there will be more accidents.

Grants and Endowments

Many types of companies have a stake in the success of the aviation community and thus have many incentives to help prevent accidents and incidents that could curtail the growth of markets they serve. Examples include aviation insurers, airport operators, aircraft lessors and equipment manufacturers. Given the scope and scale of emerging safety challenges and the societal benefits of effectively addressing them, Flight Safety Foundation is and will remain in a unique position to help reduce accident risks that — in addition to loss of life, injuries and/or aircraft destruction — cause myriad damages to business and reputation.

To ensure that the Foundation is equipped to respond to safety risks as they arise anywhere in the world, funding will be sought in the form of grants and endowments. We will seek funding from operations within traditional FSF membership groups, such as aerospace manufacturers and airlines, and from others, such as aircraft leasing and holding companies and philanthropists.

In addition to helping fund existing FSF efforts, endowments will be explored specifically as a means of funding the work of FSF Fellows, who initially would demonstrate their value under a program supported by short-term grants. The presence of FSF Fellows in a developing state or region will make aviation safety expertise accessible and affordable to the region's operators. Asia alone is expected to generate US$1 trillion in sales of equipment and supporting services during the next 25 years. It is reasonable to expect that industry leaders would be willing to make strategic investments that could reduce operational risk in that trillion-dollar market.

Poised for Action

In summary, Flight Safety Foundation will remain a neutral forum, an integrator of initiatives and an independent advocate. Some of our efforts will be directed to addressing the newly emerging threats, but our most dramatic change will be the placing of FSF Fellows on the ground around the world to serve as accessible and dependable safety touchstones.

We remain unconstrained by geographic limitations or industry boundaries. Our safety mission spans all industry segments, working to address safety challenges across organizational boundaries. Time and again, we have demonstrated our ability to be a catalyst in producing end-to-end safety solutions, even those that might require mitigation of errors across flight decks, control rooms, airports and airplane engineering and maintenance facilities. Even now the FSF-led Runway Safety Initiative is striving to reduce the risk of an accident on or around runways in an effort that brings together regulators, unions, pilots, operators, ATC providers, airports and manufacturers.

We will build synergy with industry partners by demonstrating that Flight Safety Foundation will add a "safety only" portfolio of services that will not compete with our partner for-profit organizations. Technical work of other organizations also will not be duplicated.

One of Flight Safety Foundation's key roles is continually to stimulate the safety consciousness among institutions around the world. We have a proud history and a well-earned reputation for technical competence and independence, marked by data-driven assessment of safety risks. Our work has been, and will continue to be, driven by data rather than politics or commercial interests, a capability that will be enhanced as we add FSF Fellows and other innovations.

Updated priorities alone will not accomplish the work at hand. Future core competencies for our Board of Governors, our directors and staff, our FSF Fellows and participating Flight Safety Foundation members require some time to develop. These competencies include research and analysis of safety-related industry issues; analysis of trends in aviation safety; program/product research and development; analysis of safety data; and the ability to understand data/performance gap analysis as required by the *Roadmap.* This upgrade in vision and scope gradually will have an impact on the entire FSF structure and its functional objectives, one that we expect to once more raise the level of safety in global commercial aviation. ●

A Stellar CAST

Joint U.S. government and commercial aviation initiatives invented new ways to reduce accident risk.

BY ROBERT MATTHEWS

Over the last decade airline travel has become significantly safer, measurably safer, because of groundbreaking, meticulous work by the Commercial Aviation Safety Team (CAST), formed in the aftermath of an unusual series of major accidents 10 years ago. While CAST is originally a United States project, the impact of what it has done has spread benefits far and wide, particularly in China, South Asia and all of the Americas.

The landmark government-industry group set out to reduce the risk of fatal accidents by 80 percent in 10 years, a goal many observers said was utterly beyond reach. Strictly speaking, they were right: The risk of fatal accidents declined 73 percent in the United States as aviation safety professionals worldwide adopted novel approaches to reducing risk, such as devising and implementing safety interventions guided by analyses of incidents and errors once considered inconsequential.

CAST still brings together virtually the entire commercial aviation industry, including major manufacturers, major airlines and labor organizations, plus the U.S. Federal Aviation Administration (FAA), National Aeronautics and Space Administration (NASA), Department of Defense, other national governments and international organizations such as Flight Safety Foundation (FSF).[1]

One of CAST's most important accomplishments has been demonstrating that government and industry can work together, reach consensus on the major risks to safety and develop detailed implementation plans in which specific sectors of aviation commit to specific actions. Thus far, CAST has developed 65 safety projects, including 47 near-term and 18 long-term projects. Forty safety projects had been completed as of October 2007, and 25 are under way.

Crisis of Confidence

CAST was established in 1997 while the U.S. aviation community was facing a crisis of public confidence in air travel. In the 30 months from July 1994 through January 1997, U.S. airlines had 13 major fatal accidents with 841 fatalities and 90 serious injuries. Something meaningful had to be done to lower the fatal accident rate quickly and permanently.

In response, the White House Commission on Aviation Safety and Security, chaired by Vice President Al Gore, was established in August 1996. The U.S. Congress soon formed the National Civil Aviation Review Commission chaired by former Rep. Norman Mineta, who later became secretary of transportation under President George W. Bush. Other government and industry groups were developing their own

CAST | The Commercial Aviation Safety Team

responses to the crisis, including the FAA's Safer Skies initiative and the formation of the Industry Safety Strategies Team, a coalition of manufacturers and airlines.

In February 1997, the White House Commission set a goal of an 80 percent reduction in the fatal accident rate within 10 years and said that government and industry should develop partnerships to improve safety, with the FAA and industry jointly developing a comprehensive strategic safety plan to implement existing safety recommendations. The Review Commission also urged joint government-industry efforts to develop performance measures and milestones to assess the plan's progress and periodically review safety priorities.

How Could It Work?

Agreeing to work together was the easy part for industry and government. The tough part was deciding exactly how to do it. The FAA, NASA and the Industry Safety Strategies Team began by forming the Commercial Aviation Safety Strategy Team and recognizing that, to be effective, it had to include the Department of Defense and key labor groups, including the National Air Traffic Controllers Association (NATCA), the Air Line Pilots Association, International (ALPA), the Allied Pilots Association (APA) and others. The expanded group, adopting the current name, committed itself to the White House Commission goal.

The member organizations agreed that CAST would operate with one co-chairperson each from industry and government, and that each member organization would be represented on the CAST Executive Committee by senior officials with authority to commit the organization to specific actions. Issues might require consultations within each member organization, but other member organizations subsequently could expect action to follow.

CAST quickly created a team to develop the accident baseline, an initial point for measuring risk reduction. The baseline included fatal accidents and nonfatal hull losses from 1987 through 1996 that involved U.S. Federal Aviation Regulations Part 121 passenger or cargo operations, and scheduled passenger flights in aircraft with 10 to 30 passenger seats, a category of operation then transitioning to Part 121. With the criteria for the data set established, each accident was assigned to a single accident type. The CAST data set for the United States has been updated regularly since 1997 to include all hull-loss accidents, and a worldwide data set also has been established by including comparable hull-loss accident data from other countries.

Another key agreement was that CAST would remain strictly a voluntary group. The representatives involved in CAST are safety professionals who understand that if the data identify risks that can be mitigated, it is incumbent upon them to take the appropriate action. Once an agreement is reached, every member is expected to support it.

Similarly, CAST has observed a rule of personal and intellectual trust. Representatives can raise any issue, say precisely what is on their minds and expect their opinions to be treated confidentially. Sensitive data presented to CAST cannot be shared with others unless the owner of the data agrees.

First Three Targets

CAST started its work by addressing the three biggest killers in aviation: controlled flight into terrain (CFIT), approach-and-landing accidents (ALAs) and accidents involving loss of control in flight (LOC). For each accident category, CAST planned to create and direct a joint safety analysis team (JSAT) and a joint safety implementation team (JSIT). In fall 1997, CAST directed the first team, the CFIT JSAT, to develop and document a data-driven analytical process, apply that process to CFIT accidents and recommend specific interventions to reduce their frequency.

The CFIT JSAT adopted a case-study approach in developing a methodology to help understand accidents, identify high-leverage interventions and reduce the risk of future accidents, documenting detailed chains of events and identifying problems. The process was fully documented in the *JSAT Process Handbook,* which will include future changes.

The CFIT JSAT used 10 well-documented reports on CFIT accidents from accident investigation authorities in several countries. The team established a detailed sequence of events for each accident and identified problems of omission or commission, some of which may not have been explicitly noted in the accident report. Possible interventions were developed for each problem, and each intervention was evaluated for its effectiveness against CFIT accidents.

Because this was its first joint study, CAST also directed the CFIT JSAT to review CFIT reports by other organizations, including the International Civil Aviation Organization (ICAO), National Aerospace Laboratory–Netherlands, Flight Safety Foundation and others. This review ensured that CAST had the benefit of other high-quality work and provided a reality check on the results of the JSAT process.

In November 1998, CAST received the *CFIT JSAT Results and Analysis Report,* which became the model for later teams. The analysis team identified 106 possible interventions, with an estimated effectiveness score for each intervention. The interventions were forwarded to the CFIT JSIT, which assessed each one for overall effectiveness in reducing accidents within a category. The CFIT JSIT — setting the pattern for subsequent JSITs — then assessed the feasibility of implementing each recommendation. Feasibility decisions were based on the following considerations:

- Technical criteria — Can the recommendation be implemented?
- Financial criteria — Can it be financed?
- Operational criteria — Can it be integrated into the system and produce results?
- Schedule criteria — Can it be accomplished within the stated time?
- Regulatory criteria — Can it be accomplished without a lengthy regulatory process?
- Sociological criteria — Will it be acceptable to the public?

After interim reviews and approvals by CAST, the final product is a manageable number of safety enhancements, with detailed implementation plans that identify the precise actions to be taken, by whom, when and at what estimated cost. While the CFIT JSIT was finishing its tasks in summer 1998, CAST created the Approach and Landing Accident Reduction (ALAR) JSAT. The scoring process was refined, but the ALAR JSAT used the same core analytical process introduced by the CFIT JSAT.

The ALAR JSAT identified 192 possible interventions and rated the effectiveness of each. Because some of the recommended interventions addressed problems already well known to the CFIT teams, CAST created a combined CFIT-ALAR JSIT, which eliminated low-ranking interventions, consolidated the strongest ALAR interventions into five broad safety projects and added them to the eight CFIT safety projects. The ALAR-related safety projects focused on these areas: aircraft design; flight crew training; maintenance procedures; organizational policies and culture; and upgrades or installation of equipment to improve flight crew situational awareness and checklist completion.

CAST recognized that as safety projects emerged from future JSATs and JSITs, competition for resources would increase. Consequently, CAST decided to create a separate and centralized team — called the joint implementation measurement data analysis team (JIMDAT) — primarily to develop a method for prioritizing the safety projects from the JSITs. Unlike the JSATs and JSITs, the measurement team does not disband after completing an assigned study or task; instead, it provides ongoing staff support to CAST.

Initially, the JIMDAT made a categorical distinction between LOC accidents and ALAs. Consistent with the occurrence categories in a taxonomy developed later with ICAO, which allows analysts to associate any occurrence with multiple categories, the team distinguished types of accidents and incidents by criteria other than whether they occurred during the approach and landing phases of flight (Figure 1).

To prioritize safety projects, the JIMDAT computed scores as a measure of the severity of each accident in the CAST accident data set. Considering each accident as weighted by its severity score, the team then estimated each safety project's potential for reducing the risk of each accident in the data set. The JIMDAT then could track safety-project implementation and assess a safety project's actual contribution to reducing the risk of fatal accidents. This has remained the basic CAST process for evaluating risk reduction.

CAST also assigned the JIMDAT additional tasks. One was to develop a methodology for estimating the cost

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of an accident and the cost savings that might be associated with safety projects.

As progress was made toward the 80 percent reduction goal, a major advancement occurred when the JIMDAT was assigned to develop a methodology for analyzing incident data to identify risks before they lead to accidents. This assignment also included considering the emergence of new risks, as well as those from the original data set.

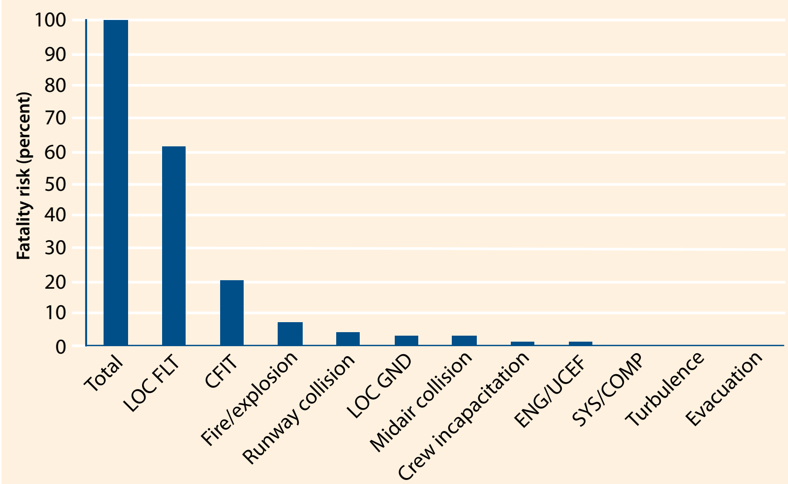
In September 1999, CAST created the LOC JSAT, which developed 292 possible interventions. CAST accepted the *LOC JSAT Results and Analysis Report* in December 2000 and forwarded it to a newly created LOC JSIT, which again applied the process documented by the other JSITs. This implementation team consolidated the most effective interventions into the following three broad areas and safety projects:

- Aircraft design comprising autoflight design in new airplane designs; display and alerting features in new airplane designs; criteria for flight in icing conditions for new airplane designs; flight-envelope protection in new airplane designs; and vertical-situation displays in new airplane designs;
- Policies and procedures comprising risk assessment and management; standard operating procedures (SOPs); dissemination of essential safety information and procedures; flight crew proficiency; and,
- Training comprising human factors and automation, and advanced maneuvers training.

More Safety Projects

After the CFIT, ALAR and LOC work, CAST created several more JSATs and JSITs. The Turbulence JSAT began working in late 1999. Although turbulence had caused four fatalities in 50 years, these events had caused the largest share of all serious injuries, with flight attendants especially exposed to turbulence-related injuries. The Turbulence JSAT studied all turbulence accidents from 1983 through 1999 and developed 30 possible interventions. A Turbulence JSIT, created in January

Historical Part 121 Risk, 1987–2000



LOC FLT = loss of control in flight; LOC GND = loss of control on the ground; ENG/UCEF = engine or uncontained engine failure; SYS/COMP = system/component failure or malfunction–powerplant

Notes:

All security-related events were excluded.

Part 121 of U.S. Federal Aviation Regulations pertains to air carriers.

Source: U.S. Commercial Aviation Safety Team

Figure 1

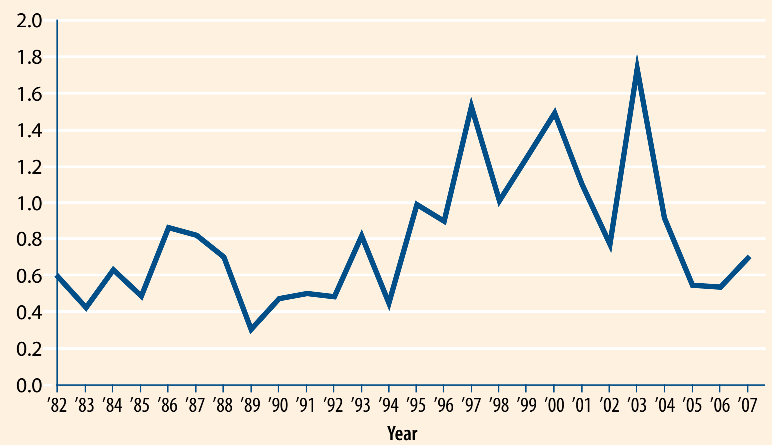
2001, combined the highest-ranked recommendations into the following broad safety projects: best practices for turbulence avoidance; improving the quality of turbulence information, such as manuals, standardized language and training/education; pilot training; and improved cabin procedures and design. Turbulence-related safety projects did not get under way until 2003. Recent statistics show that the projects — particularly those involving best practices and procedures — appear to have reduced turbulence accidents (Figure 2, p. 26).

Next was the creation of the Runway Incursion JSAT. Because of the nature of the data and the types of risks involved, this team included extensive representation from the Joint Steering Committee, the U.S. general aviation industry–government counterpart to CAST. The Runway Incursion JSAT also was the first team to begin CAST's long-intended transition to incident analysis as a basis for identifying risk.

The Runway Incursion JSAT developed 22 possible interventions, from which the Runway Incursion JSIT distilled seven safety projects.

Turbulence Accidents per Million Flight Hours

U.S. Part 121 Operations, 1982–2007

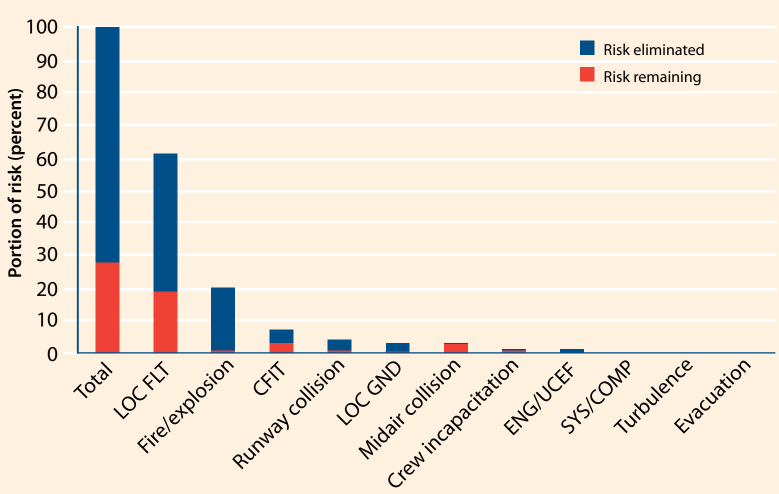


Note: Data include operations from 1982 to 1997 that were subject to U.S. Federal Aviation Regulations (FARs) Part 135 but became subject to FARs Part 121 in spring 1997. Part 135 pertains to commuter and on-demand operations; Part 121 pertains to air carrier operations. The rate for 2007 was estimated based on data through Aug. 15.

Source: U.S. Commercial Aviation Safety Team

Figure 2

Preventing U.S. Fatal and Hull-Loss Accidents: Portion of Total Fatality Risk Mitigated by the *CAST Plan* 2007 Implementation Values



LOC FLT = loss of control in flight; CFIT = controlled flight into terrain; LOC GND = loss of control on ground; ENG/UCEF = engine or uncontained engine failure; SYS/COMP = system/component failure or malfunction–powerplant

Note: Data are from the U.S. Commercial Aviation Safety Team *Fatal/Hull Loss Data Set 1987–2000.* All security-related events were excluded.

Source: U.S. Commercial Aviation Safety Team

Figure 3

The safety projects emphasized SOPs for pilots and all other surface operators, air traffic control training and procedures, and technologies to improve situational awareness on the surface, such as airport movement area safety system, automatic dependent surveillance-broadcast, airport surface detection equipment model X, moving maps and on-board alerting systems.

With the completion of safety projects by JSATs and JSITs in five accident categories, the "big killers" in U.S. commercial aviation largely were addressed. Nevertheless, residual sets of risks had not been addressed. Consequently, CAST created the Remaining Risk JSAT to address cargo operations, midair collisions and issues related to maintenance and icing that may not have been addressed by the earlier efforts.

The JIMDAT estimated that these additional efforts brought the total risk reduction to 73 percent by the end of the government's 2007 fiscal year (Figure 3). While a hair short of an 80 percent risk reduction, no one disputes that substantial and permanent improvements have been achieved.

In addition to basing its processes on analytical rigor, CAST is rooted in the practical world and applies practical tests before endorsing and adding a safety project to the *CAST Plan,* the document that reflects all these decisions. Clearly, neither government nor industry has infinite resources. Choices must be made. Consequently, with support from the JIMDAT, CAST consistently has required a good "return on safety" (Figure 4) — similar to return on investment in business — before committing financial and other resources. Unfunded recommendations would have imposed prohibitive costs for industry and government in return for little additional safety improvement.

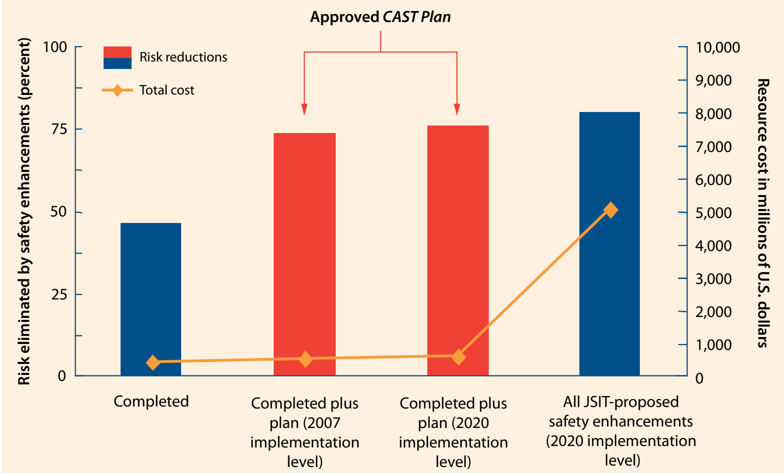
CAST estimates that the 73 percent reduction in risk will cost the U.S. government and industry US$540 million, but the safety benefit far exceeds the cost. The JIMDAT also developed a methodology for theoretically allocating the cost of accidents and risk across all Part 121 operators. This methodology produced an estimate that the risk of accidents imposes an average cost of $90 per flight. At current commercial air traffic volumes, this computes to about $1.05 billion annually in the United States. The JIMDAT also estimated that the *CAST Plan* will reduce this cost to just $32 per flight. Notably, the estimated $540 million cost has been based on an allocation over 13 years — yet the reduction in accident-related costs will exceed $670 million every year. Safety really is good for business.

International Cooperation

CAST recognized early that risks cross international borders and wished to ensure its access to the perspectives and expertise of the other governments and organizations like Flight Safety Foundation, the International Air Transport Association (IATA), the Joint Aviation Authorities (JAA) Safety Strategy Initiative in Europe and others. CAST's partnership with the ICAO Cooperative Development of Operational Safety and Continuing Airworthiness Program (COSCAP) has been particularly productive in China and South Asia, where CAST has worked closely with the regional COSCAPs. For example, the latest revision of China's civil aviation regulations has fully incorporated many CAST recommendations and FAA advisory circulars that responded to CAST recommendations. China also has committed to implementing 27 CAST safety enhancements. Similar results have been achieved in Korea and other states. Examples include risk-assessment procedures, and incorporation of the *CAST ALAR Handbook* — developed by the FSF CFIT/ALAR Action Group emphasizing the use of the FSF *ALAR Tool Kit*. CAST also is active in the COSCAP in the Commonwealth of Independent States.

In the Americas, the Pan American Aviation Safety Team implemented many of the safety enhancements from CAST's CFIT and ALAR safety projects. The safety enhancements involve aircraft equipment, area navigation procedures and incorporation of the *CAST ALAR Handbook* into regulations and training. More than 12,000 pilots from countries with PAAST participants have received ALAR training.

Resource Cost Versus Risk Reduction for *CAST Plan* Safety Enhancements



JSIT = Joint safety implementation team

Source: U.S. Commercial Aviation Safety Team

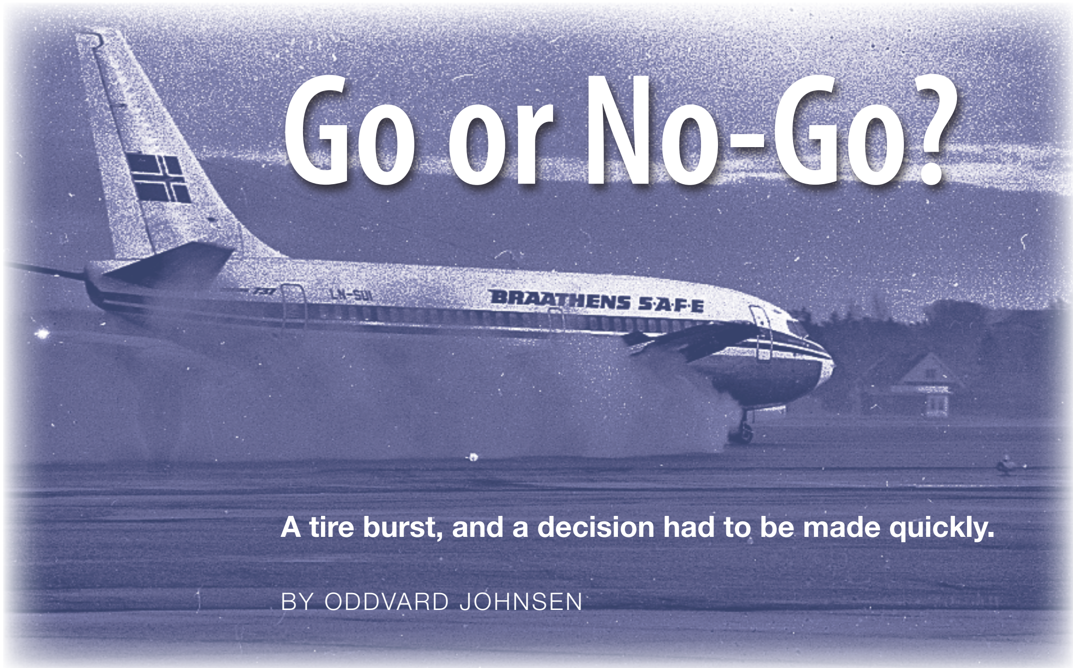
Figure 4

CAST demonstrates that government and industry can act quickly to reduce risk by advancing a robust methodology and a cooperative structure to continuously monitor data from voluntary reporting systems and incidents. ●

Robert Matthews, Ph.D., the senior aviation safety analyst in the FAA Office of Accident Investigation, for more than 10 years has been an active participant in the U.S. government's contribution to safety partnership with commercial aviation through CAST.

Note

1. The CAST membership includes the Aerospace Industries Association; Airbus; ALPA; Air Transport Association of America with active participation from many airlines; APA; Boeing Commercial Airplanes; Department of Defense; engine manufacturers' representative (Pratt & Whitney with GE Aircraft Engines as alternate); FAA; Flight Safety Foundation; International Federation of Air Line Pilots' Associations; JAA and European Aviation Safety Agency; NASA; NATCA; Regional Airline Association; and Transport Canada. Observers include the Air Transport Association Canada; Association of Asia Pacific Airlines; Association of Flight Attendants–Communications Workers of America; Civil Aviation Safety Authority, Australia; IATA; ICAO; National Air Carrier Association; and National Business Aviation Association.



Go or No-Go?

A tire burst, and a decision had to be made quickly.

BY ODDVARD JOHNSEN

A mechanic had performed a routine preflight check, and, as captain of the Boeing 737-200 Advanced, I had conducted a walk-around inspection before departure. No abnormalities were observed. As we began the takeoff roll, the first officer and I sensed that acceleration was not as brisk as normal; then, at about 130 kt, we noticed that the aircraft seemed to be "shivering" sideways. A quick look at the attitude director indicator showed that the aircraft was tilting slightly to the left. Something apparently was wrong with the left main landing gear. A tire failure!

Although well below our 149-kt V_1 — still called the "takeoff *decision* speed" when this incident took place in December 1982 — I decided to continue the takeoff rather than perform a rejected takeoff (RTO) because I realized that, with the apparent inadequate acceleration, the V_1 point geographically had been placed farther down the runway, meaning less stopping distance. Among other factors considered in the split-second decision were the runway conditions. There was a low overcast at the Bergen, Norway, airport. Temperature was 2 degrees C (36 degrees F). A thin layer of slush had been cleaned off the 2,675-m (8,777-ft) runway five hours earlier, and it was officially reported as damp. Nevertheless, pilots had complained for many years that the runway was extraordinarily slippery when wet, but no action had been taken to improve the pavement.

The aircraft was pulled up into the air, entering clouds at 100 ft. We purposely left the landing gear extended briefly to cool the landing gear and prevent a wheel-well fire. Inspection of the runway confirmed that we had left behind a lot of rubber fragments. We broke through the clouds at about 12,000 ft and prepared for an emergency landing at the Stavanger airport, 165 km (89 nm) down the coast, where weather conditions were good. We flew for 2 1/2 hours to burn off fuel and reduce our landing weight. The burn-off was managed to use more fuel from the left wing tanks than the right wing tanks, to reduce the weight on the single tire remaining on the left gear during the landing.

During the flight, an air force fighter pilot offered to join up and visually inspect the landing gear. He confirmed what we had suspected: The left outboard tire had burst and was torn to pieces. There was no related damage, no hydraulic leaks or fuel leaks.

FirstPerson is a forum for sharing personal experiences that have yielded lessons about aviation safety. We welcome your contributions. Send them to J.A. Donoghue, director of publications, Flight Safety Foundation, 601 Madison St., Suite 300, Alexandria VA 22314-1756 USA or donoghue@flightsafety.org.

The passengers accepted the explanation of the situation that I offered over the public address system and behaved calmly.

The emergency landing at Stavanger was conducted with the fuel imbalance within allowable limits. We touched down gently on the intact right main gear and carefully lowered the damaged-wheel side. Maximum allowable reverse thrust was applied (see photo p. 28), but braking was performed only on the intact wheel pair. The remaining left tire served its duty well, until we stopped after turning off the runway; the temperature fuse in the tire popped, causing the tire to collapse.

In retrospect, the tire failure at Bergen, a seemingly minor occurrence, could have had a disastrous outcome if an RTO had been performed. The damaged tire and wheel would have reduced the effectiveness of the antiskid braking system. Moreover, an RTO would have meant full brake pressure, which would have put enormous force on the damaged gear's torque link, possibly causing the intact wheel to twist 90 degrees. The tire would have been torn off, with just stubs left of the landing gear. A similar outcome had befallen a Fokker F28 during a landing some years earlier.

Post-incident calculations indicated that, even without further damage to the landing gear as described above, the aircraft would have run off the Bergen runway at about 110 kt if an RTO had been performed "by the book." There is only a 130-m (427-ft) stopway at the end of the runway before a rocky slope that drops into the fjord. The accident likely would have resulted in a large number of casualties. There were 129 people aboard the aircraft.

Today, the definition of V_1 has been refined to emphasize that any go/no-go decision must be made *before* reaching that speed. Moreover, RTOs above 100 kt now are considered high risk. But, in the early 1980s, the standard operating procedure was "no go" all the way up to V_1.

At the time of the incident, I had accumulated about 15,000 flight hours, including about 10,000 hours in the 737. I am convinced that many lives were saved by the split-second decision to go — a decision supported by knowing the aircraft quite well and by above-average familiarity with runway pavement issues gained from participating in studies performed by the International Federation of Air Line Pilots' Associations (IFALPA; *ASW*, 8/07, p. 36).

The lesson from this incident is as important today as it was 25 years ago: *Stay ahead of your aircraft.* In my opinion, the ability to stay ahead of the aircraft involves not only experience and knowledge, but also skill in observing and analyzing details gained from continual education. I believe that staying ahead of the aircraft is the deciding factor in why, given the same hazardous circumstances, the outcome is sometimes good and sometimes disastrous. ●

The lesson from this incident is as important today as it was 25 years ago: *Stay ahead of your aircraft.*

Oddvard Johnsen is a retired Braathens captain with more than 21,000 flight hours. He has served for the past 35 years as an adviser to the Norwegian Accident Investigation Board on runway conditions and installations, and is former vice chairman of the IFALPA Airworthiness Study Group.

What Lies Below

Plan to avoid the rocks during an emergency descent.

BY PATRICK CHILES

Flying over mountains on a clear day, it is common to see passengers craning their necks toward the cabin windows to take in the scenery. Although the view can be spectacular from such a vantage point, it also shows the hazards that lie below. While our passengers enjoy the sights that break up the monotony of a long flight, pilots must be mindful of what it would take to avoid the hazards if need be. Ensuring safe terrain clearance is a basic aspect of route planning, but it frequently is overlooked or oversimplified.

Checking the minimum en-route altitudes (MEAs) on the airway chart is easy but does not tell the full story. Standards for adequate terrain clearance are similar among regulatory agencies, but concepts such as *track widths*, *net drift-down flight paths* and *depressurized profiles* will further influence an air carrier's terrain-avoidance planning.

As with most topics involving airplane performance, this one can be reduced to a simple question: What are the worst possible points en route to lose an engine or cabin pressure, and what happens next?

Engine-Out Regulations

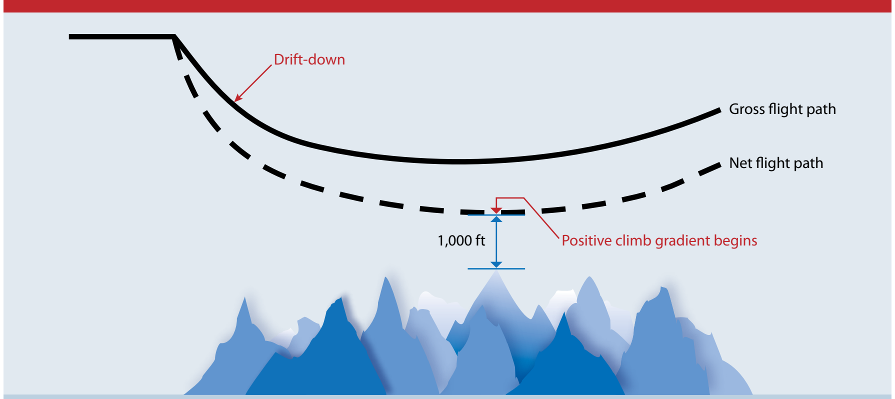
The International Civil Aviation Organization (ICAO), the European Aviation Safety Agency (EASA), the Joint Aviation Authorities (JAA) and the U.S. Federal Aviation Administration (FAA) have the same basic engine-out performance standards for en route terrain avoidance. The standards apply when route segments have terrain-limited MEAs that are higher than the airplane's one-engine-inoperative (OEI) service ceiling.

The standards require that within a specified lateral distance of the intended en route track, a given flight must have at least 2,000 ft of vertical clearance from terrain during the engine-out drift-down to the OEI service ceiling or to an airway segment with a lower MEA and 1,000 ft of vertical clearance in the level-off segment. Moreover, the airplane's OEI performance must be adequate to achieve a positive climb gradient when the airplane is 1,500 ft above the airport at which it would be landed following an engine failure. The flight cannot be initiated at a takeoff weight that would not allow the airplane to meet these minimum performance standards en route.

The specified lateral distance, or track width, for obstacle clearance is where the regulatory bodies differ. ICAO and the FAA specify 4.3 nm (8.0 km) on either side of the intended track.[1,2] JAA specifies 5.0 nm (9.3 km).[3] Track width differences adopted by other civil aviation authorities include the Civil Aviation Administration of China's 13.5 nm (25 km).

The harmonized EASA and FAA transport category airplane certification standards require en route drift-down flight paths to be determined using the most conservative airplane configuration, including the most unfavorable center of gravity and with the critical engine(s) inoperative.[4,5] Airplane manufacturers are required to apply decrements to the actual, or *gross*, en route flight paths to

Drift-Down Flight Paths



Source: Patrick Chiles

Figure 1

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establish the *net* drift-down flight paths (Figure 1). The engine-out net flight path represents actual climb performance — which is negative above the OEI service ceiling — reduced by a gradient of 1.1 percent for two-engine airplanes, 1.4 percent for three-engine airplanes and 1.6 percent for four-engine airplanes. Moreover, three- and four-engine airplanes have two-engines-inoperative requirements that reduce actual climb performance by a gradient of 0.3 percent and 0.5 percent, respectively.

Because these decrements are percentages applied over distance and time, the margin between gross and net performance increases throughout the drift-down segment. A comparison of the net level-off heights with the gross level-off heights published in the airplane performance manual will reveal a significant difference. While this should provide us some comfort, it is important to differentiate between the two when planning a route. Mistakenly using gross performance data could lead to incorrect planning solutions and erase the intended safety margins built into the regulations.

Given the high performance of current production jet transports, there are only a few areas of the world where terrain clearance can be problematic: the Andes in South America, the Himalayas between India and Tibet, and the Hindu Kush regions of Central Asia. However, older turbojet airplanes might have trouble clearing the North American Rockies or the European Alps with one engine inoperative.

Offered here are some general techniques to develop en route engine-out terrain-escape paths. The techniques are by no means all-inclusive or model-specific. It is the responsibility of the individual air carrier, charter company or corporate aviation department to devise a plan that best suits its operations and equipment.

Working Backward

The simplest way to check engine-out terrain clearance is to begin at the desired end condition — net level-off height — and work backward. If, at any given step, there is adequate terrain clearance, the analysis is complete. If not, it is necessary to move on to the next step until clearance standards are met.

The next step begins with a check of level-off height resulting from the planned takeoff weight, using the net level-off chart provided in the airplane flight manual (AFM) or performance manual. The chart depicts regulatory terrain clearance as a function of airplane weight and ambient temperature. If the net level-off height exceeds the highest terrain elevation plus 1,000 ft along the planned route, then the flight is unquestionably safe. A very easy way to check this is by planning the flight to remain on published airways and comparing the MEAs with the net level-off height. If the minimum en route altitudes are too high, use the depicted minimum off-route altitudes (MORAs), because MEAs are not necessarily based only on terrain clearance. However, the solution may not end there.

Continuing to work backward, the analysis progressively becomes more complicated. Suppose the minimum clearance altitude exceeds the net level-off height at the planned takeoff weight? In that case, it is necessary to calculate the planned fuel burn-off and determine the airplane's weight when it enters the area of terrain. If this shows that the clearance altitude does not exceed net level-off height, the flight is safe. The maximum weight when entering that area should be added to the expected fuel-burn weight to determine maximum takeoff weight for terrain clearance. If set at a fixed value for simplicity, the most adverse temperature should be assumed; otherwise, the actual maximum drift-down weight should be determined for each flight.

If, however, the expected fuel burn-off will not shed enough weight for terrain clearance en route, an obvious solution is to reduce takeoff weight by trimming payload, which means less revenue, or carrying less fuel, which might mean an en route fuel stop, adding time and expense.

Drift-Down Flight Path

With thorough route planning, reducing takeoff weight should be an option of last resort. Recall that net level-off height is not the only limiting factor; drift-down also must be considered, and they are not exactly the same thing. Level-off is just the end of the drift-down segment. For some airplanes, that segment can be quite long. An engine failure does not result in the airplane dropping straight down to the level-off height; it takes some time and distance to get there. In many cases, the descent path may be long enough and sufficiently shallow to get beyond critical terrain.

The correlation is obvious when an engine-out drift-down flight path diagram, such as the one shown in Figure 1, is compared with an airplane's net drift-down chart, such as the example shown in Figure 2. It helps to visualize the chart as a graphic depiction of the actual descent path adjusted for the required net flight path decrements. An airplane at any given weight will follow its own curve resembling the diagram in Figure 1, and the associated top of the curve in Figure 2 will move farther across the chart as weight is reduced. This represents how much distance the airplane can cover at cruise altitude while airspeed is bled off. At some point, the airplane inevitably "starts downhill." Typically, net drift-down charts are constructed so that the user can find the elapsed time and/or ground distance adjusted for wind. Some airplanes could easily take nearly an hour to reach the level-off height; in that time, they could cover about 300 nm (556 km), which might be enough to safely get out of the critical area.

As with takeoff performance, it pays to know the carrier's underlying operating assumptions. The manufacturer's data often assumes a maximum lift-to-drag ratio descent with some residual climb gradient at level-off. Some carriers elect to use drift-down profiles consistent with their extended operations (ETOPS) policies and trade some of that altitude capability for speed. There are also more options at the bottom of the descent path, such as trading speed for altitude as fuel is burned off or descending further to immediately accelerate to the selected engine-out speed (Figure 3).

Given these choices, it is still possible that the illustrated descent case may not be enough. A good example is a direct route between Panama City, Panama, and Buenos Aires, Argentina, that bisects the Andes, where minimum obstruction clearance altitudes (MOCAs) exceed 25,000 ft.

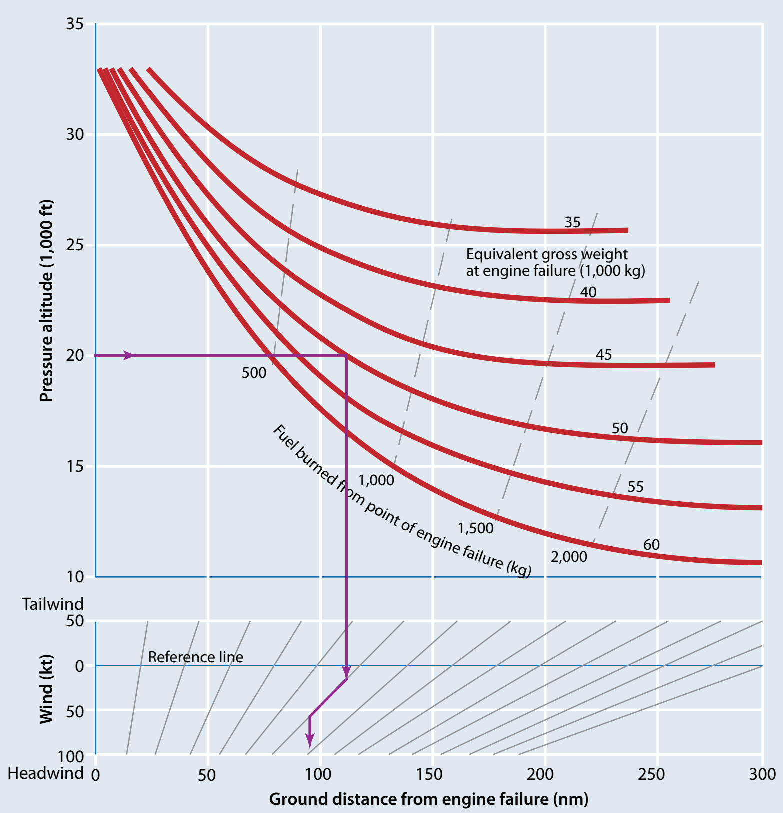
Equal-Time Points

A quick method to check your drift-down flight path is to calculate equal-time points (ETPs) for alternates selected at either end of the mountain range. If an ETP drift-down path does not violate any published obstacle-clearance altitudes, the flight is safe to proceed as planned at that weight and temperature condition.

During a route-planning exercise, it is important to consider prevailing winds for the time of year — not to be confused with the "zero wind" condition used for ETOPS planning (*ASW*, 3/07, p. 12). Winds will affect ETP location and any subsequent critical-path analysis. Specifically, the following must be considered:

- Net performance — drift-down/level-off with the required gradient decrements;
- Expected en route ambient temperatures;

Net Drift-Down Profiles



Note: In this example, equivalent gross weight is actual gross weight at time of engine failure corrected for ambient temperature and use of anti-icing systems.

Source: Patrick Chiles

Figure 2

- Adverse winds;
- Fuel and oil consumption, with enough fuel remaining after reaching the intended airport for 15 minutes of flight at cruise thrust; and,
- Fuel jettison.

Also, three- and four-engine airplanes have a different standard to meet than twins: No terrain analysis is required if suitable airports are available within 90 minutes of all points along the route; if not, a two-engine-out scenario must be evaluated.

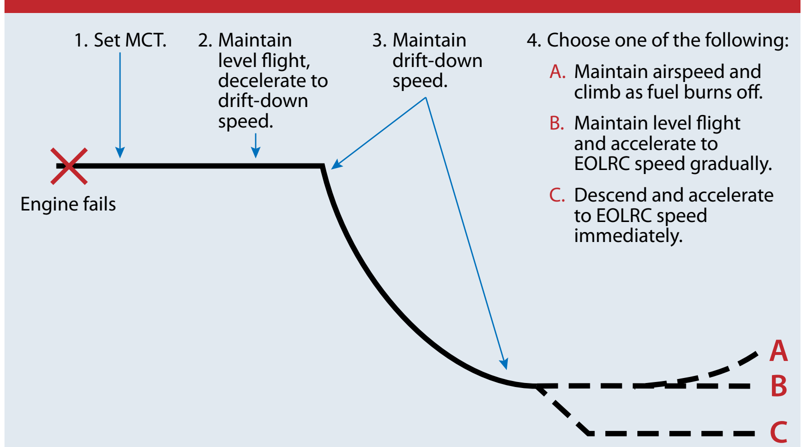
If the calculation is performed manually, the terrain-clearance path should be a great circle drawn from the ETP to each alternate. Terrain within the specified track width, including any turn-backs, also must be considered. More commonly, the calculation will be done using flight-planning software. As with the carrier's operating assumptions, it is crucial to understand the software's calculation methods. For instance, how is drift-down start weight determined? Does it use AFM-derived net drift-down? Does it assume a residual climb rate or acceleration segment? Are the MOCAs considered in the calculation consistent with the en route charts being used? These calculation assumptions must be compared with the carrier's desired methods, consistent with the appropriate regulations.

Scheduled airlines have a distinct advantage in this regard, because routes typically are analyzed by an engineering staff or a working group of pilots and dispatchers well in advance of the actual flights. Unscheduled charter and corporate operators flying the same routes typically have less time to prepare and often must rely on their flight-planning services for assistance.

Escape Areas

At this point in the analysis, if a flight is still too heavy to maintain safe engine-out terrain clearance, the options are more limited. If other airways can be found around the area,

Drift-Down Options

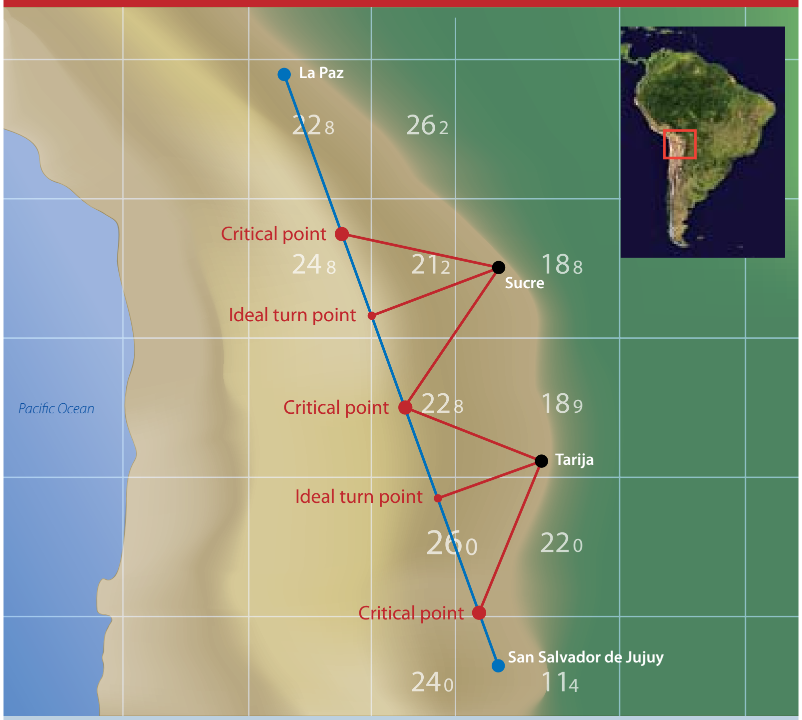


EOLRC = engine-out long-range cruise MCT = maximum continuous thrust

Source: Patrick Chiles

Figure 3

Escape Areas



Source: Patrick Chiles

Figure 4

the penalty of flying a greater distance may be offset by fewer terrain problems. Another alternative to reducing fuel or payload is to create "alternate availability areas" — or "escape areas" — along sections of the route. Escape areas may not completely eliminate the need to reduce weight, but they can at least limit the impact on operations.

Each escape area allows the airplane, following an engine failure at any point along a designated section of the route, to drift down safely from cruise altitude and land at an alternate airport.

The alternate airports ideally should be located somewhat perpendicular to the intended route, preferably in less hostile terrain and at relatively short distances within the drift-down flight path. Once the alternates have been identified, "critical points" can be established. A maximum airplane weight that will maintain drift-down and level-off clearance should be determined for each critical point.

The concept is simple, but the planning and execution can be complex. There could be multiple iterations of the same escape area, depending on the entry path, airplane weight, wind and temperature. Accurate terrain information is crucial, and commonly used en route charts may not provide enough detail. A better source is U.S. Defense Mapping Agency operational navigation charts, or "ONC charts," which provide excellent terrain detail. They depict airports and special-use airspace — but not airways. Thus, it is necessary to locate the lat/long coordinates of the desired route and plot them manually on an ONC chart before working out escape areas.

Here is the technique for putting this concept to work: For each of the selected alternates, the "ideal" turn point is established; the direct flight path from this ideal turn point to the alternate is perpendicular to the route and, thus, comprises the shortest distance from the route to the alternate. After the ideal turn point is established, other critical points before and after the ideal turn point are determined. This will create a triangular escape area, with the apex being the off-route alternate and the other corners being the designated critical points on the desired route. Depending on the distance covered during the flight, it may be necessary to create multiple off-track escape areas, which would be laid out as consecutive triangles. Within each triangle, all terrain must be examined in great detail and compared with the drift-down net-flight-path charts for the correct airplane weight.

For example, escape areas created along the route from La Paz, Bolivia, to San Salvador de Jujuy, Argentina, are shown in Figure 4. The airway between these cities, UA558, has an MEA of 24,500 ft.

Information on en route escape areas should be provided as clearly as possible to the flight crews. This could be done as part of the normal flight dispatch briefing or by including a list of predetermined weights and critical points in the company operations manual. It should certainly be part of an operator's training program.

Turn-Back Points

An alternative to constructing multiple escape areas is to designate turn-back points. Assuming that at least one escape area has been created, the first critical point for the escape area can be considered a decision point. If the airplane loses an engine before reaching the decision point and is over the maximum weight designated for that critical point, the crew should turn back along the airway and proceed to the nearest alternate.

However, turn performance should be considered, and bank angles minimized. The gradient loss in an engine-out flight path will be greater if a turn-back is included in the escape procedure. In addition, the terrain in the turn path must be analyzed. The direction of the turn also can have some effect on terrain clearance; turning into the area with the lowest MORA is recommended. Also, a teardrop course reversal can limit exposure to surrounding terrain, depending on the turn-back point.

Constructing terrain-escape paths is rigorous work, but it provides better alternatives than reducing payload or adding a fuel stop to reduce takeoff weight. There are some areas where off-track escape routes are mandatory. Most notably, the L888 airway in southern China is very close to the Himalayan range. In addition to showing that it meets Future Air Navigation System (FANS) requirements, a carrier must submit its terrain-escape plans to China Civil Air before gaining approval to use that airway. Considering that L888 is one of the most efficient routes between Southeast Asia and Western Europe, it is certainly worth the effort to break out the topographic charts and the AFM.

Rarefied Air

Besides engine-failure scenarios, en route terrain-avoidance planning must consider loss of cabin pressure. Some kind of escape path likely will be necessary because less time will be available to descend to a safe altitude. Depending on the type of emergency oxygen system aboard the airplane, the crew might have as little as 12 minutes to get down to a safe altitude — at worst, 10,000 ft.

Some airliners and many business jets have relatively high-capacity gaseous emergency oxygen systems. In most airliners, however, emergency oxygen for the passengers is provided by solid chemical systems. Commonly known as "burner systems" because of the heat produced during the chemical reaction, they typically provide only 12, 15 or 22 minutes of oxygen. A carrier operating large airplanes over high terrain should opt for the higher-capacity gaseous emergency oxygen system, if available; the associated tanks and plumbing add weight, but the increased time at altitude allows greater distance for terrain-escape paths.

Because the physiological needs of crew and passengers vary with altitude, minimum oxygen flow must be considered in a depressurized profile. Once an emergency descent speed is determined, the distance covered during the appropriate time limit is simple to determine. If the airplane has a low-capacity oxygen system, the emergency descent profile could conflict with terrain.

More off-track escape routes often are needed for depressurization scenarios than for engine-outs. The techniques for developing the escape routes are similar to the engine-out analyses, with the difference being the consideration of emergency oxygen capacity versus time/distance, instead of single-engine performance.

One apparent advantage to the depressurization scenario is that it is assumed to involve all engines operative; thus, higher speeds are possible. However, if a depressurization does occur en route, and the pilots suspect that it was caused by a structural failure, they would have to fly the airplane at a lower speed than planned and limit maneuvering loads. This could substantially limit their options for escaping terrain.

Proper planning for en route terrain avoidance can be easy to overlook, or it may be done "sight unseen" to the flight crew. As with any performance consideration, there are a number of choices available to the operator that should be made known to the flight crew. When the passengers begin to enjoy the mountain scenery, the flight crew should know what precautions and actions will keep them safely above the rocks below.●

Patrick Chiles is the technical operations manager for the NetJets Large Aircraft (BBJ) program and a member of the Flight Safety Foundation Corporate Advisory Committee.

Notes

1. ICAO. *Annex 6, Part I: International Commercial Air Transport — Aeroplanes*. Attachment C, *Aeroplane Performance Operating Limitations*.

2. FAA. U.S. Federal Aviation Regulations (FARs) Part 121, *Operating Requirements: Domestic, Flag and Supplemental Operations*, Sections 121.191 and 121.193; and FARs Part 135, *Operating Requirements: Commuter and On Demand Operations*, Sections 135.381 and 135.383.

3. JAA. Joint Aviation Requirements — Operations 1, *Commercial Air Transportation (Aeroplanes)*. JAR-OPS 1.500, "En-route — One Engine Inoperative," and JAR-OPS 1.505, "En-route — Aeroplanes With Three or More Engines, Two Engines Inoperative."

4. EASA. CS-25, *Certification Specification for Large Aeroplanes*. CS 25.123, "En-route flight paths."

5. FAA. FARs Part 25, *Airworthiness Standards: Transport Category Airplanes*, Section 25.123, "En route flight paths."

Moving Aviation Safety Forward

Center: Maimuna Taal (projected image), who was unable to attend the seminar, conveys her appreciation to the Foundation (Bill Voss at the podium) for her receipt of the FSF President's Citation for Outstanding Service. Right: Danny Ho (l.) and Steve Lin (r.), EVA Airways, with the airline's citation for The Richard Teller Crane Founder's Award.

Some of those who made special contributions received awards at IASS '07.

Aviation safety derives from the efforts of many people throughout the industry. Some contribute by doing their jobs responsibly, following the SOPs and refusing to take short cuts. Others supply their skills, developed over many years and kept sharp. Although they may not be recognized specifically for their contribution to safety, they can take pride in the parts they play.

Some individuals go "above and beyond," demonstrating exceptional ability, dedication, initiative and sometimes the courage to buck the system if it becomes dysfunctional. Flight Safety Foundation and its co-sponsors are greatly pleased to publicly recognize these men and women through prestigious awards, most of which are presented at the annual International Air Safety Seminar (IASS).

These pages show some of those who were so honored at the most recent IASS in Seoul, Korea. Such outstanding individuals exemplify the highest standards and move the state of aviation safety forward. ●

To read more about these and other award recipients, each award's criteria or to submit a nomination online, visit the FSF Web site, <www.flightsafety.org/awards.html>.

Left: David Huntzinger (l.), Korean Air, acknowledges receipt from Ed Stimpson, Flight Safety Foundation, of the Cecil A. Brownlow Publication Award on behalf of Korean Air's *SkySafety21*. Center: Mike Mena (l.) and Tom Horne (r.) of Gulfstream Aerospace Corporation accept the Honeywell Bendix Trophy for Aviation Safety, on behalf of recipient Gulfstream, from Ted Mendenhall, FSF Corporate FOQA Program. Right: John R. Ackland (l.), Boeing Commercial Airplanes, with The Laura Taber Barbour Air Safety Award presented by Ed Stimpson.

Left: Allen Parra (l.), Dallas/Fort Worth International Airport, is shown with the FSF Airport Safety Award given to the airport and presented by Ed Stimpson. Center: Steven Swift (l.), Civil Aviation Safety Authority of Australia, receives the International Federation of Airworthiness Whittle Award from Ron Yates, IFA. Right: The FSF *Aviation Week & Space Technology* Distinguished Service Award, presented by Ed Stimpson, goes to Jean Pinet (l.), Académie de l'Air et de l'Espace.

Photos: Alan Bond

Left: Peter Naz (l.), DHL Air, with the FSF President's Citation for Outstanding Service, and Bill Voss. Center: John K. Lauber (l.), Airbus, recipent of the Flight Safety Foundation–Boeing Aviation Safety Lifetime Achievement Award, shares the stage with Ed Stimpson (c.) and Curt Graeber (r.), Boeing. Right: William L. McNease (l.), FAA, receives from Ed Stimpson the FSF Admiral Luis de Florez Flight Safety Award on behalf of himself and Gerald Pilj, FAA.

Zero Time to First Officer

A training program for the multi-crew pilot license yields insights into global challenges.

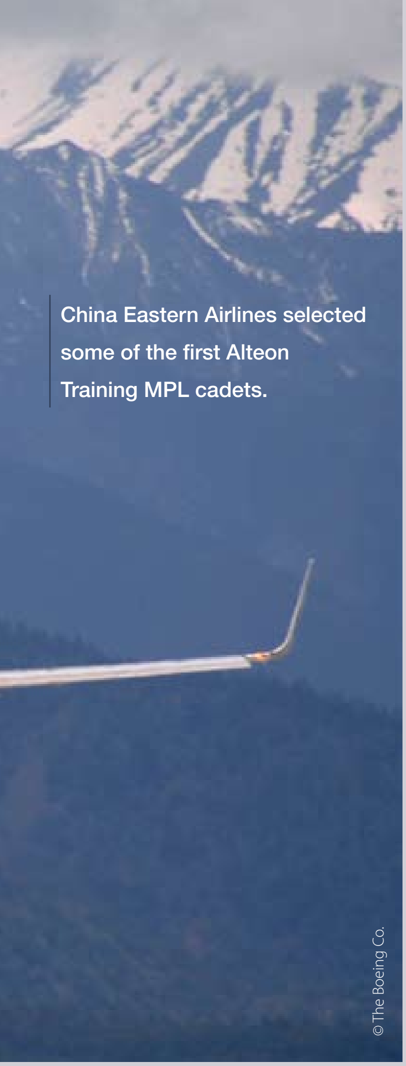
BY WAYNE ROSENKRANS | FROM SEOUL

In the first year after the International Civil Aviation Organization (ICAO) introduced the multi-crew pilot license (MPL), the developmental test of an MPL training program in Brisbane, Australia, has made significant progress, including collecting data to validate its effectiveness, according to Marsha Bell, vice president, marketing, Alteon Training.[1]

Airline industry advocates consider the MPL an essential step in modernizing pilot training that will further reduce operational risk as the global airline fleet doubles to more than 35,000 airplanes (Figure 1, p. 40) with 363,100 new pilots required to support this projected fleet growth and pilot retirements from 2006 to 2026, Bell told the joint meeting of the 60th annual International Air Safety Seminar, International Federation of Airworthiness 37th International Conference and International Air Transport Association (IATA) in October.

"There was an opportunity, in response to airlines' request, for developing a better way to train pilots … to serve their airline role by incorporating airline operations [with] a competency-based metric of performance rather than an hours-based requirement," Bell said. "The MPL is in essence an airline transport pilot license. It qualifies the holder, through a [limited] type rating endorsement for a specific commercial jet type … to operate as a first officer. Broadly, the MPL is designed … to have a greater emphasis on synthetic training devices, to incorporate airline operating procedures and airline disciplines around crew resource management [CRM] and threat-and-error management [TEM] in a multi-crew training environment."

The license and its associated training requirements come from a comprehensive six-year development process involving specialists from airlines, pilot organizations, regulators and training organizations. During that time, ICAO member states and international organizations recognized safety challenges in some parts of the world, including substandard training infrastructure lacking pilot career paths comparable



China Eastern Airlines selected some of the first Alteon Training MPL cadets.

to the United States or Europe, inadequate measures of airline pilot competence, inconsistent use of competency-based training among states and training standards out of step with high-fidelity flight simulation and methods.

"In many respects, [the MPL] is being perceived as a new way of training pilots, the future of pilot training — but it is not without its challenges," Bell said. "ICAO recognized that over the years, what had evolved in pilot training had splintered so that there wasn't a global and harmonized standard for pilots. The MPL was first motivated by ICAO's desire to improve safety. So they looked at the old practices that had not been updated for over 40 years and evaluated new ways to develop pilot training … by convening a large international group to serve on its Flight Crew Licensing and Training Panel. It was a global effort."

The effort included a functional task analysis and risk assessment before full development of the MPL and a commitment by ICAO to follow up MPL introduction with proof-of-concept safety analysis for several years.

Misconceptions Persist

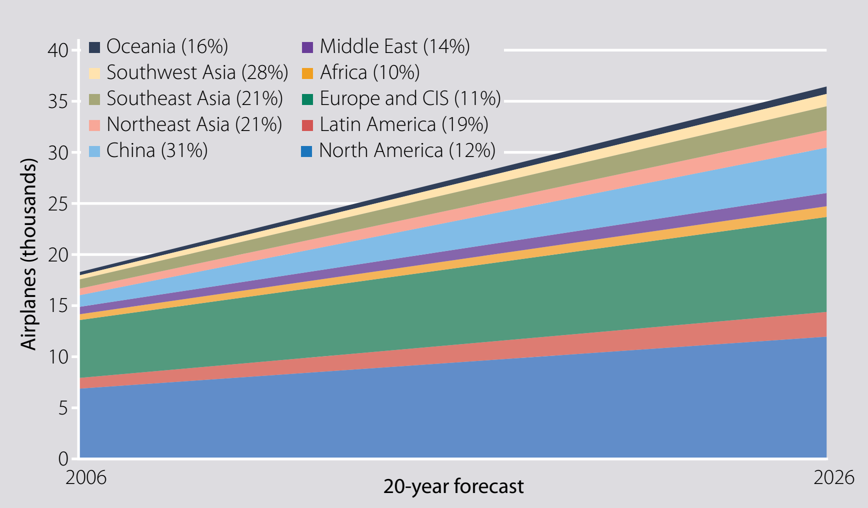
Gradual MPL adoption — such as its December 2006 addition to European Joint Aviation Requirements[2] and plans for regulatory changes that will enable MPL issuance in Australia by the end of 2007[3]— and ongoing validation efforts have not dispelled misconceptions and concerns expressed by some within the aviation community. Bell said that the following beliefs are not supported by the facts: that the MPL is "rushing to market," that it is intended as a "cheaper and faster way to create a pilot," that first officers with an MPL will not be ready for command because of their limited range of experience, and that MPL training is a "zero-time type program."

Advocates argue that the MPL reflects years of research, deliberations, development and consensus-building among a large group of international specialists. The new approach to training airline pilots might save orientation time within airlines because of its operationally oriented training focus, enable more efficient scheduling of flight simulators and increase use of simulators rather than airplanes, Bell said. "The MPL is not a call to fix the problem that we see with a shortage of pilots in the industry — it is about better training for safer airline operations," she said. For MPL training organizations, some costs actually will increase substantially because of instructor qualifications, requirements for several types of advanced flight training devices and simulators, and methods for initially training pilots as crewmembers rather than as individuals.

The time spent in MPL core flight training in an airplane is similar to the minimums in current conventional primary training, Bell said, and it includes mandatory upset recovery training. Types of flight experience will differ in that MPL holders are required to attain proficiency in airline methods of crew coordination and airline procedures on a commercial transport jet that conventionally trained first officers typically do not have, she said. "Is the graduate of the MPL program going into the right seat of a 737 as good as a 1,000-hour pilot who has flown a turboprop

The program in Brisbane includes a Diamond DA40 fixed-base flight simulation training device.

Explosive Airline Fleet Growth



CIS = Commonwealth of Independent States
Note: Percentages for regions show cumulative average growth rate over 20 years.
Source: The Boeing Co.

Figure 1

for night freight operations going to that same right seat?" she said. "I believe so."

MPL Overview

After exhaustive analysis of the knowledge, skills and pilot operations required of first officers in large commercial jets, ICAO categorized them into nine broad competency units based on the work of the Flight Crew Licensing and Training Panel. Some states introducing the MPL will harmonize with ICAO requirements the details of their existing personnel licensing requirements. ICAO documents define and explain full details of the MPL requirements, including a first-class medical certificate, and the strict minimum training program for states to use as the basis for amending their aviation regulations.[4] ICAO requires in part that during a minimum of 240 actual and simulated flight hours as pilot flying and pilot monitoring, the candidate complete specified solo, cross country and night operations with at least 70 flight hours in an airplane; upset recovery training in an airplane; qualification for commercial jet operation under instrument flight rules; multi-crew certification; passing the state's airline transport pilot written examination; and a restricted type rating to captain-level proficiency, typically including 12 takeoffs and landings as pilot flying in the type-rating airplane.

For its MPL training in Brisbane, Alteon Training overlaid the competency units on existing regulations of the Civil Aviation Safety Authority of Australia (CASA), generating 465 subcompetencies, Bell said. The General Administration of Civil Aviation of China also is monitoring the training of the cadets for the Australian MPL and amending its regulations to add the MPL.

Progress in Brisbane

The training program by Alteon Training, a subsidiary of The Boeing Co., has been conducted with 12 cadets, the company said. China Eastern Airlines and Xiamen Airlines helped to select the first six, who began training in January 2007; the other cadets were selected by airlines in the Asia Pacific Region and began training in March 2007. As of mid-September 2007, each cadet had completed about 90 hours of flight as pilot flying, simultaneously accumulating about 120 hours of crew experience.

"ICAO calls for a very strict instructional systems design [for the MPL, and we] developed this training program in partnership with [Jeppesen] because their expertise was in instructional systems design as well as training materials development," Bell said. "As we developed the training program and training materials, we shared them with the industry, sought [outside specialists'] feedback and used that to shape our training program, which is now in the validation stage. We made the promise that we would show them what we are doing and involve them along the steps [in] developing and implementing the training program."

For the test, the MPL cadets completed the same commercial pilot ground school required of other Australian pilots in training because amendments to regulations had not been made for most of 2007. "So our cadets in the … test have already [taken] the five commercial pilot written tests that are standard for [the Australian commercial pilot license]," Bell said. By the time that cadets complete the MPL training they also will have taken the airline transport pilot written test.

The tools and methods used in Brisbane differ from conventional training in several respects, including the focus on conducting flights as a crew, following airline procedures and documents, applying TEM to normal and abnormal operations, and extensive use of several advanced-technology flight training devices and simulators from the outset. Bell described a few of the characteristic activities.

"Each flight lesson starts with an orientation to the flight deck and provides opportunities for the cadets to 'chair-fly' that training while using their laptop computers or a desktop trainer," Bell said. "They next have that same lesson take place in a fixed-base device … with fully collimated daylight visual so that both pilots have the same frame of reference." In each lesson, cadets rotate through the roles of pilot monitoring, pilot flying and pilot observing, with the last role functioning as a safety officer employing TEM during crew briefing and debriefing. A two-person crew then conducts the flight lesson in a Diamond DA40 single-engine airplane with the instructor and the pilot flying at the controls and the pilot monitoring performing duties typical for an airline first officer.

"Once the primary training is completed, they will move into the multi-engine [simulator] platform, and for our beta test that is going to be a Boeing 737NG because the cadets ultimately will return to their airlines and fly the 737NG," Bell said. "Because it is fixed-base device, we can manage the workload, and gradually move from basic multi-engine operations into the full complexity of the 737NG cockpit. As we move into the type-rating portion of the program, we will move into the [737NG] full flight simulator."

Before flight training lessons, the cadets review their airline's flight operations manual, flight crew operations manual and scan-flow diagrams. "The cadets are learning, even in the DA40, the discipline and the method that they will employ when they are flying the line," Bell said. Written assessments of knowledge, proficiency and TEM skills follow every lesson. Total hours for some stages of flight training in Brisbane appear similar to conventional *ab initio* training but are conducted differently. "Our multi-engine [training] all takes place in a simulator, but it is about four times the number of hours in that environment than a pilot normally would have under traditional training methods," Bell said. The MPL holder also will have experienced about 300 crew missions, compared with fewer than 50 crew missions in conventional programs, she said.

The test so far shows that the cadets habitually apply TEM and CRM skills in the airplane environment, that video debriefing systems in simulators and in the DA40 enhance crew self-critiques and help standardize instructor training delivery, and that materials have received "high marks" from visitors representing the stakeholder organizations, she said.

Policy Challenges

Near-term challenges for regulators, training organizations and airlines working to implement the MPL typically involve technical details — for example, modifying/approving airline indoctrination and initial operating experience — and augmenting resources, such as adding instructors qualified to conduct crew training at the primary level and multi-crew certification, airline operating procedures, and suitable airplanes and synthetic training devices equipped with "glass" instruments. States also implement MPL oversight by an industry advisory board.

ICAO's proof-of-concept monitoring of de-identified data about the performance of each MPL holder will "help validate the training and [identify] where there might have been gaps in the training," Bell said. The Flight Crew Licensing and Training Panel was disbanded in 2006, but IATA has assigned a task force to harmonize efforts in global implementation of the MPL, including "go team" technical consultations with states, airlines, training organizations and pilot organizations, and an MPL instructor training and standardization guide. The initial focus of the task force has been the Asia Pacific Region, and the Association of Asia Pacific Airlines convened MPL symposiums during 2007.

While considering the MPL, Alteon Training found that the alternative conventional training to prepare an airline first officer in the Asia Pacific Region typically involves a two- to three-year training program, from the *ab initio* stage through flight training in as many as four different airplane models before pilots are introduced to the type-rating airplane. The Alteon Training MPL program in Brisbane comprises 308 training days. "Most countries might benefit from an MPL that replaces the training program they have now," Bell said.●

Notes

1. ICAO, which added the MPL to Annex 1, *Personnel Licensing,* effective Nov. 23, 2006, has characterized this change as the most comprehensive revision in airline pilot training since the annex first came into use in 1948.
2. EASA. Joint Aviation Requirements JAR–FCL 1, *Flight Crew Licensing (Aeroplane).* Subpart K, "Multi-Crew Pilot Licence (Aeroplane)–MPL(A)." Dec. 1, 2006.
3. CASA. "Project FS 06/02, Multi-Crew Pilot Licensing (MPL)." <www.casa.gov.au/newrules/parts/061/fs0602.asp>. Pending completion of the new Civil Aviation Safety Regulations Part 61, *Flight Crew Licensing,* CASA has a project under way to provide regulatory cover (authorization) for the issuance of an MPL by amending 1988 Civil Aviation Regulations Part 5, *Qualifications of Flight Crew.*
4. ICAO documents that explain the MPL include Doc 9868, *Procedures for Air Navigation Services–Training,* first edition 2006, and the 10th edition of Annex 1, *Personnel Licensing,* published in July 2006.

U.S. Customs and Border Protection

Reining in the UAs

BY LINDA WERFELMAN

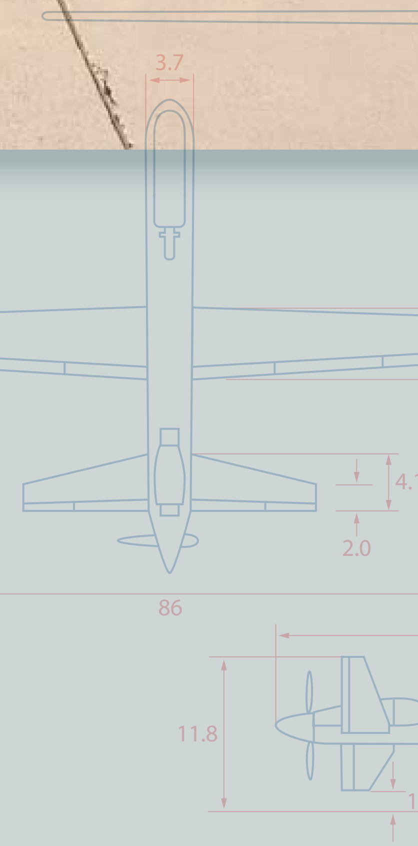
The NTSB says the requirements for unmanned aircraft should be just as stringent as those for manned aircraft.

The first investigation by the U.S. National Transportation Safety Board (NTSB) of a crash involving an unmanned aircraft (UA) produced 22 safety recommendations — an action that NTSB Chairman Mark V. Rosenker says illustrates the scope of the safety issues associated with UAs.

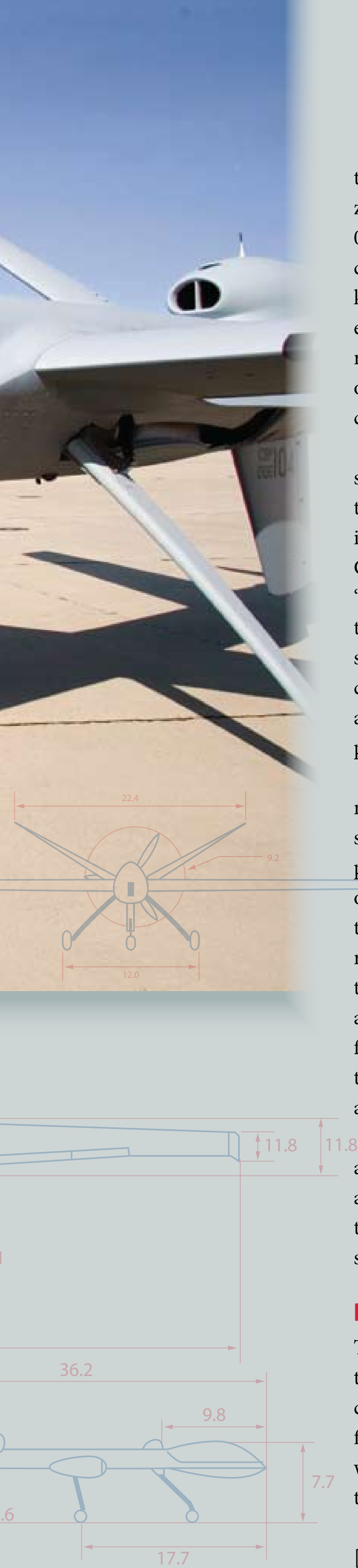
"This investigation has raised questions about the different standards for manned and unmanned aircraft and the safety implications of this discrepancy," Rosenker said.

Documents released after the final NTSB hearing on the April 25, 2006, crash of the General Atomics Aeronautical Systems (GA-ASI) Predator B indicated that the board was especially concerned about design and certification issues, pilot qualification and training, integration of unmanned aircraft systems (UASs)[1] into the air traffic management system and audio records of UAS communications.

The Predator B was owned by U.S. Customs and Border Protection (CBP) and operated as a public use aircraft. During the accident flight — conducted for surveillance of the U.S.-Mexican border — the Predator B was piloted via data link from a ground control station (GCS) at



U.S. National Aeronautics and Space Administration



the Libby Army Airfield in Sierra Vista, Arizona, U.S. The aircraft struck the ground about 0350 local time in night visual meteorological conditions in a remote area about 10 nm (19 km) northwest of Nogales International Airport, eight hours after takeoff on an instrument flight rules flight plan from the Army airfield. No one on the ground was injured in the crash, which caused substantial damage to the aircraft.

In the final report on the accident, the NTSB said the probable cause was "the pilot's failure to use checklist procedures" when switching operational control from a console at the GCS that had become inoperable because of a "lockup" condition. This resulted in the inadvertent shutoff of the Predator B's fuel valve and the subsequent loss of engine power. The report also cited the "lack of a flight instructor in the GCS, as required by the CBP's approval to allow the pilot to fly the Predator B."

The pilot was "not proficient in the performance of emergency procedures," the NTSB said, and Rosenker added, "The pilot is still the pilot, whether he [or she] is at a remote console or on the flight deck. We need to make sure that the system by which pilots are trained and readied for flight is rigorous and thorough. With the potential for thousands of these unmanned aircraft in use years from now, the standards for pilot training need to be set high to ensure that those on the ground and other users of the airspace are not put in jeopardy."

The report identified factors in the accident as "repeated and unresolved console lockups, inadequate maintenance procedures performed by the manufacturer and the operator's inadequate surveillance of the UAS program."

Different Functions

The GCS where the pilot was stationed contained two pilot payload operator (PPO) consoles designated as PPO-1 and PPO-2; their functions differed, depending on whether they were being used to control the UA or the camera that it carried.

"When PPO-1 controls the UA, movement [of] the condition lever to the forward position opens the fuel valve to the engine; movement to the middle position closes the fuel valve to the engine, which shuts down the engine; and movement to the aft position causes the propeller to feather," the report said. "When the UA is controlled by PPO-1, the condition lever at the PPO-2 console controls the camera's iris setting. Moving the lever forward increases the iris opening, moving the lever to the middle position locks the camera's iris setting, and moving the lever aft decreases the opening. Typically, the lever is set in the middle position" (Figure 1, p. 44).

Usually, a pilot controls the UA from PPO-1 and a payload operator controls the UA's camera from PPO-2. During the accident flight, however, technical problems involving PPO-1 prompted the pilot to switch control of the UA to PPO-2 soon after 0300. He told the CBP agent who had been operating PPO-2 that they needed to switch positions, and the agent left the GCS.

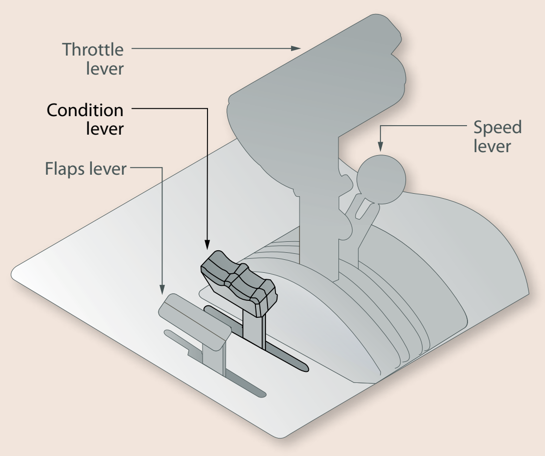
"The pilot stated that he verified the ignition was 'hot' on PPO-2 and that the stability augmentation system was on," the report said. "He reported that at some point, he used his cell phone to call another pilot (who had been his instructor) to discuss what was going on. At the time, the instructor was in a hangar building across the ramp."

Checklist procedures call for pilots to be at both PPO-1 and PPO-2 before control of the UA is switched from one console to the other. CBP procedures are for an avionics technician to work as copilot to help with checklist items before switching from one console to the other. In this instance, the procedures were not followed, the report said.

The pilot told investigators that he did not use a checklist when switching consoles and that, because he had been in a hurry, he had not matched the control positions on the two consoles. When the switch was made, the condition lever on PPO-2 was in the fuel-cutoff position; as a result, the transfer of control to PPO-2 resulted in a cutoff of fuel.

"The pilot stated that, after the switch to the PPO-2 console, he noticed that the UA was not maintaining altitude, but he did not know why," the report said. He did not immediately notice

Location of Condition Lever



Source: U.S. National Transportation Safety Board

Figure 1

that the PPO-2 condition lever was in the fuel-cutoff position.

The pilot said that he shut down the ground data terminal — an action that should have begun the "lost-link" procedure, in which the UA autonomously climbs and flies a predetermined course until the data link is reestablished. Instead, the UA descended below line-of-sight communications, and contact could not be reestablished. Without electrical power from the engine, the UA began operating on battery power — thereby eliminating power to the transponder and preventing air traffic control (ATC) from detecting a Mode C transponder return on radar.

The instructor pilot entered the GCS soon after the ground data terminal was shut off, and observed that the controls were positioned incorrectly, but he was unable to reestablish remote control of the Predator B because the aircraft was too low.

The pilot had been in contact with the Albuquerque (New Mexico, U.S.) Air Route Traffic Control Center, and an air traffic controller told the pilot about 0340 that radar contact with the UA had been lost; at the same time, the controller blocked the airspace from the surface to 15,000 ft. Seconds later, the pilot told the controller that the data link had been lost. Neither the pilot nor the controller declared mayday, although ATC considered the loss of radar contact and radio communication an emergency.

UA Flight Time

The accident pilot was employed by the Predator B's manufacturer, GA-ASI. He held a commercial pilot certificate with ratings for single-engine land, multi-engine land and instrument flight; a flight instructor certificate with the same ratings; an advanced ground instructor certificate; and a first-class medical certificate.

He had 3,571 flight hours, including 519 flight hours associated with the Predator A and 27 flight hours with the Predator B, of which five hours were training flights. A key difference between the two models is that control consoles for Predator A do not have condition levers that must be matched up between PPO-1 and PPO-2 when switching from one console to the other.

At the time of the accident, CBP required 200 flight hours in manned aircraft and 200 flight hours in UASs; the agency did not require type-specific training. CBP also required that pilots be certified by GA-ASI as "fully capable of maintaining and operating the Predator B UA and its associated equipment." Training was conducted by GA-ASI in accordance with a syllabus that had been approved for pilots who would operate the CBP UAS for the U.S. Air Force.

Forms filed with the U.S. Department of Defense and Air Force forms documented the accident pilot's training: In February 2006, the Air Force government flight representative (GFR) approved the start of training; in March 2006, the pilot completed training; and in May 2006 — after the accident — the GFR disapproved his request to serve as a Predator B pilot because he "had not completed some training modules," the report said.

"According to CBP, GA-ASI contacted their person who was being trained as a GFR and requested that the accident pilot be added to CBP's approved pilot list before the Air Force GFR approval," the report said. "CBP stated that their GFR trainee gave GA-ASI a verbal approval so that the pilot could operate the CBP UAS but only when an instructor pilot was physically present in the GCS. This verbal approval was not standard practice for CBP."

During the accident flight, pilots operated the UA in two-hour shifts. The accident pilot had flown from 1900 to 2100 on April 24 and took the controls again at 0300 April 25.

14-Hour Missions

The accident aircraft typically was flown on 14-hour missions four days a week and on a shorter mission on a fifth day.

The report said the CBP was, at the time of the accident, "unable to certify to the [U.S. Federal Aviation Administration (FAA)] that [the aircraft] was airworthy. Because of national security issues and past experience with similar UAs, the FAA temporarily waived this requirement for the issuance of the certificate [of] authorization to operate in the national airspace system."

The accident flight had been delayed by difficulty in establishing a data link between the UA and PPO-1 during the initial power-up. The report said that at the time, the avionics technician did not attempt to establish a data link with PPO-2. He told investigators that he contacted his supervisor and technical support personnel, who said that they "had not seen this type of problem before" and suggested that he switch the main processor cards on PPO-1 and PPO-2. After doing so, he was able to establish uplinks on both consoles, the report said. The technician said that he switched the cards rather than replacing the card in PPO-1 because very few spare parts had been purchased with the UAS.

Investigators found that numerous console lockups had occurred since the UAS began operations; during the three months preceding the accident, there were nine lockups, including two before takeoff on the accident flight. The report said, "Troubleshooting before and after the accident did not determine the cause of the lockups."

Emergency Procedures

Citing concerns that "deficiencies exist in various aspects of … ATC and air traffic management of UASs in the [national airspace]," the NTSB addressed five of its 22 safety recommendations to Acting FAA Administrator Robert A. Sturgell.

Those recommendations included a call for the procedures already in place for "piloted-aircraft emergencies" to also be applied to UAS emergencies. The FAA also should require operators of all UASs to file written reports with the FAA within 30 days of all "incidents and malfunctions that affect safety"; to analyze incident and malfunction data "in an effort to improve safety"; and to evaluate the data "to determine whether programs and procedures … remain effective in mitigating safety risks."

The NTSB also recommended that the FAA require UAs to have operating transponders providing altitude information "at all times while

Predator B

U.S. National Aeronautics and Space Administration

The Predator B — designed for long-endurance, high-altitude unmanned flights for surveillance, scientific research and other uses — was developed in 2000 by General Atomics Aeronautical Systems and first flown in 2001. The Predator B is longer and heavier than its predecessor, the Predator A, and has a more complex engine and engine controls. It also is able to fly twice as high and twice as fast, and to carry loads five times heavier.

The Predator B is 36 ft (11 m) long with a wingspan of 66 ft (20 m) and has a Honeywell TPE 331-10T engine mounted at the rear of the fuselage. The composite fuselage incorporates impregnated graphite skin and Nomex honeycomb panels. Maximum gross takeoff weight is 10,500 lb (4,763 kg), with an internal payload capacity of 850 lb (386 kg), an external payload capacity of 3,000 lb (1,361 kg) — carried in six wing stations — and fuel capacity of 4,000 lb (1,814 kg). The Predator B can be remotely piloted or fully autonomous.

It can be operated at maximum altitudes of 50,000 ft, with maximum endurance of more than 30 hours and maximum airspeeds of more than 240 kt.

Source: General Atomics Aeronautical Systems, U.S. National Transportation Safety Board airborne," require that all conversations involving UA pilots be recorded and retained in accordance with existing U.S. Federal Aviation Regulations, and require periodic operational reviews between UAS operational personnel and ATC facilities. These operational reviews should include discussion of lost-data-link procedures and the unique emergencies associated with UAs, the NTSB said.

In 17 recommendations to the CBP, the NTSB cited "ineffective and inadequate safety controls" that had been identified during the accident investigation and expressed concern that "the CBP operation may lack an effective plan to control safety risks in the future."

"The CBP must develop an operational safety plan using a methodical system safety process," the safety recommendation letter said. "This process could help the CBP address the widespread deficiencies noted in this investigation, as well as other presently unmitigated safety risks. It also could ensure development of a suitable monitoring program that tracks and analyzes malfunctions and incidents and incorporates lessons learned from other operators of similar UASs. This monitoring program could ensure that the safety plan remains effective throughout the UAS's life cycle."

After the accident, the CBP "performed a program review and developed policies, procedures and training that provide much stronger operational control and safety oversight of its UAS program," the NTSB said in the letter, addressed to CBP Commissioner W. Ralph Basham. Nevertheless, the NTSB said that deficiencies remained "in the design, operation and safety management" of the CBP UAS program and in the CBP's coordination of activities with ATC.

"The reasons for console lockups are varied, and when a lockup occurs, the cues may not be readily apparent to the pilot," the letter said. "The system does not diagnose the nature, cause or extent of a lockup and does not display a fault message to the pilot. … In the event of a lockup, the pilot may become aware of the problem because some parameters are not updating as frequently as expected or all visual cues may freeze."

The safety recommendations included a call for the CBP to require GA-ASI to modify the UAS "to ensure that inadvertent engine shutdowns do not occur" and to "provide adequate visual and aural indications of safety-critical faults, such as engine-out conditions and console lockups and present them in order of priority, based on the urgency for pilot awareness and response."

The NTSB criticized existing procedures to be followed in the event of a lost data link between the UA and a GCS because they are based on the assumption that the UA would continue on a predetermined course until the data link was reestablished or the UA ran out of fuel and crashed. NTSB recommendations called for developing predetermined courses that "minimize the potential safety impact to persons on the ground, optimize the ability to recover the data link and, in the absence of data-link recovery, provide the capability to proceed to a safe zone for a crash landing."

Other safety recommendations to the CBP included the following:

- Require modifications in the UAS to ensure continued transponder operation after an in-flight engine shutdown;
- Develop a method of restarting a UA engine — for use during lost-data-link emergency procedures — that does not rely on line-of-sight data-link control;
- Implement a documented maintenance and inspection program that "identifies, tracks and resolves the root cause of systemic deficiencies and that includes steps for in-depth troubleshooting, repair and verification of functionality before returning [a UA] to service";
- Develop minimum equipment lists and dispatch deviation guides for UASs, and evaluate spare-parts requirements to ensure that critical parts will be available;
- Revise the pilot-training program to ensure pilot proficiency in emergency procedures;
- Require that a backup pilot or someone else "who can provide an equivalent level of safety" be readily available during UA operations; and,
- Develop a safety plan to identify risks presented by UAs to other aircraft and to people on the ground and take the actions required to mitigate those risks. ●

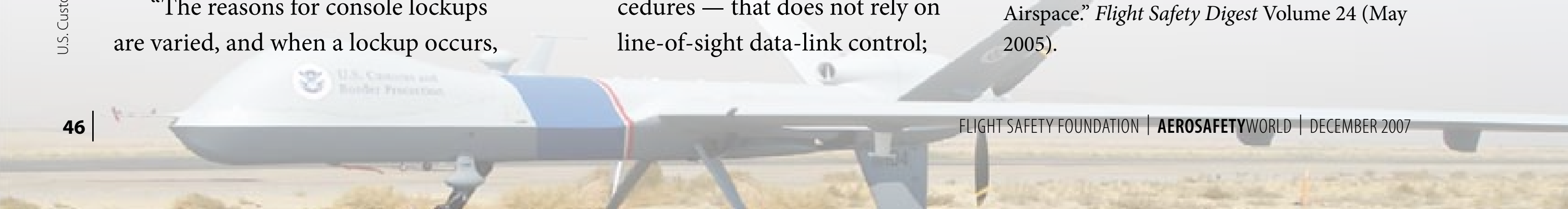
This article is based on NTSB accident report CHI06MA121 and related documents, including NTSB safety recommendations A-07-65 through A-07-86.

Note

1. An *unmanned aircraft (UA)* refers to an aircraft designed to operate without a human pilot aboard. An *unmanned aircraft system (UAS)* refers not only to the aircraft but also to the supporting system — such as a console operated by a ground-based pilot — that enables its flight. UAs and UASs also are, or have been, known by other names, including "unmanned aerial vehicles," "remotely operated aircraft" and "remotely piloted vehicles."

Further Reading From FSF Publications

FSF Editorial Staff. "See What's Sharing Your Airspace." *Flight Safety Digest* Volume 24 (May 2005).



U.S. Customs and Border Protection

© Corbis

COCKPIT Discipline

Violating the 'sterile cockpit' rule and ignoring other standard operating procedures can lead to tragedy.

BY ROBERT BARON

Nonadherence to standard operating procedures and violations of the "sterile cockpit rule" are becoming too frequent, often with tragic results.

A textbook example was the Oct. 19, 2004, crash of a Corporate Airlines Jetstream 32, which struck trees and the ground short of Runway 36 at Kirksville (Missouri, U.S.) Regional Airport after a flight from St. Louis. The airplane was destroyed; 11 passengers and both pilots were killed, and two other passengers were seriously injured.

The U.S. National Transportation Safety Board (NTSB) said, in its final report, that the probable cause of the accident was "the pilots' failure to follow established procedures and properly conduct a nonprecision instrument approach at night in IMC [instrument meteorological conditions] … and their failure to adhere to the established division of duties between the flying and nonflying (monitoring) pilot."[1]

Contributing factors included the pilots' failure to make standard callouts. The report also said that their "unprofessional behavior … and their fatigue likely contributed to their degraded performance."

The cockpit voice recorder (CVR) transcript reveals two pilots who were so comfortable working together that their conversations were personal and humorous — and clearly not in compliance with the U.S. Federal Aviation Administration's (FAA's) "sterile cockpit rule," which prohibits nonessential communication during critical phases of flight, including operations below 10,000 ft.

Why pilots routinely violate this rule is not difficult to figure out. First, pilots understand that a CVR records over itself every 30 minutes (longer, in the case of some new CVRs) and typically is not heard or transcribed unless there is an accident. Because the probability of an accident is low, pilots are confident that whatever is recorded on the

InSight is a forum for expressing personal opinions about issues of importance to aviation safety and for stimulating constructive discussion, pro and con, about the expressed opinions. Send your comments to J.A. Donoghue, director of publications, Flight Safety Foundation, 601 Madison St., Suite 300, Alexandria VA 22314-1756 USA or donoghue@flightsafety.org.

CVR will not be heard by anyone else. Second, it is easy to forget that cockpit conversations are being recorded. A CVR is out of sight and out of mind. This "what's said in the cockpit stays in the cockpit" mentality can lead to a temptation to continue nonessential conversations below 10,000 ft. Third, the fact that no one is in the cockpit to enforce the sterile cockpit rule leaves pilots to decide for themselves whether to comply. The low probability of disciplinary action plays into the mix.

The CVR transcript of the accident flight shows that, on the accident leg, the captain was the pilot flying, and the first officer was the pilot not flying (pilot monitoring). The first officer's duties included monitoring the captain's overall performance and making proper callouts as specified by the company's standard operating procedures (SOPs). However, the crew's joking, nonessential conversations continued until just a few minutes before impact with the ground.

For example, the accident report quoted the captain — at 1910 local time, about 27 minutes before the accident — as saying, "Gotta have fun" and criticizing other first officers he had flown with for being too serious.

"Too many of these [expletive] take themselves way too serious, in this job," he said. "I hate it, I've flown with them and it sucks. A month of [expletive] agony. … All you wanna do is strangle the [expletive] when you get on the ground."

As the airplane descended into the clouds, the CVR recorded the captain saying, "We're going into the crap. Look, ooh, it's so eerie and creepy … get a suffocating feeling when I see that." The first officer made a barking sound followed by a groan.

About 1925, the CVR recorded a yawn from the first officer, who then said, "They have a VASI [visual approach slope indicator] on the left hand side." The captain responded, "Yeah. Wish we had an ILS [instrument landing system] on the front side."

The CVR recording showed that both accident pilots deviated numerous times from SOPs — which become increasingly critical as an aircraft gets closer to the ground, especially in IMC or at night. The following are examples from the accident report:

- The first officer did not call out "100 feet above minimums."
- As the aircraft continued its descent below the minimum descent altitude, the pilot flying said, "I can see ground there" and "what do you think?" Contrary to procedures and training, the pilot flying was looking for external visual references during the approach rather than leveling off and monitoring the flight instruments.
- After the pilot flying said he saw the ground, the pilot not flying said, "I can't see [expletive]." Consistent with procedures, the pilot not flying was looking for pertinent ground references. However, he did not challenge the continued descent by the pilot flying.
- Company procedures called for descent rates of no more than 900 fpm below 300 ft above ground level (AGL). The accident airplane's descent rate was consistently about 1,200 fpm until immediately before it struck the trees. The first officer failed to challenge the rate of descent.

Making standard callouts can be difficult for a first officer, even in a disciplined cockpit setting. A 1994 study found that more than 80 percent of flight-crew-involved major accidents involving U.S. air carriers occurred when the captain was the flying pilot.[2] The study also found that a frequent factor in accidents involving pilot error was the failure of the first officer to challenge errors made by a flying captain.

Although other factors played a role in the accident, the mismanaged cockpit no doubt contributed to the inability of the crew to at least mitigate some of these factors. For example, fatigue could have been at least partially offset by compliance with SOPs.

Further, SOPs are critical to the safety of flight, and both pilots must understand what is expected of them and comply with the procedures. CRM (crew resource management) training addresses these issues with the hope that pilots will abide by the rules and procedures, and most important, use their best judgment in the practical environment. In this instance, however, the crew's behavior contradicted the principles of CRM. This was a fatal error.●

Robert Baron is president of The Aviation Consulting Group, which specializes in human factors and safety management system consulting, training and research. He has assisted many airlines and air charter operations in development and implementation of crew resource management programs.

Notes

1. NTSB. *Collision With Trees and Crash Short of the Runway, Corporate Airlines Flight 5966, BAE Systems BAE-J3201, N875JX, Kirksville, Missouri, October 19, 2004.* Aircraft Accident Report. NTSB/AAR-06/01.
2. NTSB. *A Review of Flightcrew-Involved, Major Accidents of U.S. Air Carriers, 1978 Through 1990*, Safety Study NTSB/SS-94/01. Washington, D.C. 1994. Cited in NTSB, *Collision With Trees and Crash Short of the Runway, Corporate Airlines Flight 5966, BAE Systems BAE-J3201, N875JX, Kirksville, Missouri, October 19, 2004.*

A Statistical Fluke

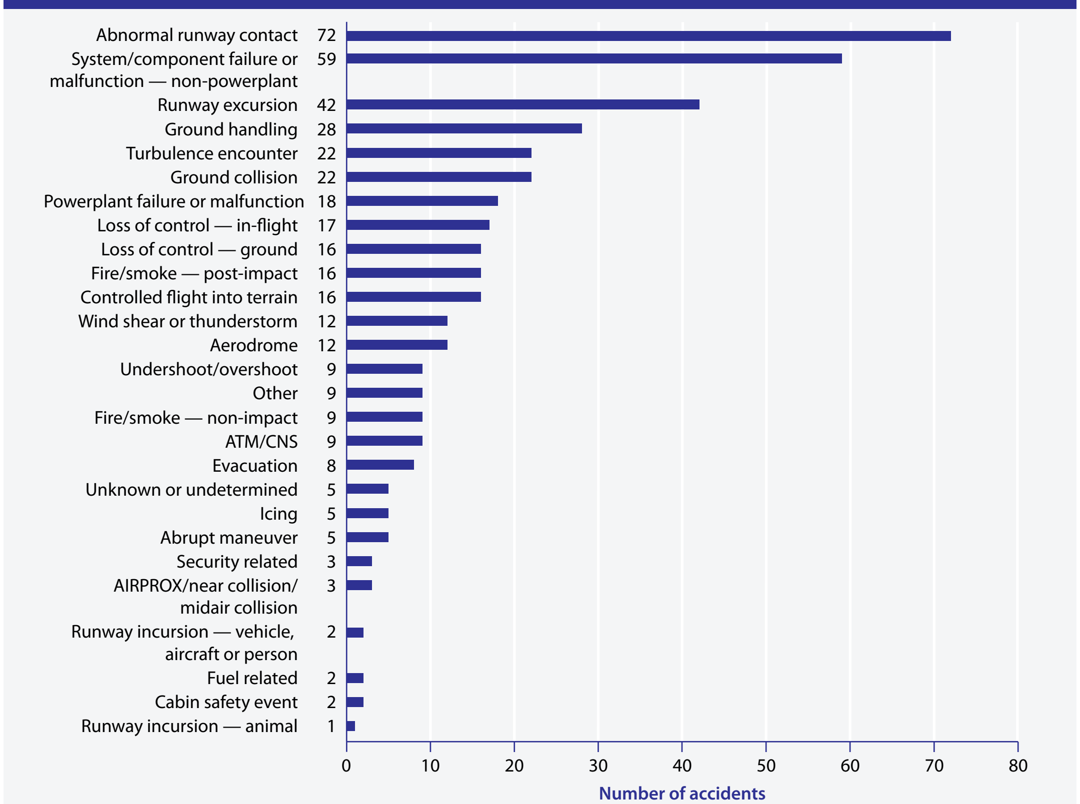
A non-Europe-based airline's accident in Russia raised the number of 'European' fatalities for 2006 because of the state of registration.

BY RICK DARBY

"European aviation safety performance is high, although the number of fatal accidents slightly increased since 2004," the European Aviation Safety Agency (EASA) says in its 2006 annual safety review.[1] "This review also shows that Europe's accident improvement rates are lower than in the rest of the world."[2]

European Accident Categories, 1997–2006

Accidents involving aircraft registered in EASA member states, used in public transport operations or general aviation, turbine powered airplanes, over 5,700 kg/12,500 lb



ATM/CNS = air traffic management/communications, navigation, surveillance; MTOW = maximum certificated takeoff weight

Note: Accidents could involve multiple categories.

Source: EASA

Figure 1

Although the top three categories were the same for "foreign" airplanes — those not registered in one of the EU states — the order was different.

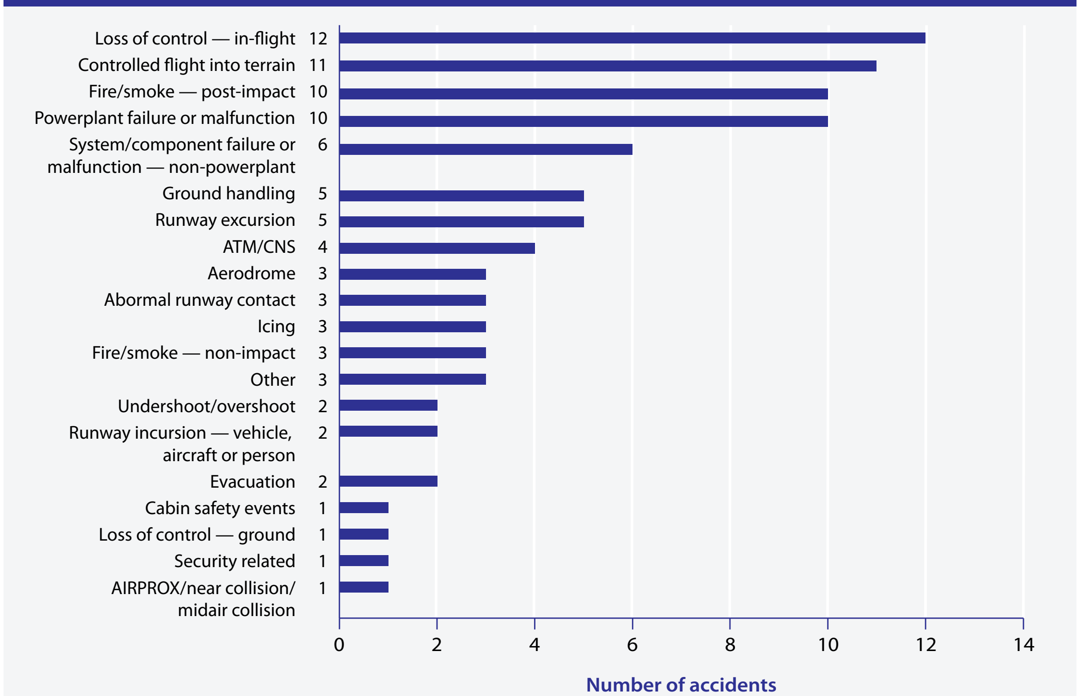
In 2006, six fatal accidents involving airplanes in public transport operations occurred in Europe, compared with five in 2005 and two in 2004.[3] "However, the number [for 2006] is equal to the average of fatal accidents for the decade 1997–2006," the review says.

The number of on-board fatalities increased from 127 in 2005 to 147 in 2006, above the average for the 1997–2006 decade (105.3). But the apparent increase in fatalities for 2006 was the result of a technicality involving a single accident, the landing overrun of an Airbus A310 in Irkutsk, Russia, with 126 fatalities. The circumstances were unusual for Europe because the airplane was registered in an EASA member state, France, but was operated by Sibir Airlines, based in Russia, a non-member state.

The review analyzes accident categories for EASA member states over a 10-year period based on the CAST-ICAO (U.S. Commercial Aviation Safety Team-International Civil Aviation Organization) taxonomy.[4] Figure 1 (p. 49) shows the numbers of accidents by category for 1997 through 2006. "Abnormal runway contact," "system/component failure or malfunction, non-powerplant" and "runway excursion" were the three most frequent categories. Although the top three categories were the same for "foreign" airplanes — those not registered in one of the EU states — the order was different: "Runway excursion" was the category with the largest number, followed by "abnormal runway contact" and "system/component failure or malfunction, non-powerplant."

European Fatal Accident Categories, 1997–2006

Fatal accidents involving aircraft registered in EASA member states, used in public transport operations or general aviation turbine powered airplanes, 5,700 kg/12,500 lb MTOW



ATM/CNS = air traffic management/communications, navigation, surveillance; MTOW = maximum certificated takeoff weight

Note: Accidents could involve multiple categories.

Source: EASA

Figure 2

For fatal accidents (Figure 2), "loss of control in flight" and "controlled flight into terrain" were the two predominant categories, consistent with worldwide data for large commercial jets published by Boeing Commercial Airplanes.

For public transport operations from 2000 through 2006, the three most significant accident categories by rate were "controlled flight into terrain" (Figure 3), "loss of control in flight" (Figure 4) and "accidents related to aircraft/aircraft systems or aircraft engine failures" (Figure 5, p. 52).

European public transport helicopter operations resulted in 18 accidents, six of them fatal, in 2006 (Figure 6, p. 52). More than half of the 20 fatalities occurred in two accidents, one in an offshore operation and one in a positioning flight.

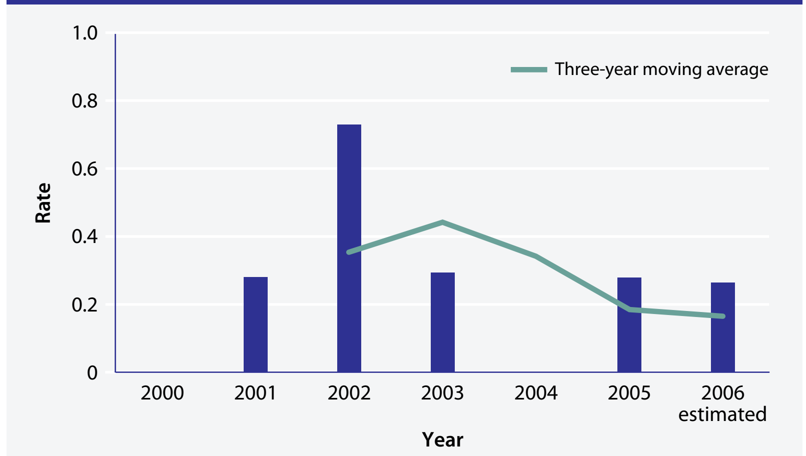
The review analyzed the dominant CAST-ICAO accident categories for European-registered large aircraft — greater than 5,700 kg/12,500 lb — in terms of numbers of fatalities for the 1997–2006 period. The largest number of fatalities, 386, was associated with "system/component failure or malfunction — non-powerplant." The second largest number of fatalities, 338, involved "fire/smoke — non-impact."

"Fire/smoke — post-impact" ranked third, with 303 associated fatalities, followed by "aerodrome," with 239 fatalities.

Once again, however, the perennial problem of small numbers in aviation fatal accident statistics can give a misleading picture. "As only [a] few accidents with a large number of fatalities occur with European-registered aircraft, a single accident can influence the order of the categories," the review says. "The large number of fatalities related to the category of non-impact fires is the result of two accidents: Swissair MD-11 (1998) and the Air France Concorde (2000). Both accidents also account for almost all of the fatalities in the 'system and component failure or malfunction — non-powerplant' category."

European Controlled Flight Into Terrain Accidents, 2000–2006

Rate per million departures of fatal accidents, airplanes over 2,250 kg/5,000 lb MTOW, registered in Europe, public transport operations



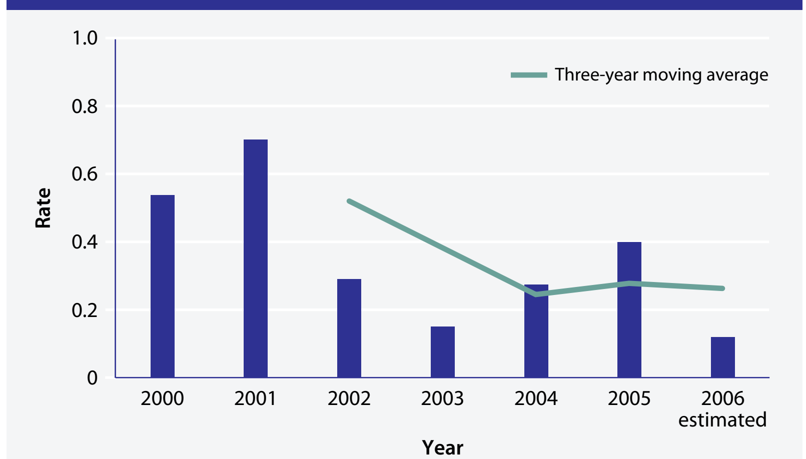
MTOW = maximum certificated takeoff weight

Source: EASA

Figure 3

European Loss of Control in Flight Accidents, 2000–2006

Rate per million departures of fatal accidents, airplanes over 2,250 kg/5,000 lb MTOW, registered in Europe, public transport operations



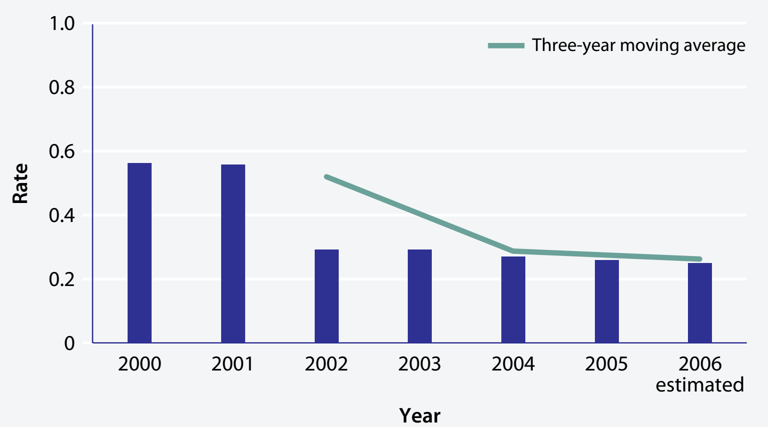
MTOW = maximum certificated takeoff weight

Source: EASA

Figure 4

European Accidents, Aircraft Systems/ Components/Engine Failures, 2000–2006

Rate per million departures of fatal accidents, airplanes over 2,250 kg/5,000 lb MTOW, registered in Europe, public transport operations



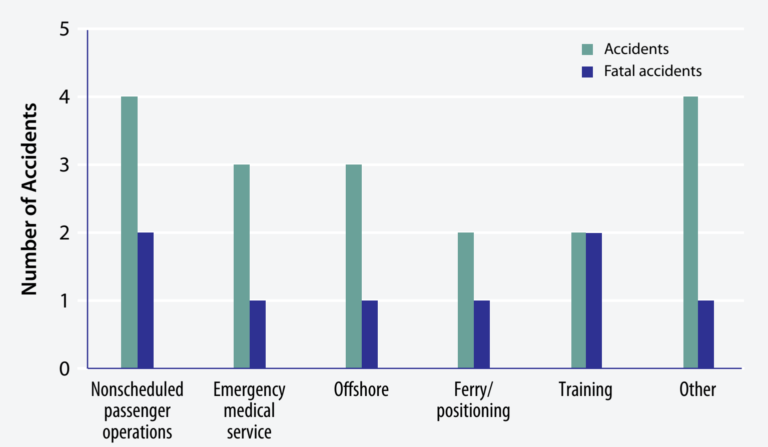
MTOW = maximum certificated takeoff weight

Source: EASA

Figure 5

European Public Transport Helicopter Accidents, 2006

Accidents and fatal accidents per type of public transport operation, helicopters, registered in EASA member states



Source: EASA

Figure 6

The unusually high ranking for "aerodrome" was similarly brought about by two major accidents: at Milan, Italy, in 2001 involving an SAS MD-80, resulting in 137 fatalities, and the Concorde accident, resulting in 162 fatalities.

For non-EASA member state large aircraft, the greater number of fatal accidents over the 10-year period produced a distribution more in line with expectations. "Controlled flight into terrain" produced the largest number of fatalities, 2,763. "Loss of control in flight" ranked second, with 2,573 associated fatalities.

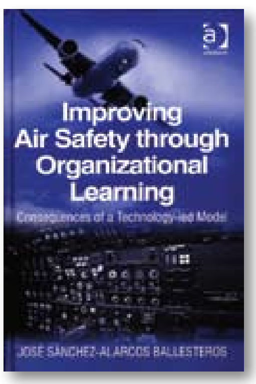
"The data show that the safety level of European aviation is high and that there is a trend towards continuing improvement," the review says. "Nevertheless, there are concerns: Improvement rates are lower than in the rest of the world, there is a persistent [although] low number of accidents and some accident categories are almost exclusively dominated by accidents of European aircraft." ●

Notes

1. EASA. *Annual Safety Review 2006*. The review in portable document format (PDF) can be accessed via the Internet through a link on the EASA home page, <www.easa.europa.eu/home/index.html>.
2. The area considered to be Europe in this report comprises the 27 European Union (EU) member states plus EASA member states Iceland, Liechtenstein, Norway and Switzerland. The definition of Europe has been expanded since 2005 to include the four non-EU EASA members plus the recently added EU states Bulgaria and Romania.
3. Data are for airplanes with a maximum certificated takeoff weight exceeding 2,250 kg, considered equivalent to 5,000 lb.
4. For CAST-ICAO taxonomy analysis, data include accidents involving turbine-powered airplanes with a maximum certificated takeoff weight exceeding 5,700 kg, considered equivalent to 12,500 lb.

A NEW AVIATION SAFETY MODEL FOR 'Organizational Learning'

Aviation has been blessed with effective 'organizational learning' to reduce accidents, but increasing aviation complexity and the need for greater efficiency may call for new directions.



BOOKS

Improving Air Safety Through Organizational Learning: Consequences of a Technology-Led Model

Ballesteros, José Sánchez-Alarcos. Aldershot, England, and Burlington, Vermont, U.S.: Ashgate, 2007. 188 pp. Figures, references, index.

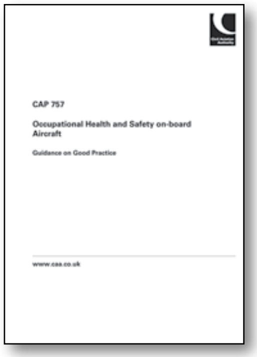
Sánchez-Alarcos, a non-professional pilot and business management consultant and teacher, says that aviation safety and business management models are essentially the same, except that aviation safety "has more pressure and, hence, it has been forced to advance further." In seeking to apply his insight to business management, he was surprised to find that the application of the aviation safety model to business management met a lukewarm reception, but he found an enthusiastic audience in aviation, including at an International Civil Aviation Organization meeting where he presented his main findings.

Aviation is a high-risk activity, he says — not statistically, but in the sense that "reliability is a more pressing problem than that of efficiency." The altitudes, speeds, routes, meteorological conditions and other factors involved in flying present risks that must be overcome by reliability.

The development of aviation risk management, which has driven significant improvement in accident rates, can be understood as a model of successful learning, Sánchez-Alarcos says. The model includes pressure from passengers, airlines and politicians, but aviation has been able to benefit from peripheral fields as well: "It has been possible to learn lessons from the military and space fields, useful for the design of new models of airplane, without incurring the costs and risks that a complete … development would represent." In addition, he says, aviation learning is spurred by the "fluidity" of information in the field, with the results of technical improvements and accident investigations widely and quickly distributed.

This benign model that has served the industry so well is nevertheless threatened to some degree by two factors, Sánchez-Alarcos says: the need for *efficiency* and an increase in *complexity*.

"Once an acceptable level of reliability is reached, the pressures toward increased efficiency in operations can impose themselves," he says. "As technology improves, the potential


CAP 757

Occupational Health and Safety on-board Aircraft

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for safety increases, but this isn't fully used for improvements in safety. The demands of efficiency, that is, improvements in speed, altitude, maneuverability, fuel consumption, reduction in training cycles and the possibility of operating in any meteorological conditions, among others, are present. These demands claim for themselves part or all of the new technological capacity."

The growing complexity of aviation technology involves the problem of systemic risk, he says. With each increase in complexity, the possibility of cascading failure looms larger: "Functionally unrelated systems can be physically close and interact in unforeseen ways." He cites several accidents:

- "The detachment of an engine in an American Airlines DC-10 caused the retraction of the surfaces that provide lift at low speeds and, hence, the destruction of the airplane;
- "A grave failure in the pressurization system in a Japan Airlines Boeing 747 caused the total loss of hydraulic fluid, resulting in losing control of the airplane;
- "An explosion in the tail engine of a DC-10 airplane caused the loss of the hydraulic systems, with loss of conventional control; [and,]
- "A blow-out of a tire was the cause of the accident of a Concorde in Paris. It led to an engine failure and the perforation of a fuel tank. Furthermore, the nebulized fuel escaping from the perforated tank was ignited by the afterburner, starting fire. Finally, the fire and a second engine failure led to the total destruction of the airplane."

Sánchez-Alarcos sees the current model for aviation risk management as having reached a point of diminishing returns, paradoxically in part because it has worked so well. Noting that, after a dramatic improvement, accident levels have remained low but not notably improving for many years, he says, "The experts in quality could explain very well the reduction in improvement levels: when a system has reached a high level of perfection, marginal improvement has a growing cost. If the level reached is considered satisfactory, there would be a clear justification to not incur ever-increasing costs."

Acknowledging that the current risk management model, based on technological and regulatory improvement, has been useful, Sánchez-Alarcos suspects that for further improvement it might be necessary to find an alternative system. "The current situation allows an easy analogy with the functioning of an engine," he says. "More power can be extracted from an engine by introducing a turbo-compressor and increasing pressure. When the overpressure is at its limits and even more power is wanted, the solution cannot consist of introducing even more pressure. Where safety is concerned, radical design changes are required, and this is the situation in commercial aviation."

The book examines how the learning model for aviation safety might evolve. Chapters include, "Explanation of the Reduction in the Rate of Learning in Complex Environments," "Organizational Learning in Air Safety: Lessons for the Future," "Meaning and Trust as Keys to Organizational Learning" and "The Future of Improvements in Air Safety."

REPORTS

Occupational Health and Safety On-Board Aircraft: Guidance on Good Practice

U.K. Civil Aviation Authority. Civil Aviation Publication (CAP) 757. August 2007. 36 pp. References. Available via the Internet at <www.caa.co.uk/docs/33/CAP 757.pdf> or from The Stationery Office.*

This updated CAP offers guidance to operators about protecting their on-board workforce, especially cabin crewmembers, from on-the-job injury. Chapters are devoted to "manual handling" — that is, manipulating objects by hand; "burns and scalds in the aircraft cabin”; “slips, trips and falls”; and “control of biohazards.”

“Although this guidance is primarily designed for large transport aircraft types, many of the principles contained within it are equally applicable to other types of aircraft,” the report says.

The most basic principles are included in a section titled “Overview of Risk Management.” Risk management involves two phases, the report says: risk assessment and risk prevention.

Risk assessment, the report says, entails asking questions such as:

- “What are the hazards that arise from the activity, location or task?
- “Who or what can be harmed and how? [and,]
- “Are the risks being adequately controlled? If not, what more needs to be done, by whom, and by when?”

Prevention is said to include:

- “Combating risks at [the] source;
- “Developing a coherent overall prevention policy which covers technology, organization of work, working conditions, social relationships and the influence of factors relating to the working environment; [and,]
- “Giving appropriate training and instructions to staff.”

Optical Radiation Transmittance of Aircraft Windscreens and Pilot Vision

Nakagawara, Van B.; Montgomery, Ron W.; Marshall, Wesley J. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-07/20. Final report. July 2007. 17 pp. Figures, references. Available via the Internet at <www.faa.gov/library/reports/medical/oamtechreports/index.cfm> or from the National Technical Information Service.**

Optical radiation, including ultraviolet and infrared as well as the visible light spectrum, can have acute and chronic effects on eye tissues if exposure exceeds the eye’s normal repair capabilities. Forms of possible degradation include conjunctivitis, which affects the eyelid membranes so that they become inflamed and cause discomfort; photokeratitis, an inflammation of the cornea tissue that results in an aversion to bright light, often accompanied by pain; and cataracts, a progressive clouding of the lens.

The FAA Civil Aerospace Medical Institute measured the transmittance properties of aircraft windscreens for both visible and invisible optical radiation. The sample windscreens included those made of multilayer composite — laminated — glass, from a McDonnell Douglas MD-88, an Airbus A320, a Boeing 727 and a 737, a Fokker 27, an ATR 42 and a Raytheon Hawker Horizon, and those of polycarbonate plastic, from a Beech Bonanza and a Cessna 182.

“This study found that, of the windscreens that were tested, the laminated glass commercial aircraft windscreens transmitted substantial UV [ultraviolet] radiation below 380 nm [nanometers], while the polycarbonate general aviation aircraft windscreens were more effective UV blockers,” says the report.

Both types of windscreens blocked most of the UV-B radiation, which is more harmful than UV-A. “On the other hand, since pilots are repeatedly exposed to higher levels of both UV-A and UV-B than those found at sea level, and for long periods, the cumulative effects of UV exposure are still of concern,” the report says. “For a pilot, hazardous exposure to naturally occurring UV and visible radiation is most likely to occur when flying over a thick cloud layer or a snow field with the sun at its zenith. Snow reflects 85 percent of visible and UV radiation, while clouds can reflect up to 80 percent.

“In such conditions, sunglasses with a closely fitting wrap-around frame design are best, since UV-blocking lenses are useless if radiation is allowed to enter the eye from the sides of the frame.”

WEB SITES

Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA), <www.bea-fr.org>

The BEA is responsible for technical investigations of civil aviation accidents and incidents occurring on French territory and represents France in investigations conducted abroad. Its Web site is accessible in three languages — French, English and Spanish — with some unique and some identical information in each language.

BEA's searchable accident reports database contains more than 1,250 reports of accidents that occurred between 1968 and the most recent 2007 updates. Most reports are in French, with a few in English. Translated reports are identified as such. Reports are full-text and may include color photographs and other figures.

Several full-text safety studies are available. Examples include "Study of GPS Events," "Sea Search Operations" and "Flight Data Recorder Read-Out: Technical and Regulatory Aspects."

Select air transport incident reports that involved French operators or occurred in France are presented with the intent of "help[ing] to draw lessons that can prevent similar future events from happening with, perhaps, more dramatic consequences," says the BEA.

The Web site also contains general aviation reports having significant safety implications, annual statistical reports, and the newsletter, *REC Info* (2001–2007), produced by REC (Recueil d'Evénements Confidentiel), the confidential event reporting system.

Australian Society of Air Safety Investigators (ASASI), <www.asasi.org>

ASASI was formed, according to its Web site, "to better serve and represent the views of air safety investigators in Australia." One of the organization's contributions to air safety is co-hosting the Australia and New Zealand Societies of Air Safety Investigators conference; see this month's Safety Calendar (p. 7), listing for May 30–June 1.

PowerPoint presentations and papers presented at these events, 1997–2007, are available online at no cost and may be downloaded or printed. Topics addressed include accident investigation, data recovery and analysis, communication, human factors training, threat and error management, and other safety issues. ●

Sources

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P.O. Box 29
Norwich NR3 1GN
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Internet: <www.tso.uk/bookshop>

** National Technical Information Service
5385 Port Royal Road
Springfield, VA 22151
Internet: <www.ntis.gov>

— Rick Darby and Patricia Setze

Mixed Mode Mishap

Landing was conducted with autopilot off, autothrottles on.

BY MARK LACAGNINA

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

JETS

No Guidance for Bounced Landing Recovery

Boeing 737-800. Substantial damage. No injuries.

Nighttime visual meteorological conditions (VMC) prevailed, with winds from 260 degrees at 4 kt, when the flight crew conducted a visual approach to Runway 24 at University Park Airport in State College, Pennsylvania, U.S., on Nov. 19, 2005. The captain used the "mixed-mode method of flight control," said the report by the U.S. National Transportation Safety Board (NTSB) — he disengaged the autopilot about 575 ft above ground level (AGL) but left the autothrottles engaged.

The flight crew said that they used flight management system vertical navigation guidance and the Runway 24 instrument landing system (ILS) as backups for the visual approach. After disengaging the autopilot, the captain observed that the airplane was "a little low" with reference to the ILS glideslope and increased the 737's pitch attitude. The autothrottle system commanded a thrust increase when airspeed decreased below 143 kt, the value selected on the mode control panel.

Nearing the runway, the captain observed that the airplane was "a little high" with reference to the precision approach path indicator (PAPI) lights. He disengaged the autothrottle system but did not move the throttle levers to idle when he began the landing flare about 30 ft AGL. Groundspeed was 132 kt when the airplane touched down on the 6,700-ft (2,042-m) runway.

The airplane bounced and became airborne. The captain moved the throttles to idle, which caused deployment of the speed brakes. He said that he then attempted to reduce the resulting high descent rate by "adding flare." Pitch attitude was 9.5 degrees nose-up, and peak vertical acceleration was 2.5 g — 2.5 times standard gravitational acceleration — when the 737 touched down again. The tail struck the runway, damaging the tail skid, several fuselage skin panels and some internal structural components. None of the 127 airplane occupants was injured.

The Boeing 737NG Flight Crew Training Manual (FCTM) recommends that, to recover from a bounced landing, the pilot flying should hold or re-establish a normal landing attitude and add thrust as necessary to control the rate of descent. "The FCTM also advises that thrust need not be added for a 'shallow skip or bounce'; however, if a 'high, hard bounce' occurs, the pilot should initiate a go-around," the report said.

The report noted that two months before the accident, NTSB recommended that the U.S.

Federal Aviation Administration (FAA) require commercial aircraft operators to incorporate bounced landing recovery techniques in their flight manuals and to include the techniques in initial and recurrent pilot training. The recommendation was generated by the investigation of a nonfatal ATR 72 bounced landing accident in San Juan, Puerto Rico, on May 9, 2004. In response to the recommendation, the FAA in June 2006 issued Safety Alert for Operators (SAFO) 06005, recommending that operators revise their manuals and training programs to include bounced landing recovery techniques. "The SAFO was not a requirement," the report said. "Rather, it was a recommendation." NTSB subsequently asked the FAA to survey operators to determine how many of them adopted the SAFO recommendations. At press time, the FAA had not responded to the request.

The report also noted that, in a 1996 FAA document titled *The Interfaces Between Flightcrews and Modern Flight Deck Systems*, a human factors (HF) team said that possible hazards of mixed-mode flight control operations include unintended mode or airplane configuration changes, inappropriate pitch or thrust applications and masking of flight path or energy trends (*Flight Safety Digest*, 9–10/1996). "Some operators [surveyed by the team] stated they expressly discouraged mixed-mode flying on some airplane types, while others generally encouraged its use as a means to retain manual skills proficiency while minimizing workload," the report said. "As a result of the study, the HF team recommended that the FAA require operator manuals and initial/recurrent qualification programs to provide clear and concise examples of circumstances in which the autopilot should be engaged, disengaged or used in a mode with greater or lesser authority … and appropriate combinations of automatic and manual flight path control — for example, autothrottles engaged with the autopilot off."

Possible hazards of mixed-mode flight control operations include unintended mode or airplane configuration changes, inappropriate pitch or thrust applications and masking of flight path or energy trends.

The 737 FCTM recommends that, except during takeoff and climb, the autothrottles be used only when the autopilot is engaged. The report said that the accident airplane operator's manuals contained no prohibition against mixed-mode operations or guidance for bounced landing recovery.

Based on the findings of the investigation, NTSB said that contributing factors were "the operator's failure to provide sufficient information on the use of autothrottles and bounced landing recovery techniques, along with the [FAA's] failure to require the inclusion of mixed-mode flight control guidance and bounced landing recovery techniques in operator pilot training programs and flight manuals." The probable cause of the accident was "the pilot's improper touchdown and recovery from a bounced landing," NTSB said.

Parking Brake Engaged on Approach

Airbus A319-100. Substantial damage. No injuries.

The first officer was the pilot flying the scheduled flight from London to Leeds–Bradford (England) Airport on Jan. 24, 2007. The airplane entered a snow shower when it descended below the clouds about 3,000 ft AGL during the approach to Runway 32. Winds were reported from 010 degrees at 14 kt, variable from 340 degrees to 050 degrees. However, weather conditions at the airport were changing, and air traffic control (ATC) issued five wind reports to the crew, said the report by the U.K. Air Accidents Investigation Branch (AAIB).

The report said that the commander likely focused his attention on the wind reports during the approach. "The commander stated that he had been involved in a previous landing at Leeds–Bradford in difficult wind conditions, which resulted in the use of a significant portion of the runway length, due to a tail wind," the report said.

The A319 was descending through 1,300 ft when the first officer called for full flaps. "Coincidentally, ATC transmitted a further wind check, and this was acknowledged by the commander," the report said. Meanwhile, the captain engaged the parking brake, instead of selecting full flaps. "The parking brake handle and flap selection lever are located on the aft section of the center pedestal," the report said. "The flap lever is moved fore and aft through the various flap position 'gates,' while the parking brake is selected by grasping the parking brake handle and rotating it clockwise. Despite these controls being of different shapes, requiring different methods of activation, their shapes allow both to be grasped in a similar manner prior to selection."

The report noted that the airplane's flight warning computer (FWC) was an earlier model that displays an amber "PARK BRK" indication on the electronic centralized aircraft monitor (ECAM) when the parking brake is engaged in flight. Later-model A319 FWCs also trigger the master caution light and an aural tone, and display a checklist item on the ECAM that advises the crew to disengage the parking brake.

A few seconds after calling for full flaps, the first officer noticed that the "FLAP 3" setting was still selected. He repeated the request, and the commander selected full flaps. Neither pilot noticed the "PARK BRK" indication on the ECAM.

"Immediately after touchdown, the flight crew noted that the brakes appeared to take effect immediately with a greater deceleration than usual," the report said. "After coming to a halt, the commander requested the first officer to apply the parking brake, but the first officer found it already set."

The crew thought that one tire on the main landing gear had deflated during the landing. However, aircraft rescue and fire fighting (ARFF) personnel notified the crew that all four main landing gear tires had deflated. The 53 passengers disembarked and were taken to the terminal by bus.

Wing Strikes Runway on Landing

Cessna Citation 560. Substantial damage. No injuries.

Five passengers were aboard the airplane for a charter flight from Chicago to Lakeland Airport near Woodruff, Wisconsin, U.S., the morning of Jan. 5, 2006. The airport was reporting 10 mi (16 km) visibility, a 1,300-ft overcast and winds from 350 degrees at 14 kt, gusting to 21 kt. The flight crew calculated a landing reference speed, VREF, of 101 kt, and the captain flew the localizer approach to Runway 36 at 110 kt, the NTSB report said.

The Citation encountered light rime icing conditions while descending from 4,500 ft to 2,600 ft, and the crew activated the deicing boots three times. According to the report, the airplane operating manual (AOM) says that small amounts of ice normally form on unprotected areas of the airplane and can cause about a 5-kt increase in stall speed. The AOM advises that approach speeds and landing reference speeds should be adjusted accordingly.

After descending below the clouds about 1,000 ft AGL, the captain used the PAPI for visual descent guidance to the runway. "At approximately 50 feet, the captain brought the power levers to idle," the report said. "All seemed normal until [the Citation was] approximately 20 to 30 feet [AGL], when the aircraft felt as if it lost lift, and the right wing dropped."

The first officer said that airspeed decreased 4 or 5 kt below VREF when the Citation was about 20 ft AGL. The captain said that he increased power when the stick-shaker — stall warning — activated and attempted to level the wings. However, the right wing tip struck the runway when the airplane touched down. The airplane bounced, turned slightly right, touched down off the right side of the runway and struck a snow bank.

NTSB said that the probable cause of the accident was "the captain's failure to maintain adequate airspeed during the landing, which resulted in a stall/mush."

The Citation encountered light rime icing conditions while descending, and the crew activated the deicing boots three times.

Brake Warning Caused by Broken Wheel Hub

Boeing 767-300. Substantial damage. No injuries.

The "BRAKE TEMP" warning light illuminated during takeoff from London Heathrow Airport on March 3, 2007, and the flight crew saw indications that the no. 1 wheel brake was hot and getting hotter, the AAIB report said. Airspeed was between 90 and 100 kt when the crew rejected the takeoff. After slowing to taxi speed, they turned the 767 off the runway.

Brake temperature continued to increase rapidly, and the crew requested ARFF services. ARFF personnel saw that the no. 1 wheel was severely damaged. "Although there was no fire, the wheel was sprayed with water as a precaution," the report said. The 189 passengers disembarked and were taken by bus to the terminal. The no. 1 wheel was replaced before the airplane was towed off the taxiway.

Examination of the damaged wheel showed that a bearing housing had become detached and had rubbed against the inner hub. "The likely cause of the failure was probably fatigue or stress corrosion, or a combination of both," the report said. The wheel was manufactured in 1994 and had accumulated 1,145 flight hours and 205 cycles.

Flight Attendant Ejected From Galley

Bombardier CRJ200. No damage. One serious injury.

The flight attendant said that before the passengers were boarded for departure from Chicago on May 31, 2005, the captain told her to keep at least one door open because an external air conditioning cart was being used to cool the cabin. "The captain did not specify that the reason the flight attendant needed to keep a door open was because the air conditioning cart [also] pressurized the cabin if all the doors were closed," the NTSB report said.

"The flight attendant stated that after the [24] passengers had boarded the airplane … the captain asked her to shut the [galley] service door and the main cabin door," the report said. She shut the doors, and the cabin began to pressurize. "The captain felt the pressure rise in his ears and yelled, 'Get the door open.'"

The flight attendant said that she bent over, held the service door assist handle with her left hand and opened the service door with her right hand. "As she lifted the handle upward, the door exploded open, and she was blown out of the airplane and onto the ground," the report said. "The flight attendant sustained a fractured left shoulder."

The air conditioning cart is powered by a diesel engine and provides 1,500 cu ft per minute of cooled or heated air to the cabin. With only an on/off switch, "the cart has no means of regulating the amount of pressurized, conditioned air that it feeds to the cabin," the report said.

The operator's pilots and ramp personnel — but not its flight attendants — receive training on the operation of the air conditioning cart. "The airplane has two placards warning to keep a door open when the air conditioning cart is hooked up to the airplane," the report said. "One placard is on the overhead console in the cockpit, and the other is outside of the cabin on the fuselage skin directly above the connection for the external air conditioning cart."

TURBOPROPS

Asymmetric Power Cited in Excursion

BAE Systems ATP. Minor damage. No injuries.

The airplane was on a cargo flight from Umeå, Sweden, to Luleå–Kallax Airport the night of Oct. 13, 2006. The destination airport was reporting winds from 320 degrees at 4 kt, runway visual range (RVR) 550 m (1,800 ft) and vertical visibility 100 ft in fog. The RVR was at the minimum for the ILS approach to Runway 32, said the report by the Swedish Accident Investigation Board (SHK).

Runway 32 was 3,450 m (11,319 ft) long and 45 m (148 ft) wide. It had a painted runway centerline but no centerline lights. The report said that the edge lights were 4 m (13 ft) from the runway edges despite Swedish civil aviation regulations that require edge lights to be displaced no more than 3 m (10 ft).

The copilot flew the approach with the autopilot engaged. Both pilots said that although the power levers were in the same position, the engine instruments showed indications of asymmetric power. Recorded flight data showed that the right engine was producing more power than the left engine. Among the recorded torque values were 50.2 and 28.0, respectively, at 50 ft radar altitude and 17.0 and 4.2 on touchdown.

The pilots saw the approach lights about 200 ft AGL, and the copilot disengaged the autopilot. The report said that when the copilot reduced power to flight idle about 50 ft AGL, he likely did not reduce right rudder control pressure that had been applied to counter the asymmetric thrust; as a result, the airplane yawed right and touched down near the right side of the runway. "Rudder control was applied, but the aircraft went out to the edge of the runway before it could be steered back to the center of the runway," the report said.

After parking the airplane, the crew found that one of the tires on the right main landing gear had been damaged when it struck a runway edge light.

SHK said that the incident was caused by the crew's "failure to maintain the correct heading during landing, probably caused by the differential power from the engines, combined with the limited experience of the pilots [in] this type of aircraft." The crew had been flying the ATP about three months. The commander had 3,495 flight hours, including 124 flight hours in type. The copilot, the pilot flying, had 1,861 hours, including 109 flight hours in type.

The board said that contributing factors were the absence of runway centerline lighting and the displacement of the runway edge lights.

Ice Ingestion Suspected in Power Loss

Jetstream 41. No damage. No injuries.

The airplane was en route from Leeds–Bradford (England) Airport to Southampton with 17 passengers the morning of Jan. 11, 2007. In adherence with the manufacturer's recommendations and the company's standard operating procedures for flight in potential icing conditions, the flight crew operated the engine anti-icing and continuous ignition systems throughout the flight, the AAIB report said.

The crew also activated the propeller deicing system when the Jetstream encountered light-to-moderate icing conditions during climb and cruise at Flight Level (FL) 190 (about 19,000 ft). "During the flight, the crew occasionally heard ice being shed from the propellers … but airframe ice accretion was not sufficient to require operation of the pneumatic deicing boots," the report said.

Nearing Southampton, the crew was told by ATC to descend to FL 70 and was given a radar vector to intercept the ILS localizer for Runway 20. As the airplane descended through 7,500 ft, the right engine lost power. "Some 62 seconds later, the right engine began an auto-restart as a result of the operation of the continuous ignition system, following which, both engines ran normally," the report said. The airplane was landed without further incident.

Examination of the airplane revealed no technical defects that could have caused the power loss. The report said that it might have been caused by ice that accumulated above the heated upper lip of the right engine's air intake and then entered the intake when the airplane descended into warmer air.

Investigators were unable to determine why the continuous ignition system did not restart the engine within five seconds, as designed, "or why, given that both engines were likely to have experienced exactly the same environmental conditions, only the right engine was affected," the report said. "The possibility that the right engine was predisposed to flameout in the 'right' conditions — due to, for example, the condition of the igniters or fuel nozzles — could not be dismissed."

The report said that modified engine air intakes developed by the manufacturer to further reduce the risk of ice ingestion had not been installed — and were not required to be installed — on the airplane.

Pilot Continues Landing Over Snowplow

Beech Super King Air 200. Substantial damage. No injuries.

The pilot was conducting a positioning flight from Oklahoma City to Angel Fire (New Mexico, U.S.) Airport, which was reporting 7 mi (11 km) visibility in light snow and a broken ceiling at 1,900 ft the morning of March 24, 2007. The pilot said that he announced his position three times on the common traffic advisory frequency while conducting an area navigation approach to Runway 17, which is 8,900 ft (2,713 m) long and 100 ft (30 m) wide.

The pilot said that he announced his position three times on the common traffic advisory frequency.

The King Air was about 2 nm (4 km) from the airport when the pilot saw a snowplow near the approach end of the runway. He maneuvered the airplane to avoid flying over the snowplow and touched down about 1,000 ft (305 m) from it. "Pictures of the accident airplane and runway environment, taken immediately after the accident, depict a swath of unplowed snow in the middle of the runway," the NTSB report said. "During the landing roll, the left wing contacted the swath of snow. The airplane yawed about 25 degrees left and departed the runway environment." Damage included a collapsed nose landing gear.

The report said that no notices to airmen (NOTAMs) had been issued for runway conditions or the snow-removal operations at the airport. The snowplow operator said that he was carrying a hand-held radio but did not hear the pilot's position reports.

NTSB said that the probable cause of the accident was "the pilot's inability to maintain clearance from the snow bank." Contributing factors included "the pilot's failure to perform a go-around/missed approach procedure after observing snow-removal equipment on the runway [and] the lack of NOTAMs for runway conditions."

PISTON AIRPLANES

Procedures Omitted After Engine Failure

Cessna 414A. Destroyed. Three fatalities.

Daytime VMC prevailed for the air ambulance positioning flight from Honolulu to pick up a patient in Kahului, Maui, Hawaii, U.S., on March 8, 2006. The airplane was about 2 nm (4 km) from Runway 02 at Kahului Airport when the pilot told ATC, "We lost an engine. We need assistance."

Investigators determined that the left engine had failed but were unable to determine why it failed. The pilot did not feather the propeller or retract the landing gear and flaps. The 414 stalled, rolled right, descended rapidly into an automobile dealership and was destroyed by the impact and post-impact fire. The pilot and both flight medical attendants were killed. Ten automobiles were destroyed, but no one on the ground was hurt.

NTSB said that the probable cause of the accident was "the failure of the pilot to execute the published emergency procedures pertaining to configuring the airplane for single-engine flight."

The report indicated that the pilot — who held airline transport pilot and flight instructor certificates and had about 3,142 flight hours, including 1,519 flight hours in multiengine airplanes — had been involved in a similar accident about eight months earlier.

That accident occurred while the pilot was providing flight instruction to a private pilot in a Piper Apache 160 on July 1, 2005. He had intentionally shut down the left engine and feathered the propeller for instructional purposes but then was unable to restart the engine. The hydraulic pump driven by the left engine normally is used to extend the landing gear. With the left engine inoperative, the pilot attempted to extend the landing gear manually while the student flew the Apache back to Honolulu International Airport.

The July accident report said that the pilot did not conduct the manual or emergency gear-extension procedures correctly. However, a tower controller told the pilot that the landing gear appeared to be fully extended. The pilot took control of the Apache and was about to flare the airplane for landing when someone radioed that the nose gear did not appear to be extended. "The [pilot] then reactively applied power, and the airplane rolled to the left and impacted the ground," the report said. Neither pilot was injured; the Apache was substantially damaged.

Air in Brake Line Contributes to Overrun

Piper Seneca II. Minor damage. No injuries.

During an instructional flight the evening of March 3, 2007, the airplane was landed about 476 m (1,562 ft) beyond the normal touchdown point on the 1,310-m (4,298-ft) runway at Cork (Ireland) Airport. The instructor, the pilot flying, said that judging the approach and flare had been difficult because of sun glare. When he applied the wheel brakes after touchdown, the left toe-brake pedal "went full down" and the right main wheel locked, causing the tire to skid, said the report by the Irish Air Accident Investigation Unit.

"The resulting asymmetric braking made directional control difficult," the report said. Because of this, and because he believed enough runway remained to stop the aircraft, the instructor decided not to conduct a go-around.

The student pilot then applied hard wheel braking, locking both main wheels and deflating the tires. With no effective braking remaining, the Seneca overran the runway at 40 kt and came to a stop in a grassy area 30 m (98 ft) from the end of the runway.

Investigators determined that air had entered the hydraulic fluid in the wheel-braking system operated from the Seneca's right seat and had caused the inadequate and asymmetric braking performance encountered by the instructor.

Reversed Trim Causes Loss of Control

Cessna 310Q. Substantial damage. One fatality.

The airplane was being flown on Dec. 14, 2006, for the first time following completion of an annual inspection in Montgomery, New York, U.S. Witnesses said that pitch oscillations occurred on initial climb before the 310 turned left, descended and crashed in a wooded area.

The elevator trim tab was found in the full, 10-degree, nose-down position. The NTSB report said that further examination revealed that the elevator trim cables had been reinstalled incorrectly after replacement of the trim actuator during the annual inspection.

NTSB said that the probable causes of the accident were "improper maintenance performed on the airplane by maintenance personnel and the failure of the mechanic with an inspection authorization to verify the maintenance work performed, which resulted in a reversed elevator trim system and subsequent loss of control."

HELICOPTERS

Winds, Weight Reduce Climb Performance

Bell 212. Substantial damage. Twelve minor injuries.

The helicopter was near maximum gross weight after boarding 11 people who had skied down Spearhead Glacier near Whistler, British Columbia, Canada, on Feb. 11, 2005. Elevation of the area was 6,300 ft, and the pilot took off into 30-kt, gusting winds and toward the face of the glacier, said the report by the Transportation Safety Board of Canada.

After attaining a positive rate of climb, the pilot turned the helicopter downwind. "It began to descend, and it was evident that the helicopter would not clear the lower ridge," the report said. "The pilot turned the helicopter toward a somewhat level area. As it contacted the snow, the helicopter bounced, struck a snowdrift, dug in, stood on its nose, pirouetted and came to rest on its right side."

The main rotor blades severed the tail boom. There was no fire. The report noted that stainless steel elbow fittings, installed on the helicopter's fuel lines in accordance with Airworthiness Directive CF 97-04, remained intact in an area that was crushed during the accident.

"The evacuation from the wrecked helicopter was carried out in a calm manner," said the report, which noted that the passengers remembered instructions they had received during interactive emergency training before the first flight of the day.

Engine Fails Over Dense Forest

Eurocopter AS 350BA. Destroyed. One serious injury, four minor injuries.

The pilot was conducting a sightseeing flight over a dense tropical forest in Hana, Maui, Hawaii, the morning of Jan. 10, 2006, when the helicopter began to vibrate, and the low-rotor-rpm warning horn sounded. "The pilot entered an autorotation and tried to arrest the helicopter's forward velocity before settling into the treetops [on a steep slope]," the NTSB report said.

"The helicopter dropped nose-first toward the forest floor and came to rest on its right side, suspended in the trees a few feet from the ground. The four passengers and the pilot [who was seriously injured] were able to lower themselves to the ground." They used a cell phone to call for assistance.

Examination of the Turbomeca Arriel 1B engine revealed that a second-stage turbine blade had separated as a result of a fatigue fracture initiated at a corrosion pit. The engine had been operated 9,593 hours, including 1,764 hours since its last overhaul. "As a result of the investigation into the engine failure, the engine manufacturer has reduced the life limit of the second-stage turbine blades from 6,000 hours to 3,000 hours and implemented additional turbine-inspection criteria," the report said. ●

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Oct. 4, 2007	Kinshasa, Democratic Republic of Congo	Antonov An-26	destroyed	49 fatal, 1 serious
The airplane crashed in a residential area after an engine failed on takeoff. The fatalities included 28 people on the ground.				
Oct. 4, 2007	Pagosa Springs, Colorado, U.S.	Raytheon King Air C90A	destroyed	3 fatal
The air ambulance was descending in nighttime visual meteorological conditions (VMC) during a positioning flight when it struck terrain at 11,900 ft.				
Oct. 7, 2007	Naches, Washington, U.S.	Cessna 208B	destroyed	10 fatal
Radar data indicated that the Caravan entered a rapid descent from 13,000 ft and struck mountainous terrain at about 4,300 ft. The airplane was returning to Shelton, Washington, after a skydiving event in Star, Idaho.				
Oct. 7, 2007	Santo Domingo, Venezuela	Gulfstream IIB	destroyed	2 fatal
Nighttime instrument meteorological conditions (IMC) prevailed when the airplane struck trees and crashed on approach.				
Oct. 8, 2007	Cubarral, Colombia	Let 410UVP	destroyed	18 fatal
The airplane was on a scheduled flight from Villavicencio to Uribe when it struck a mountain at about 7,875 ft.				
Oct. 11, 2007	Bogotá, Colombia	Beech Super King Air 200	destroyed	7 fatal
Soon after the captain reported an engine problem during takeoff for an air ambulance flight, the King Air stalled and descended into a residential area. The fatalities included two people on the ground.				
Oct. 11, 2007	Istanbul, Turkey	McDonnell Douglas MD-83	substantial	163 NA
The airplane was en route from Hurghada, Egypt, to Warsaw, Poland, when the crew reported an electrical problem and diverted to Istanbul. The landing gear separated when the MD-83 overran the runway.				
Oct. 11, 2007	Memphis, Tennessee, U.S.	Cessna Citation 525	none	2 none
Nighttime VMC prevailed when the airplane took off from Taxiway M, instead of the assigned Runway 36L, at Memphis International Airport and passed 400–500 ft over a regional jet holding on the taxiway.				
Oct. 14, 2007	Olathe, Kansas, U.S.	North American Sabreliner 65	substantial	2 none
During a landing on Runway 18 in heavy rain, the pilot selected reverse thrust just as the wind shifted from southeast to west. Directional control was lost, and the Sabreliner hydroplaned off the left side of the runway.				
Oct. 14, 2007	Cumberland, Maryland, U.S.	Aero Commander 560F	destroyed	4 fatal
Witnesses said that they heard a "rough-running" engine when the airplane took off in VMC. The Aero Commander struck a barn and burned about 3 nm (6 km) from the airport.				
Oct. 17, 2007	Phnom Penh, Cambodia	Antonov An-12BP	substantial	1 serious, 4 none
The crew reported an engine problem during departure for a cargo flight to Singapore and attempted to return to Phnom Penh. The Antonov struck a rice field about 25 km (14 nm) from the airport.				
Oct. 17, 2007	Guadalcanal, Spain	Britten-Norman Islander	destroyed	2 fatal
The airplane, which was operated by a police department in England, struck mountainous terrain under unknown circumstances.				
Oct. 17, 2007	Goodland, Kansas, U.S.	Learjet 35A	substantial	2 none
The pilot said that after entering VMC about 250 ft above ground level on approach, uncontrolled left and right rolling motions occurred when he attempted to align the airplane with the runway centerline. The left wing struck the runway on touchdown.				
Oct. 25, 2007	Chibougamau, Quebec, Canada	Beech King Air A100	destroyed	2 fatal
During the second landing attempt in IMC, the airplane crashed and burned near the end of the runway.				
Oct. 26, 2007	Butuan, Philippines	Airbus A320-200	destroyed	34 serious, 120 none
The A320 landed long in VMC, overran the 6,450-ft (1,966-m) runway and came to a stop in a coconut grove.				
Oct. 27, 2007	Atlantic City, New Jersey, U.S.	Cessna Citation 650	substantial	2 none
The Citation landed hard and overran the runway.				
Oct. 28, 2007	Katowice, Poland	Boeing 737	substantial	125 NA
Nighttime IMC prevailed when the 737 struck approach lights while landing.				

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.