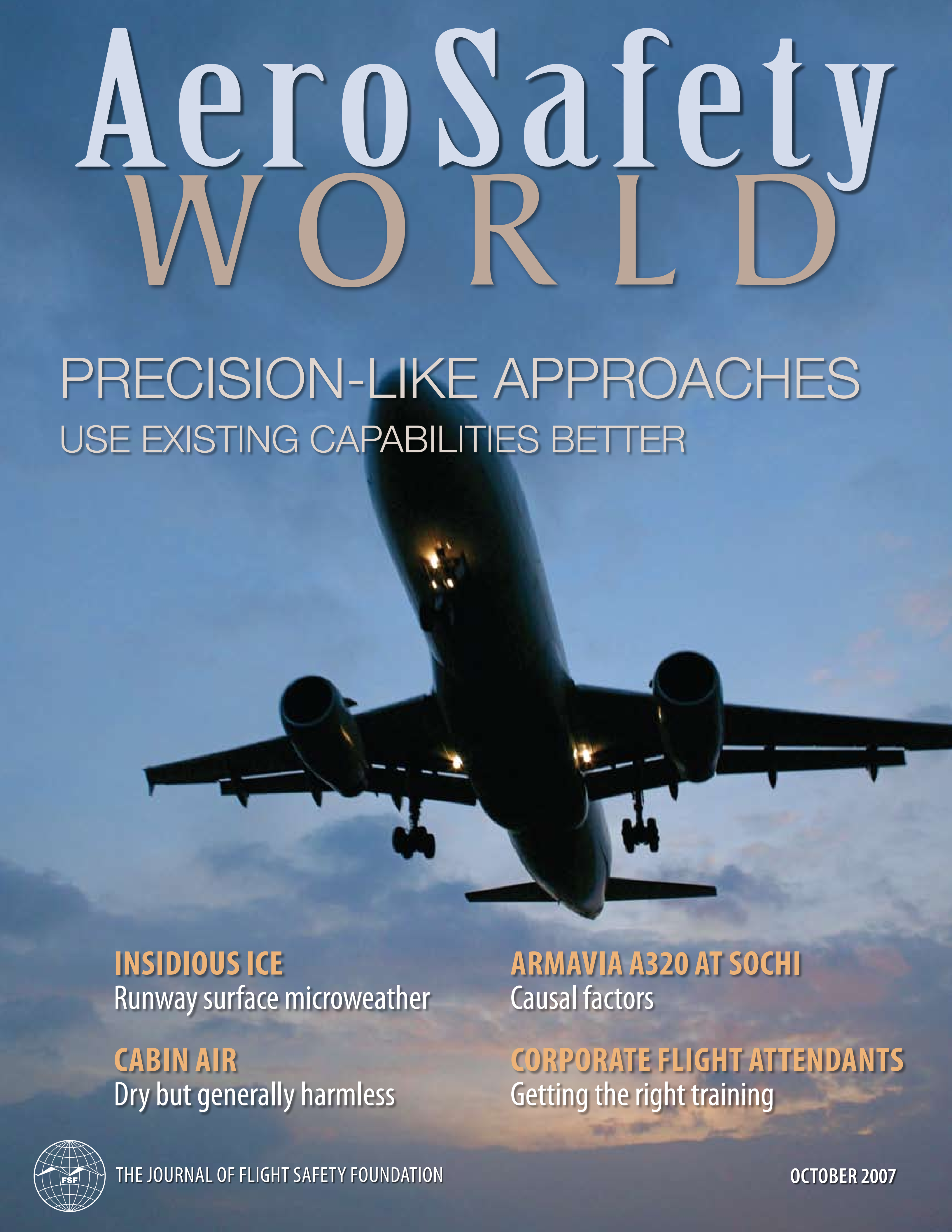
AeroSafety WORLD



PRECISION-LIKE APPROACHES
USE EXISTING CAPABILITIES BETTER

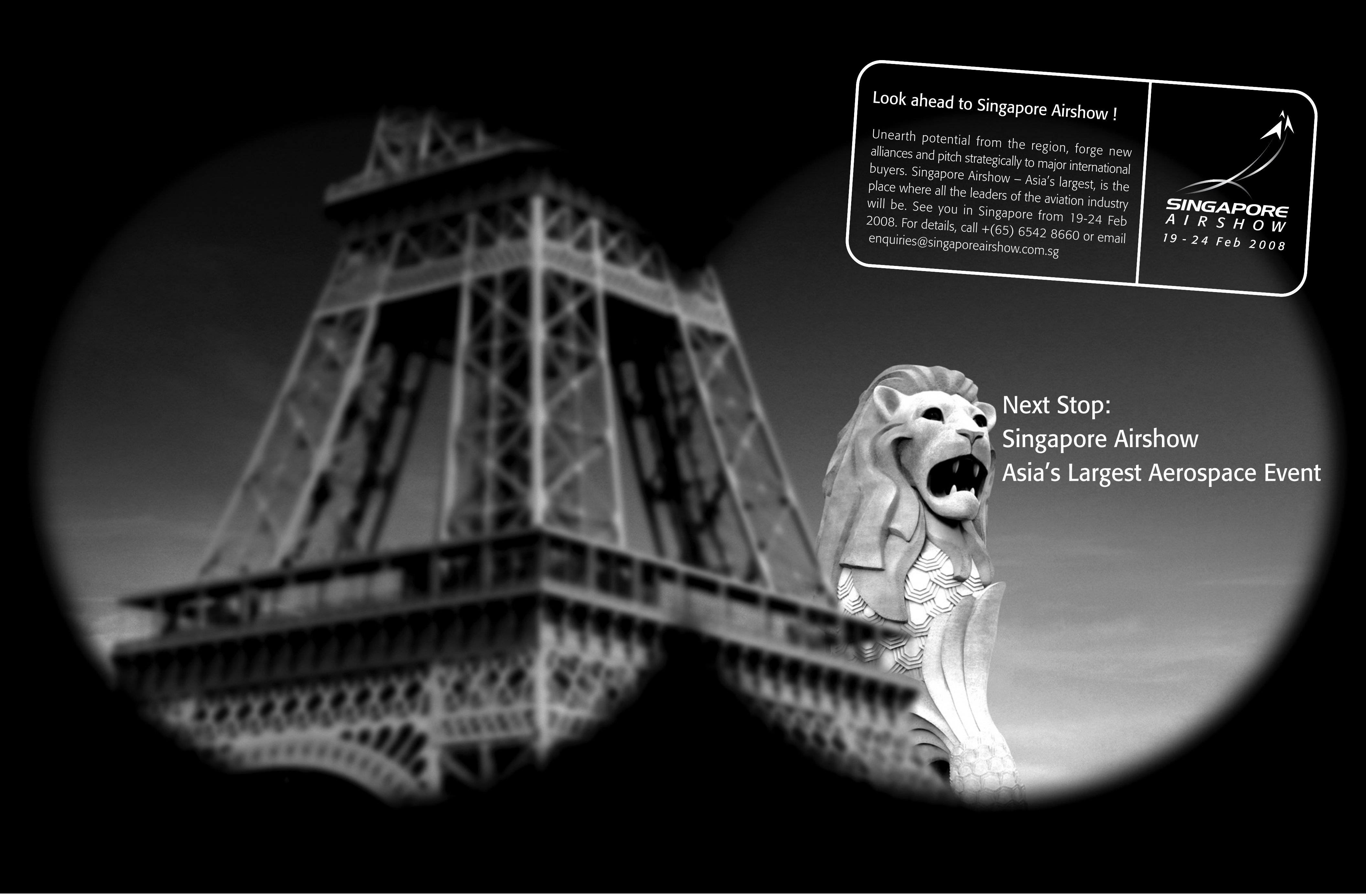
INSIDIOUS ICE
Runway surface microweather

CABIN AIR
Dry but generally harmless

ARMAVIA A320 AT SOCHI
Causal factors

CORPORATE FLIGHT ATTENDANTS
Getting the right training

FSF
THE JOURNAL OF FLIGHT SAFETY FOUNDATION
OCTOBER 2007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Community

The air safety situation in Brazil has been an issue since my first day on the job at the Foundation. Everything started unraveling with the midair collision between an Embraer Legacy and a Gol Boeing 737-800. Within hours, the highest levels of the Brazilian government engaged in outrageous finger-pointing and speculation. Air traffic controllers revolted against what they characterized as unsafe conditions and set off national air transportation and political crises. We will have to wait for the official investigation's conclusions, but numerous errors and circumstances apparently combined to cause that tragedy. That errors were made is understandable. That many warning signs were ignored is troubling.

On July 17, we got another reminder of what can happen when warning signs are ignored. A TAM A320 skidded off the runway at Congonhas Airport, São Paulo, killing 199 people. Again, it will be a while before we know the causes, but this happened at a difficult airport under difficult conditions. Previous incidents and safety reports had warned of problems. Unfortunately, the safety situation wasn't really under control of the safety officials. Instead, judges and city politicians debated the types of airplane that could operate on the runway and the conditions required.

Another political frenzy followed the Congonhas tragedy. The most discouraging moment came on Aug. 1, when the transcript of the cockpit voice recording was made public as part of an investigation by the Brazilian House of Representatives; the international press sensationalized the last few moments of that crew's struggle. The recording should have been protected as part of the safety investigation under international law, but the information took pressure off politicians and officials responsible for the airport.

What not many people know is that, in that same week, there were victories in Brazil for the protection of safety information. The safety professionals in Brazil have been fighting back. On Aug. 7, the investigator-in-charge refused to provide the House of Representatives with information from the accident investigation. He cited in court a 1994 Supreme Court ruling barring the incarceration of people who refuse to release data protected by duty or professional obligation. It worked. The information was protected and he didn't go to jail.

It didn't end there. That same morning, criminal prosecutors seized computers and register books from some ATC facilities. The seizure was appealed to a higher court and was reversed. Since then, there has been talk of an initiative within Brazil's House of Representatives to revise their laws based on best practices elsewhere for the protection of safety data.

The safety professionals in Brazil are doing their job. They don't make as much noise as the politicians, but they are having an effect. They are risking their careers and their liberty to do the right thing. Our job in the safety community is to make sure such efforts don't go unnoticed, or unsupported. We must not forget that their fight is our fight. That is what it means to be a community.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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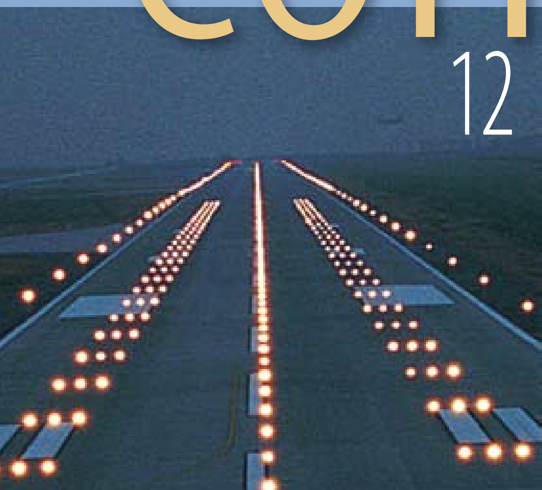
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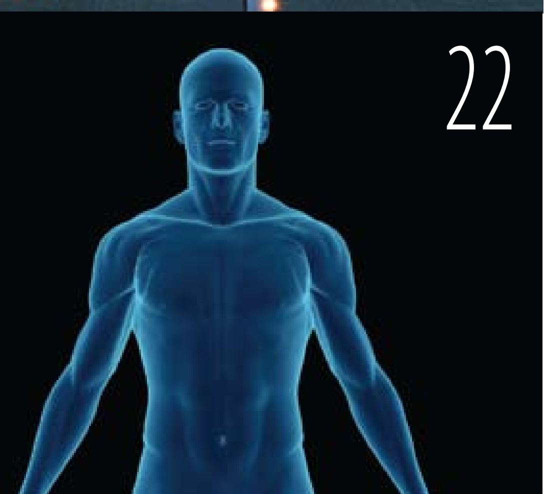
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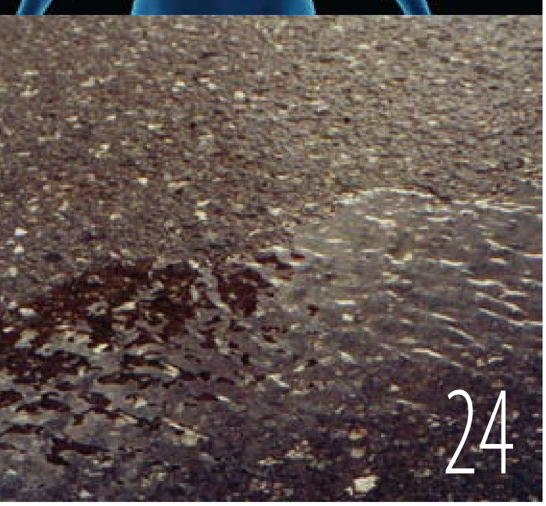
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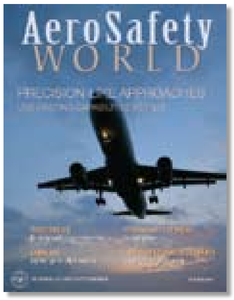

About the Cover
More-precise approaches using existing equipment.
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Serving Aviation Safety Interests for More Than 50 Years

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.

Member**Guide**

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Glut

The number of airliners being ordered these days is nothing but good news for equipment manufacturers around the world. After suffering through years of constrained demand after the 9/11 terror attacks exacerbated the economic decline that began with the tech stock collapse at the start of the century, manufacturers are happy to see buyers taking delivery positions for years to come.

Steven Udvar-Hazy, chairman and CEO of International Lease Finance Corp., a company that owns more than 900 airplanes, noted in a recent interview that for the past three years lessors and airlines have ordered airplanes at twice the rate at which they are being built, and big U.S. carriers for the most part have yet to join the party.

While this order eruption is powered by the resurgence of older airlines, it is supercharged by a large number of new and rapidly expanding airlines that are taking advantage of relaxed barriers to market entry and controls over competition to stimulate the air travel market to a remarkable degree, most notably in areas of the world where a reasonably priced airline ticket is an exciting novelty.

Some elements of this order surge remind me of what the U.S. airline industry went through in the early years of deregulation, when suddenly airlines could fly wherever and whenever they wanted. Orders swelled then, too. It was said that each airline ordered enough airplanes to single-handedly take care of all anticipated market growth. The result, of course, was too much capacity. When the next downturn hit, whole fleets of airliners were parked in the desert and put up for sale.

I think it is safe to expect something similar to happen in the future, but on a global scale. While the benefits of deregulation are undeniable, also undeniable is the fact that the industry becomes more volatile, more subject to economic damage as management both good and bad collides with inevitable economic fluctuations. And herein lurk two safety threats.

The first threat is that new airlines going through their first bout with lean times might, in the absence of diligent safety regulation, be tempted to work to the edges of the safety margin and beyond. For this problem, the answer is simple: Regulators need to step up their vigilance when their carriers are feeling the pain.

The second threat is more difficult to constrain. The classic result of overcapacity and an economic downturn is that airplanes and spare parts get very cheap and very available. This opens the door for people with not too much money and little or no aviation experience to acquire a few airplanes and start operations in an area where safety regulation is lightly applied. Little attention is paid to maintenance and operating rules, and the result is unavoidable. This has been the fate not only of many Soviet-era airplanes flown without the necessary care in the developing world but also of the occasional Boeing or Airbus. No level of design and manufacturing magic can forever forestall the tragic consequences of an unsafe hand.

There is some breathing room before the next glut of cheap airplanes comes around, but it would be good to be thinking about solutions now rather than later.

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

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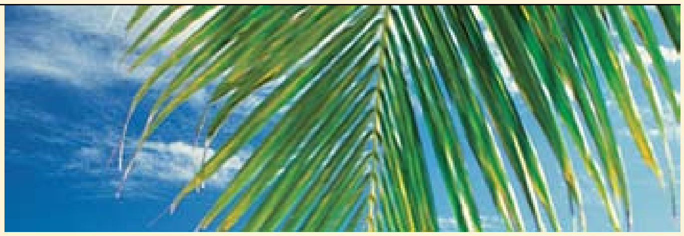
April 29–May 1, 2008

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

The Innisbrook Resort and Golf Club, Palm Harbor, Florida

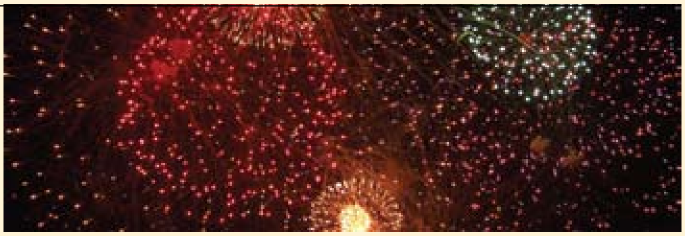


Corporate Aviation Safety Seminar

April 21–23, 2009

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

Hilton Walt Disney World, Orlando, Florida



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OCT. 1–2 ➤ UKFSC Annual Seminar: Technical Innovation and Human Error Reduction. U.K. Flight Safety Committee. Heathrow. <admin@ukfsc.co.uk>, <www.ukfsc.co.uk/annual%20seminar.htm>, +44 (0)1276 855193.

OCT. 1–4 ➤ 60th Annual International Air Safety Seminar. Flight Safety Foundation, International Federation of Airworthiness, and International Air Transport Association. Seoul, Korea. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org/seminars.html#iass>, +1 703.739.6700, ext. 101.

OCT. 2–4 ➤ Helitech 2007. Reed Exhibitions. Duxford/Cambridge, U.K. Sue Bradshaw, <sue@helitech.co.uk>, <www.helitech.co.uk/>, +44 (0)20 8439 8894.

OCT. 4–5 ➤ Fuel and Hazardous Materials Safety Workshop. American Association of Airport Executives, National Air Transportation Association and Air BP Aviation Services. Pittsburgh. Christy Hicks, <christy.hicks@aaae.org>, <http://www.aaae.org/products/meeting_details.html?Record_id=469>, +1 703.824.0500.

OCT. 8–9 ➤ 3rd National Conference on Human Vibration. VDI Wissensforum. Dresden, Germany. <www.vdi.de/hs2007>, <wissensforum@vdi.de>, +49 (0)211 62 14-201.

OCT. 8–11 ➤ Flight Simulator Engineering and Maintenance Conference. ARINC. Montreal, Quebec, Canada. Sam Buckwalter, <sbuckwal@arinc.com>, <www.arinc.com/fsemc>, +1 410.266.2008.

OCT. 10–14 ➤ CAMA Annual Scientific Meeting. Civil Aviation Medical Association. San Diego. James L. Harris, <Jimlharris@aol.com>, <www.civilavmed.com/Meeting_Events.htm>, +1 405.840.0199.

OCT. 14–17 ➤ Wildlife Management Workshop. American Association of Airport Executives. Minneapolis. Natalie Fleet, <natalie.fleet@aaae.org>, <http://www.aaae.org/products/meeting_details.html?Record_id=491>, +1 703.824.0500.

OCT. 15–19 ➤ Accident Investigation Orientation for Aviation Professionals. U.S. National Transportation Safety Board. Ashburn, Virginia. <TrainingCenter@ntsb.gov>, <www.ntsb.gov/Academy/CourseInfo/AS301_2007.htm>, +1 571.223.3900.

OCT. 15–16 ➤ European Aviation Training Symposium Pilot Training Conference. *CAT Magazine* and Halldale Media Group. Berlin. Chris Lehman <chris@halldale.com>, <www.halldale.com/eats>, +44 (0)1252 532000.

OCT. 15–19 ➤ Survival Factors in Aviation Accidents. U.S. National Transportation Safety Board. Ashburn, Virginia. <TrainingCenter@ntsb.gov>, <www.ntsb.gov/Academy/CourseInfo/AS302_2007.htm>, +1 571.223.3900.

OCT. 16 ➤ All Clear? The Path to Clear Communications ToolKit Workshop. Eurocontrol. Brussels. Leila Ikan, <leila.ikan@eurocontrol.int>.

OCT. 16–18 ➤ Aviation (Asia) Fire Conference 2007. International Aviation Fire Protection Association. Singapore. <iafpa2007conference@yahoo.com.sg>, <www.iafpa.org.uk/conference/Singapore/>, +65 6541 2523.

OCT. 17 ➤ European Aviation Training Symposium Maintenance Training Conference. *CAT Magazine* and Halldale Media Group. Berlin. Chris Lehman <chris@halldale.com>, <www.halldale.com/eats>, +44 (0)1252 532000.

OCT. 17–19 ➤ Wildlife Hazard Management Workshop. Embry-Riddle Aeronautical University, Center for Professional Education. Seattle-Tacoma International Airport, Seattle. Billy Floreal, <florealb@erau.edu>, <www.erau.edu/ec/soctapd/seminar_progs.html>, +1 386.947.5227.

OCT. 17–19 ➤ ERA General Assembly 2007. European Regions Airline Association. Athens, Greece. <info@eraa.org>, <www.eraa.org/inside-era/generalassembly/Welcomeera2007.php>, +44 (0)1276 856495.

OCT. 17–19 ➤ Convergence: 16th Annual Forum & AGM. Canadian Aviation Maintenance Council. Mississauga, Ontario. Leslie Corkill, <lcorkill@camc.ca>, <www.camc.ca/en/WhoWeAre/ForumAGM/2007/invitation.html>, 1 800.448.9715, ext. 231.

OCT. 24–26 ➤ Master and Commander Conference: Command/Leadership for Captains. Morning Star Aviation Safety. Denver. Capt. David L. Bair, <davidbair@morningstaraviation.net>, <http://www.morningstaraviation.net/home.php?page=conferences>, +1 720.981.1802.

OCT. 28–31 ➤ 52nd Annual Conference and Exposition. Air Traffic Control Association. Washington. Gail Hanline, <gail.hanline@atca.org>, <www.atca.org/atca52nd.asp>, +1 703.299.2430.

OCT. 29–31 ➤ 45th Annual Symposium. SAFE Association. Reno, Nevada, U.S. <safe@peak.org>, <www.safeassociation.com/symposium.htm>, +1 541.895.3012.

OCT. 29–NOV. 1 ➤ Fifth Triennial International Aircraft Fire and Cabin Safety Research Conference. Jointly sponsored by numerous national civil aviation authorities. Atlantic City, New Jersey, U.S. April Horner, <april.ctr.horner@faa.gov>, <www.fire.tc.faa.gov/2007Conference/conference.asp>, +1 609.485.4471.

NOV. 1–2 ➤ Second Annual Aviation Health Conference. Quaynote Communications. London. Lorna Titley <lorna@quaynote.com>, <http://www.quaynote.com/ankiti/www/?code=uk07&f=home&conf=381a49808c0ceeab0da60a934822e741>, +44 (0)20 8531 6464.

NOV. 1–2 ➤ 8th Safeskies International Aviation Safety Conference. Safeskies Australia. Canberra, Australia. <safeskies@bigpond.com>, <www.safeskiesaustralia.org/index.html>, +61 2 6236 3160.

NOV. 5–7 ➤ 17th ACI World Annual General Assembly, Conference and Exhibition and ACI Latin America Regional Conference and Assembly. Airports Council International. Buenos Aires, Argentina. <aci@aci.aero>, <www.aci.aero/cda/aciworld/display/main/aciworld_content.jsp?zn=aci&cp=1112-2133_128_2>, +41 22 717 8585.

NOV. 8–9 ➤ 2007 Intermodal Conference on Safety Management and Human Factors. Interfleet Technology. Sydney, Australia. Joey Anca, <joseanca@interfleetaust.com>, <www.conferenceworks.net.au/hfactors>, +61 (0)3 96003655.

NOV. 11–15 ➤ 10th Anniversary Dubai Airshow 2007. Fairs and Exhibitions. Dubai. Nandini Rego. <www.dubaiairshow.org/airshow07/site/show_info/introduction.php>, +971 4 286 7755.

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

Hot Wired

Fires near the windshield heat terminals on two Boeing 757-200s have prompted a recommendation by the U.S. National Transportation Safety Board (NTSB) for airworthiness directives requiring replacement of windshield heat terminal blocks on all 747s, 757s, 767s and 777s.

The NTSB also recommended that the U.S. Federal Aviation Administration (FAA) "complete the process begun in 2004 to approve the service bulletin for the installation of the redesigned windshield heat terminal block on Boeing 767 airplanes."

The NTSB's recommendations were prompted by a Jan. 25, 2004, fire on an American Airlines 757 during departure from Dallas–Fort Worth International Airport and a Jan. 21, 2004, fire on an Air Greenland 757 in Copenhagen, Denmark, as the airplane was being prepared for flight. The crew of the Dallas aircraft declared an emergency and returned to the airport for a safe landing.

Investigations determined that both fires resulted from misalignment of a screw attaching the power wire to the windshield heat terminal block; the misalignment caused an electrical arc.

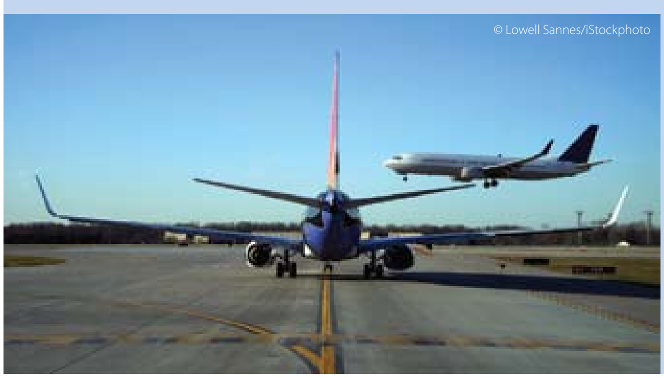
During the investigation, Boeing told the NTSB that similar events had occurred in at least four other airplanes and that the terminal block had subsequently been redesigned. The redesign was included in new production airplanes beginning in mid-2004, about the same time a related service bulletin was issued for 777s. Service bulletins for 747s and 757s were issued in 2006, but the service bulletin for 767s has not been issued because of "minor disagreements between the FAA and Boeing," the NTSB said.

"In August 2007, Boeing informed investigators that it was making requested changes to the 767 [service bulletin] and would resubmit it to the FAA in October 2007," the NTSB said. "The Safety Board is very concerned that the ADs [airworthiness directives] originally scheduled to be issued as early as September 2004 still have not been issued. The Board considers any kind of fire and/or smoke in the cockpit to be a serious issue that could affect other aircraft systems, lead to a loss of visibility, provide a distraction or incapacitate the crew and possibly lead to an accident."

Runway Check

The U.S. National Transportation Safety Board (NTSB), citing a 2006 accident in which a Comair Bombardier CRJ100 crashed during takeoff from the wrong runway in Lexington, Kentucky, U.S., has recommended action to require flight crews to confirm before takeoff that their airplane is about to enter the correct runway.

The NTSB recommendation says that the U.S. Federal Aviation Administration (FAA) should require air carriers and commercial operators, commuter and on-demand operators, and fractional ownership operators to "establish procedures requiring all crewmembers on the flight deck to positively confirm and cross-check the airplane's location at the assigned departure runway before crossing the hold-short line for takeoff."



The recommendation follows the NTSB's investigation of the Aug. 27, 2006, Comair accident, in which the flight crew was told by air traffic control to conduct a takeoff from Runway 22 but instead taxied onto Runway 26 and began the takeoff roll. The airplane overran the departure end of Runway 26, which was 3,500 ft (1,068 m) long, half the length of Runway 22. Forty-nine of the 50 people in the airplane were killed, and one — the first officer — received serious injuries.

The NTSB said that the probable cause of the accident was the flight crewmembers' "failure to use available cues and aids to identify the airplane's location on the airport surface during taxi and their failure to cross-check and verify that the airplane was on the correct runway before takeoff."

The NTSB also recommended that the FAA require operators to install "on their aircraft cockpit moving map displays or an automatic system that alerts pilots when a takeoff is attempted on a taxiway or runway other than the one intended." Other recommendations called on the FAA to require enhanced taxiway centerline markings and holding positions signs at runway entrances; to prohibit issuance of a takeoff clearance until after an airplane has crossed all intersecting runways; and to tell air traffic controllers to "refrain from performing administrative tasks … when moving aircraft are in the controller's area of responsibility."

Short-Term Safety Plan

Representatives of the U.S. Federal Aviation Administration (FAA) and the aviation community, in response to 21 serious runway incursions in the first seven months of 2007 and other related problems, have implemented a five-point, short-term plan to improve runway safety.

"Recent close calls at some of our nation's busiest airports show that action must be taken to reduce the risk of runway incursions and wrong-runway departures," the FAA said.

© Baloncici/Dreamstime

The plan, adopted Aug. 15, said that — within 60 days — the aviation community would begin safety reviews at the U.S. airports "where wrong-runway departures and runway incursions are the greatest concern," would disseminate runway safety information and training throughout the industry, would accelerate the planned installation of improved airport signage and markings at major airports and would review clearance procedures for both pilots and air traffic controllers. The five-point plan also called for implementation of "a voluntary self-reporting system for all air traffic organization safety personnel, such as air traffic controllers and technicians."

The FAA said that in addition to the short-term plan, "mid- and long-term goal areas are being pursued to address maximizing situational awareness, minimizing pilot distractions and eliminating runway incursions using procedures and technology."

Technical Harmony

Aviation organizations in Europe and North America say they will collaborate to harmonize technical data standards in aerospace, defense and commercial aviation.

In an Aug. 13 agreement, the AeroSpace and Defence Industries Association of Europe (ASD), the Aerospace Industries Association of America and the Air Transport Association of America said that they will work together to advance the development and maintenance of the S1000D specification for the production of technical publications.

"This approach will harmonize how technical data are conveyed between the original equipment manufacturer and user community," the three organizations said in a statement.

ASD Secretary General François Gayet said, "The cooperation on S1000D is further proof that our industries can only profit from cross-Atlantic developments where both sides have equal value in the cooperation. From the manufacturers' point of view, all solutions that simplify through standardization [are] welcome."

Multicrew Training

Six students have demonstrated "sound two-crew procedures" in the first phase of training based on the principles behind a proposal for multicrew pilot licensing, the Civil Aviation Safety Authority of Australia (CASA) says.

The students, who are from two Chinese airlines, are enrolled in a trial course conducted by Alteon in conjunction with the Australian Airline Academy, and monitored by CASA. The training calls for extensive use of large aircraft simulators rather than general aviation training aircraft.

"Through the use of high-quality visual flight simulators and adherence to multicrew phraseology and standard operating procedures, the … students have demonstrated sound two-crew procedures," a CASA report said. "This has started right from the *ab initio* stage, where the student engaged in the pilot monitoring role uses the standard calls of 'altitude' or 'bank angle' to prompt the pilot flying during flight maneuvers. This results in a pilot's frame of mind that is 'multicrew' from day one."

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Data Monitoring for Light Aircraft

A flight data monitoring and recording system designed for light aircraft has won certification from the U.S. Federal Aviation Administration (FAA). The FAA issued a supplemental type certificate for the Aircraft Logging and Event Recording for Training and Safety (ALERTS) system developed by Air Logistics, a subsidiary of Bristow Group, and Appareo Systems — the first certificate for a monitoring system designed specifically for small aircraft.

The FAA certification will allow the ALERTS system to be installed in Bell 206s and Bell 407s. The system can store more than 100 hours of high-resolution flight data. The manufacturers said that it also contains three-dimensional flight replay and analysis software to allow for flight tracking and analysis, "including automatic analysis of flight characteristics to determine if the pilot adhered to standard operating procedures."

Flight data recording and monitoring are among the priorities of the International Helicopter Safety Team, which has called for an 80 percent reduction in helicopter accidents worldwide by 2016.

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Runaway Trim

The U.S. National Transportation Safety Board (NTSB), citing the ditching of a Cessna Citation 525 after a loss of elevator trim control, is recommending the addition of both an aural trim-in-motion warning and contrasting-color bands on the pitch trim wheel "to provide the pilot with more timely recognition of a trim runaway condition before control forces become unmanageable."

No one was injured in the July 22, 2003, ditching in the waters of Penn Cove, Coupeville, Washington, U.S. The pilot said that, as the airplane reached 14,000 ft during a climb to Flight Level 330 (about 33,000 ft), the rate of climb decreased. He pressed the autopilot/trim disengage switch, and the airplane's nose pitched down. He said that, as he pulled back on the control yoke, "within seconds, it was apparent that level flight was not possible." The pilot had difficulty moving the manual trim wheel, but — with the passenger's help, he pulled back on the control column and was able to ditch the airplane about 900 ft (274 m) from shore.

The NTSB also recommended that the U.S. Federal Aviation Administration require tests to ensure that the maximum control forces during a pitch trim runaway in a Citation 525 meet certification requirements and also require use of a more easily identifiable pitch trim circuit breaker.

In Other News …

Era Helicopters, with fleets in the Gulf of Mexico and Alaska, has become the first helicopter operator with a flight operational quality assurance (FOQA) program approved by the U.S. Federal Aviation Administration. The company's FOQA program also is the first approved for any U.S. Federal Aviation Regulations Part 135 "Commuter and On-Demand" operator. … **The International Federation of Air Line Pilots' Associations** (IFALPA) warns that pilots operating around Ben Gurion Airport in Israel should be prepared for interrupted radio transmissions because of pirate radio broadcasts, which are frequently blocking air-ground communications. IFALPA says that the Israeli Air Line Pilots Association and the Israeli Air Traffic Controllers Association have asked the government to act to end the threat to aviation safety. … **Australia** has authorized penalties of up to two years in prison for pointing a laser light or a similar device at an aircraft; officials say that reported cases of laser beams being aimed at aircraft have increased to about 10 a month.

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Compiled and edited by Linda Werfelman.


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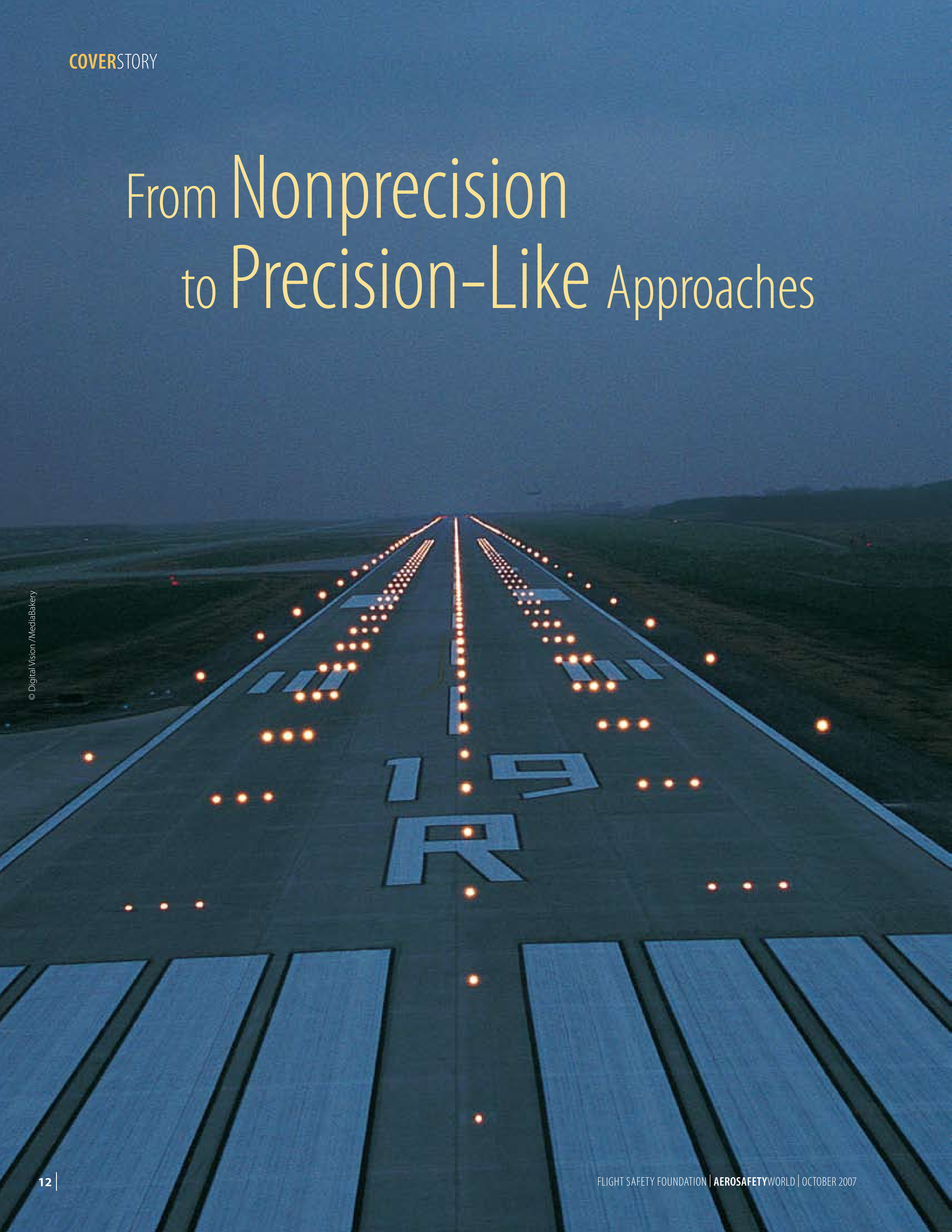
From Nonprecision to Precision-Like Approaches



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

BY ETIENNE TARNOWSKI

Flying a nonprecision approach in traditional nonprecision ways is less safe than flying the same approach using the capabilities most transport aircraft today possess to fly a nonprecision approach in a precision-like manner. The FSF Approach and Landing Accident Reduction (ALAR) Task Force found that more than half of the accidents and serious incidents involving controlled flight into terrain (CFIT) occur during step-down nonprecision approaches. Other data showed that nonprecision approaches are five times more hazardous than precision approaches. The FSF International Advisory Committee believes there is insufficient attention being paid to the potential of using procedures that create precision-like approaches — how to fly them and how to design and approve them — despite the fact that most aircraft and flight crews are capable of using them.

The methods and operational procedures that have been recommended by aircraft manufacturers, airlines and operators for flight crews to fly non-ILS (instrument landing system) approaches have evolved over the past 35 years. They range from the traditional step-down approaches — also known as "dive-and-drive" or "stairway" approaches — of the 1970s, to the constant descent angle/stabilized approaches of the 1980s, to the precision-like approaches of the 1990s and onward.

The evolution has significantly improved safety; the latest procedures, when applicable, have suppressed the main causes of unstabilized approaches and, thus, have minimized the risks of CFIT during final approach and runway excursions and tail strikes during landing.

Any type of instrument approach procedure to a runway is a defined lateral and vertical trajectory to be flown in instrument meteorological conditions down to the published minimum altitude, where the required visual references must be acquired to safely continue the approach and landing.

A non-ILS approach has a lateral path supported by a radio navigation aid (navaid) and a vertical path defined in a more-or-less discontinuous way. With the advent of navigation sensors and airborne navigation equipment such as the global positioning system (GPS) receiver, inertial navigation system (INS) and flight management system (FMS), the area navigation (RNAV) point-to-point method of navigation, which is not dependent on ground-based navaids, has allowed more flexibility in the definition of final approach lateral and vertical paths.

Traditionally, most instrument final approaches have been flown "straight in" or, when clear of clouds, continued with a circle-to-land procedure. With the modern flexibility, segmented or curved final approaches have been defined.

Non-ILS Approaches

The non-ILS approaches typical of the 1970s are referenced to ground-based navaids used to form the final approach trajectory. The navaids include nondirectional beacons (NDBs), VHF omnidirectional radios (VORs) and localizers (LOCs) often paired with distance measuring equipment (DME).

They are called nonprecision approaches because their overall performance is dictated by the performance of the navaid — for example, plus/minus 5 degrees for an NDB, plus/minus 3 degrees for a VOR — and the location of the navaid — on the airport, close to the airport, on or off the extended centerline of the runway, and because there is no vertical path guidance.

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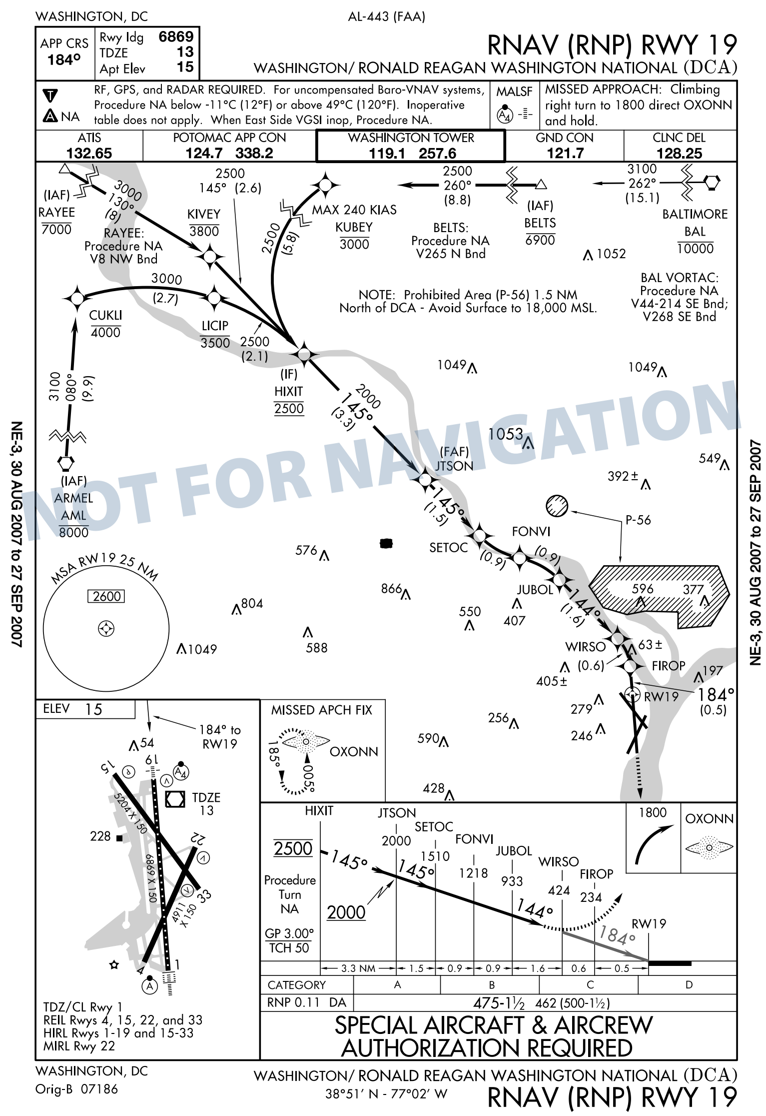
While the availability of DME helps the flight crew maintain awareness of the airplane's position along the lateral path, nonprecision approaches are characterized by poor definition of the vertical path of the final approach. Vertical path definition is partial and discontinuous, and often is provided only by an assigned altitude at the final approach fix (FAF) and by the distance from the FAF to the missed approach point (MAP). Thus, the crew's awareness of the airplane's vertical position versus the intended vertical path of the final approach is quite low.

The advent of RNAV approaches in the 1980s allowed adequately equipped airplanes to be flown point-to-point based on latitude and longitude coordinates that were assigned crossing altitudes. Consequently, RNAV approaches clearly define both a lateral and a vertical trajectory.

From the 1990s onward, required navigation performance (RNP) RNAV approaches have been defined basically as RNAV approaches with a *performance-based concept*, meaning that the airplane is capable of flying the RNAV approach trajectory meeting specific RNP accuracy levels — 0.15 nm, for example. Thus, the airplane's navigation system must monitor its actual navigation performance (ANP) — typically, total navigation error, including system error and flight technical error — and has to identify whether the RNP is actually being met during the approach.

The performance-based concept ensures that the airplane remains *contained* within the specified volume of airspace, without requiring an outside agent to monitor its navigation accuracy and integrity. This concept gives great flexibility to approach designers; indeed, the notion of containment allows designers to consider approach trajectories that can satisfy various complicating and potentially conflicting constraints such as terrain, noise, environment and prohibited areas. The concept ensures a comfortable, flyable, constant descent angle vertical path, with approach minimums dictated by RNP. Figure 1 is an example of an RNP RNAV approach procedure.

Required Navigation Performance Approach



Source: U.S. Federal Aviation Administration

Figure 1

Position-Fixing

The methods and procedures recommended to fly non-ILS approaches obviously depend upon the ability of the on-board equipment to ensure the functionalities of navigation, guidance and display.

In the 1970s, the navigation functionalities essentially were based on equipment that received radio navigation signals from ground-based stations. Some airplanes had an INS that could be updated by ground-based signals. Other systems, such as long-range navigation (LORAN) and Omega, were used for long-range navigation where accuracy requirements were relatively low.

Two major steps forward in the 1980s were the widespread use of INS and the adoption of the FMS. Many transport airplanes were equipped with a least one INS, which computes the airplane's position autonomously, and at least one FMS, which also computes the airplane's position. The FMS provides lateral and vertical flight planning functions by stringing together all the legs of a flight, including the approach. The FMS can assign crossing altitudes at various waypoints of the approach, as well as a descent angle for specific legs, such as the final approach.

From the 1990s onward, the major advance in navigation technology has been achieved through the use of GPS, which is accurate, available worldwide, able to reliably specify its performance and capable of monitoring its integrity. GPS is used as a primary navigation source by the FMS. The resulting FMS-computed position is extremely accurate. The navigation databases used by the FMS have been upgraded, and, whenever required, the descent angles assigned to specific legs also are included in the database for a better determination of approach profiles.

Tracking a Trajectory

Guidance functionalities used by crews to fly approaches in the 1970s included the conventional attitude director indicator (ADI), vertical speed indicator (VSI) and altimeter. Early autopilots and flight directors with basic modes aided in the crew's ability to fly instrument approaches.

Enhancements to FMS performance allow the ability to fly any type of non-ILS approach with great precision.

In the 1980s, guidance functionalities were greatly improved by the "glass cockpit," in which the electronic flight instrument system (EFIS) featured new guidance cues such as the flight path vector (FPV). The FPV assists the crew in stabilizing segments of trajectory, particularly during final approach.

The FMS developed further and allowed additional autopilot and flight director modes better suited for tracking a trajectory. These guidance enhancements included lateral navigation (LNAV) and vertical navigation (VNAV).

From the 1990s onward, guidance functionalities have been improved by increased use of the head-up display (HUD) and by continued enhancements of the FMS. The basic flying reference in a HUD is the FPV, which allows the crew to control the airplane's trajectory in relation to external references, such as the runway. The enhancements to FMS performance allow the ability to fly any type of non-ILS approach with great precision and, thus, to meet RNP criteria.

Additionally, specific FMS "approach" modes have been developed to provide flight crews with common methods and procedures when flying any straight-in approach, ILS or non-ILS. These modes are part of the integrated approach navigation (IAN) system in Boeing airplanes and the FMS landing system (FLS) in Airbus airplanes, in which the FMS computes a virtual "beam" to the runway, based on the FMS flight plan, as illustrated by Figure 2. These new modes allow the crew to monitor deviations from the beam and make corrections similar to an ILS approach. Figure 3 is an example of an IAN-adapted display.

Increased Awareness

Displays present the crew with the information required to adequately monitor a non-ILS approach.

The essential information provided in the 1970s was the position of the airplane relative to the intended lateral trajectory of the approach — that is, the current radial to the reference navaid versus the intended approach radial.

This information was displayed by the radio magnetic indicator (RMI) during NDB and VOR approaches, and by the electronic horizontal situation indicator (EHSI) for VOR and LOC approaches. The addition of DME improved the crew's awareness of the airplane's position along the bearing indicated by the EHSI or RMI.

In this period, the crew's awareness of the airplane's vertical position versus the intended vertical path generally was very poor. The VSI, altimeter, clock and DME were used to estimate the airplane's position. The advent of EFIS displays in the 1980s brought the primary flight display (PFD) and the navigation display (ND), which is directly linked to the FMS.

Linking the FMS to the ND greatly improved the crew's lateral orientation by showing the direct relationship of the current path to the intended path. The PFD displays the vertical deviation from the intended final approach path, as selected in the FMS.

Since the 1990s, display functionalities have been further enhanced to the point that most non-ILS approaches can now be flown as precision-like approaches, provided that the adapted pieces of information are displayed for crew situational awareness. Furthermore, the development of the RNP performance-based concept has led to specific monitoring requirements.

The evolution of display functionalities may be summarized as follows: profile views of the approach displayed at the bottom of the ND for enhanced vertical situational awareness; and, on the PFD and ND, displays adapted to RNP, which has lateral and vertical deviation scales and annunciations tailored to IAN or FLS.

Factors Affecting Procedures

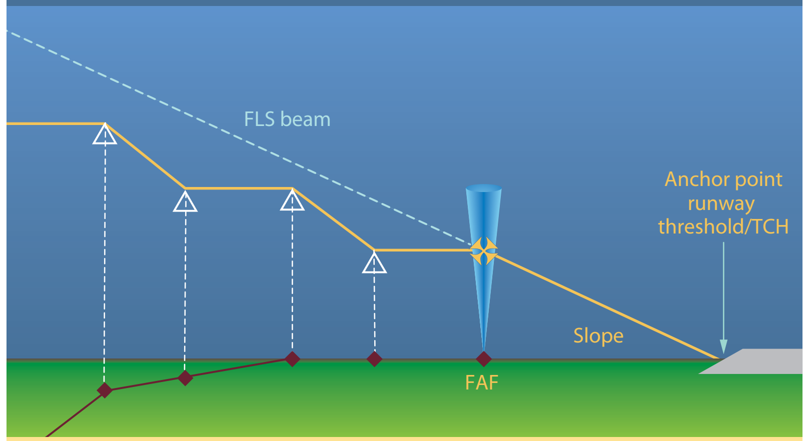
As noted earlier, the methods and procedures recommended to fly non-ILS approaches depend on the nature of the non-ILS approach and the on-board equipment. The procedures are affected by additional factors associated with the approach.

One factor is the position of the FAF, which is either defined as a geographical point on a straight-in approach or estimated by the crew — for example, at the end of the procedure turn of a teardrop approach.

Another factor is the position of the MAP, which may be located at the runway threshold or before or beyond the runway threshold.

The nature of the minimum altitude also affects the procedure. No altitude loss below the minimum descent altitude (MDA) is allowed during the approach and go-around. This applies to either the level-off at the MDA or, in the case of a constant descent angle, a go-around initiated before reaching the MDA, to keep from going below that altitude. This is not required when the minimum is a decision altitude (DA). If the required visual runway environment

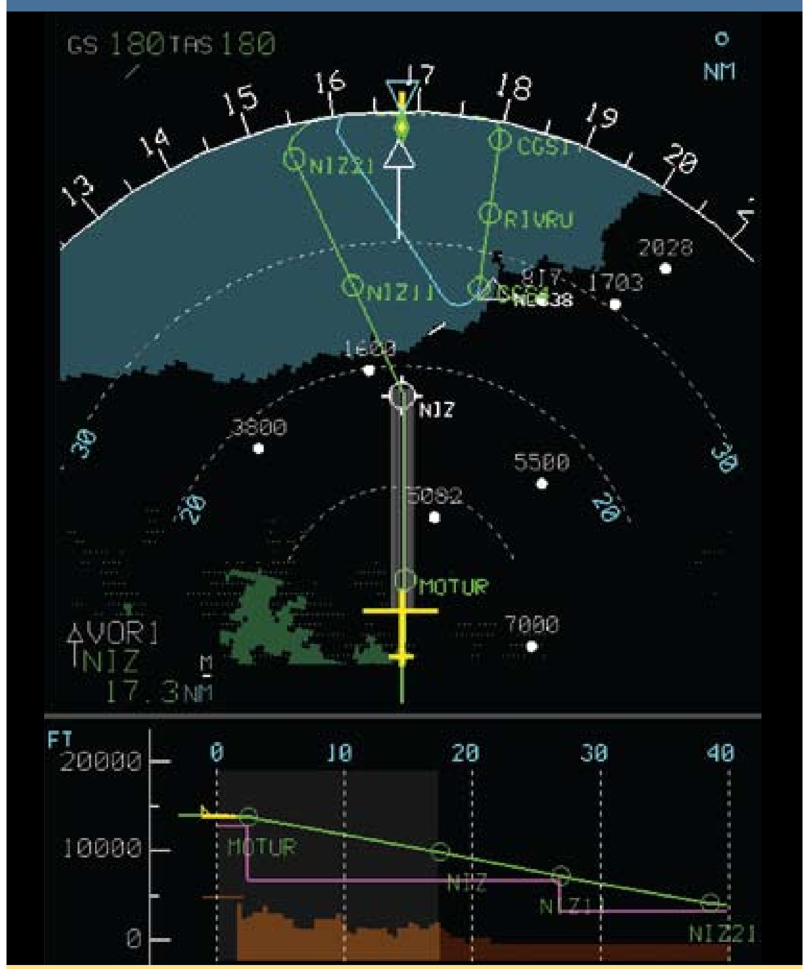
FMS Landing System Beam



Source: Etienne Tarnowski

Figure 2

Profile View on Display



Source: Etienne Tarnowski

Figure 3

references are not acquired when reaching the DA, a go-around must be initiated.

Considering all these factors, let us review the evolution of non-ILS approach procedures in the three periods discussed.

The non-ILS approach procedures in the 1970s were the traditional nonprecision approaches using NDBs, VORs, LOCs and, possibly, DME as reference navaids. On-board equipment was conventional in terms of navigation, guidance and display functionalities. Two types of methods and procedures were recommended; they differed only in the control of the vertical flight path, whereas the control of the lateral flight path was similar. Also common then, as today, was the recommended use of the autopilot to reduce workload and provide more precise tracking.

Lateral flight path control was accomplished by tuning the reference navaid, setting the RMI and EHSI for the approach to be flown, and setting the final approach course as a target trajectory. Most crews used the heading mode to track NDB approaches and the LOC or VOR mode for those approaches. Once visual references were acquired, at MDA at the latest, the approach was completed visually and manually.

Control of the vertical path was accomplished by two different methods and procedures. Both methods assumed that the airplane was being flown in the landing configuration and at the final approach speed from the FAF down to the landing or initiation of a go-around. One method was the traditional step-down/dive-and-drive/stairway method, as illustrated by Figure 4. This involved using the autopilot pitch or vertical speed mode, leveling off at the step-down altitudes and at the MDA, and transitioning to a visual final approach and landing. This method involved flight path changes at low altitudes.

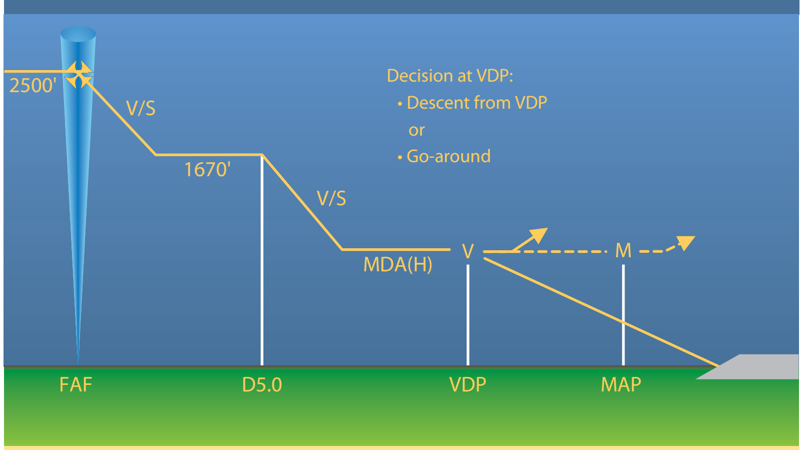
For non-FMS/non-glass-cockpit airplanes, the traditional dive-and-drive method was recommended down to MDA. The recommended procedure was to select a vertical speed of 1,000 fpm at the FAF, level off at the next step-down altitude and monitor DME or make altitude checks as available — and to repeat these steps to MDA. If the required visual references were not in sight at an altitude equal to MDA plus 10 percent of the descent rate — for example, MDA plus 100 ft for a typical 1,000 fpm descent rate — the vertical speed was reduced to level off at the MDA.

This method could result in reaching minimums past the published or calculated visual descent point (VDP). The VDP is the last point from which a stabilized visual descent to the runway can be conducted. When not provided on the chart, the position of the VDP can be estimated by the crew either as a distance to the runway threshold or as a period of time to fly from the FAF.

This method was recommended for all nonprecision approaches by some operators that often flew NDB approaches without DME and without a published vertical descent angle or rate of descent, so as to have a common procedure for all non-ILS approaches they flew.

However, this traditional step-down approach method has drawbacks. The airplane is never stabilized during the final approach. The pitch attitude needs to be changed even at low altitudes; thus, thrust and pitch have to be continually adjusted. Additionally, the airplane reaches the MDA in level flight either before

Dive and Drive



Source: Etienne Tarnowski

Figure 4

or after the VDP. Consequently, pitch attitude affects the acquisition of visual references and visual perspective of the runway. Furthermore, if past the VDP, the crew is tempted to continue visually at a high descent rate. This technique leads to unstabilized approaches, which have been shown to result in off-runway touchdowns, runway excursions/overruns and tail strikes.

Constant Descent Angle

The second method that evolved during the 1970s was the constant descent angle approach, which enables the crew to continue a stabilized approach to a landing once visual references have been acquired (Figure 5).

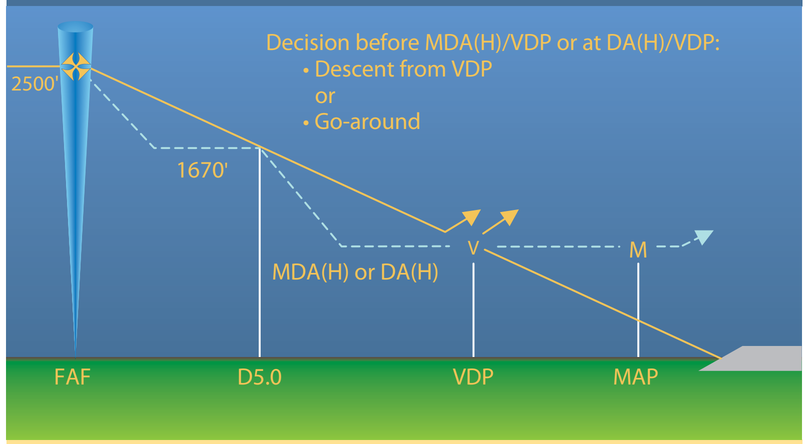
The principle of this method is for the crew to compute a vertical speed adequate to fly from the FAF to the VDP on a constant descent angle. This is a function of average groundspeed during approach. Some approach charts provide a table of altitude versus groundspeed to enable the crew to fly a constant descent angle. If such a table is not provided, the crew must estimate the time between the FAF and the VDP to establish the required vertical speed.

Consequently, during the intermediate approach segment, the crew estimates the average groundspeed, determines the constant vertical speed to be flown and estimates the VDP if one is not published. Upon reaching the FAF, the vertical speed mode is selected and the appropriate descent rate is established. The descent must be monitored by distance/altitude checks or the elapsed time if DME is not available. The monitoring must be increased as the airplane nears the VDP.

No descent below MDA is allowed if the required visual references are not acquired; a go-around must be initiated immediately. No level-off at the MDA should be considered, because with most published MAP positions, delaying the go-around decision would not allow the crew to complete a stabilized visual segment.

The advantage of the constant descent angle approach method is that the airplane is stable during the final approach, with pitch attitude, speed, thrust and pitch trim remaining constant. When reaching the VDP, the visual perspective of the runway is familiar, which allows a proper assessment of whether the approach can be continued visually and safely. The transition to visual flight is continuous, and monitoring of the vertical path is simple.

Constant Descent Angle



Source: Etienne Tarnowski

Figure 5

The Concept of Trajectory

In the 1980s, RNAV approaches were added to the mix of non-ILS approaches. EFIS and glass cockpits, FMS and improved flight director modes favored the concept of trajectory with improved flight planning. Consequently, lateral and vertical guidance, referenced from the FMS position, could be provided along a trajectory retrieved from the FMS navigation database.

The improved guidance capability allowed the tracking of this approach trajectory with little vertical deviation. While some operators still recommended the traditional step-down method, they also took advantage of the map display for improved lateral situational awareness. Many operators adopted the procedures recommended by the manufacturers, which took advantage of FMS features to support constant descent angle approaches.

Two precautions applied to full use of the FMS. The first was that the crew had to ensure that the FMS position was accurate and that its accuracy was within the tolerances of the

The coming of GPS in the 1990s … has greatly affected the way non-ILS approaches are flown.

approach — typically, within 0.3 nm. If the accuracy was within tolerances, the LNAV/VNAV modes and displays could be used. If not, other lateral and vertical modes had to be used, and a display of raw data had to be monitored for situational awareness. An inaccurately computed position directly affects the performance of FMS guidance and renders the map display misleading.

The second precaution was that the crew had to check the quality of the FMS navigation database. The final approach could not be modified by the crew. Therefore, the crew was required to check the FMS waypoints for final approach against those published on the approach chart. If these two precautions were satisfied, the FMS and its associated guidance modes and display functionalities could be used.

Segment by Segment

The constant descent angle approach method can be summarized by looking at the initial, intermediate and final approach segments. During initial approach, the crew checks FMS navigation accuracy and selects the reference navaid raw data. Then, the crew checks the final approach as inserted in the FMS against the published procedure, paying particular attention to the DA.

During the intermediate approach, the crew reduces airspeed and configures the airplane in the landing configuration. The final approach radial is intercepted via the FMS navigation mode or an intercept to the FMS final course. The crew must monitor the interception with raw data and ensure that the correct mode is selected to track the radial on final approach.

Prior to reaching the FAF on final approach, the crew must ensure that the airplane is established in landing configuration and at the final approach airspeed. At the FAF, the crew must ensure that the airplane descends on the proper path using the appropriate FMS mode, then monitor the descent both vertically and horizontally, and set the missed approach altitude in case a go-around is required. If the required visual references are acquired before or upon reaching the DA, the crew disengages the autopilot and hand-flies the rest of the approach visually, maintaining the same descent path to land. If the required visual references are not acquired, a go-around must be conducted.

The methods and procedures recommended during the 1980s emphasized stabilized approaches and constant descent angle approaches. The advantages of a stabilized approach are better horizontal and vertical situational awareness, speed awareness and energy awareness, with thrust being maintained close to the level required to fly the final approach descent angle at the final approach airspeed.

The constant descent angle approach ensures a profile that offers greater obstacle clearance along the final approach course, a technique and procedure similar to those for an ILS approach, significantly reduced crew workload, a pitch attitude that facilitates acquisition of visual references to land, and greater fuel efficiency and less noise impact on nearby communities.

GPS Precision

The coming of GPS in the 1990s, with its extremely high navigation performance and integrity-monitoring capability, has greatly affected the way non-ILS approaches are flown and has allowed full implementation of the RNP performance-based concept.

In addition, the enhancement of display and guidance functionalities has further reinforced the stabilized/constant descent angle final approach method. Thus, all non-ILS approaches now can be flown like ILS approaches and, due to GPS, may be considered as precision-like approaches.

Two methods are recommended today to fly precision-like approaches. Which method is appropriate depends on the geometry of the approach and the aircraft equipment.

The first method involves the use of final approach — LNAV/VNAV — autopilot guidance modes and is applicable to all approaches

coded in the FMS navigation database. The procedure is similar to the previously discussed constant descent angle/stabilized approach procedure. The same precautions must be taken regarding checking FMS navigation accuracy; however, because GPS monitors its performance and integrity, the crew receives alerts when the navigation performance is not satisfactory, GPS capability is lost or the RNP level is not satisfied. The same precautions also must be taken regarding checking for correct coding of the final approach waypoints in the FMS database.

The same flying technique applies, but with these considerations. If an RNP RNAV approach is being flown, the deviations provided on the PFD are scaled to RNP. Because VNAV is guiding the airplane on the flight path angle provided by the FMS, if the outside air temperature (OAT) is significantly lower or higher than standard, the barometric VNAV guidance will guide the airplane on a shallower or steeper flight path than expected. This explains why approach charts specify minimum and maximum OATs to operate with VNAV. These approaches are flown down to the DA or MDA, depending on local regulations.

The second method involves the use of the Airbus FLS or Boeing IAN mode. These guidance modes apply to all straight-in non-ILS approaches coded in the FMS navigation database. The main goal of the modes is to fly such approaches as "ILS alike," which means that the procedures recommended to flight crews for both ILS and non-ILS approaches are nearly identical: same sequence of actions, same controls and same displays.

Because these approaches are flown using the FMS navigation database, the same two precautions apply as in full use of the FMS described earlier: check the coding of the approach waypoints and check FMS position accuracy. The approach is then flown using procedures identical to flying an ILS approach. However, when reaching DA (or MDA), the crew has to disengage the autopilot and hand-fly the final segment down to landing.

Further enhancements of navigation accuracy eventually will allow autopilot-coupled nonprecision approaches to very low visibility limits and autolands. Such approaches already have been demonstrated.

Conclusion

The completion of a non-ILS approach is one of the most challenging and demanding phases of flight. Proper planning and significant strictness by the flight crew are required in the conduct of the approach, including task sharing, crew coordination, risk awareness and proper decision making.

The methods and procedures recommended to fly such approaches have significantly changed over the past decades. Unfortunately, the initial step-down/dive-and-drive methods are still widely used, even by crews of the latest-technology airplanes, despite the flaws, weaknesses and drawbacks that these outdated methods have exhibited in line operations.

Today, stabilized, constant descent angle final approaches significantly raise the safety level of this flight phase. With the spread of GPS and the latest technology glass-cockpits, all non-ILS approaches can be flown using the latest methods. The resulting procedures are very similar to the procedures recommended to conduct ILS approaches.

Furthermore, the extremely high accuracy of GPS, associated with the high performance of the lateral and vertical modes of the autopilot and flight director systems, makes the conduct of non-ILS approaches very precise.

This explains the change in the operational vocabulary from *nonprecision* approaches to *ILS-like* approaches to *precision-like* approaches. ●

Airbus, Boeing Commercial Airplanes, Bombardier Aerospace, Jeppesen, Naverus, Northwest Airlines and Qatar Airways contributed to the research and preparation of this report.

Capt. Etienne Tarnowski is an experimental test pilot at Airbus. He supervised the definition, design and development of the A310/A300-600 FMS and A320 avionics, and coordinated the overall operational definition of the A330 and A340. Tarnowski is a 1967 graduate of the French Air Force Academy and a 1975 graduate of the Ecole Supérieure d' Electricité.

Stabilized, constant descent angle final approaches significantly raise the safety level of this flight phase.

Missing Perspectives

The most frequently reported in-flight medical events typically are not those that present the greatest threat to safety or to piloting careers.

BY QUAY SNYDER, M.D.

The recent *AeroSafety World* article on flight crew illnesses (*ASW*, 8/07, p. 22) provides valuable insight into illnesses and injuries affecting flight crews during flight. The relative frequency of diseases categorized according to organ system — as reported by flight crews to MedAire's MedLink in-flight medical advice program — is important in determining fitness for any single flight. The five largest categories — ear/nose/throat, gastrointestinal, orthopedic, infectious disease and respiratory — make up nearly two-thirds of all reported in-flight medical events.

However, two other perspectives on illness are important to consider when assessing safety and career impact on pilots: the risk of in-flight incapacitation or impairment and the impact on medical certification. Interestingly, medical categories making up the majority of both the safety-compromising and career-threatening medical conditions affecting flight crewmembers do not overlap with the most frequently reported categories of in-flight illnesses.

Incapacitation and Impairment

A 2004 U.S. Federal Aviation Administration (FAA) report said that 39 cases of pilot incapacitation (inability to perform any in-flight duties) and 11 cases of pilot impairment (some ability to perform limited in-flight duties, although performance may be degraded) were reported among U.S. airline pilots from 1993–1998 (*Flight Safety Digest*, 1/05, p. 1).[1]

Loss of consciousness, which accounted for nine of the 39 impairment reports, was the most frequently cited cause, followed by gastrointestinal and neurological (six cases each), cardiac (five cases) and urological (three cases). Four of the cardiac events resulted in pilot deaths but no passenger fatalities. Of the 11 cases of incapacitation, four involved respiratory causes; there were two reports each for problems associated with fatigue and vision, and one report each for problems involving cardiac and gastrointestinal causes and infectious disease. There were no pilot deaths due to impairment, but three serious injuries occurred as a result of crew fatigue.

These FAA figures reflect a substantially different distribution of diseases than those reported to MedLink crew support services by pilots and flight attendants.

Pilot Medical Certification

Medical conditions adversely affecting medical certification are routinely reported to the joint Virtual Flight Surgeons (VFS)/Air Line Pilots Association, International (ALPA) Aeromedical Office, which provides aeromedical certification assistance to about 9,000 pilots a year.

Medical conditions potentially affecting pilot medical certification demonstrate a different distribution than in-flight illness and the in-flight incapacitation experience. This difference may reflect pilot concerns regarding medical certification issues that do not directly affect their personal decisions to fly on a particular

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day. The difference may also indicate that medical conditions that affect certification by the FAA are not proportional to the conditions that historically affect in-flight impairment, incapacitation or inquiries regarding illnesses.

Approximately 25 percent of inquiries to the VFS/ALPA Aeromedical Office involve cardiac conditions. This percentage has decreased over the previous 25 years from a high of approximately 35 percent, presumably because of the overall improvement in cardiovascular health of Americans.

Inquiries about psychiatric and psychological conditions are rising steadily in percentage; the current level is about 25 percent. This upward trend may reflect the general population's increasing recognition of mental health conditions and health professionals' increasing willingness to diagnose and treat them.

Psychiatric conditions did not result in in-flight incapacitation or impairment in the FAA study. The *AeroSafety World* article about in-flight medical advice did not individually identify mental health issues as a source of inquiries.

Other major categories of medical conditions resulting in requests to the VFS/ALPA Aeromedical Office for information and assistance with medical certification include neurological, urological, vision, gastrointestinal, ear/nose/throat, endocrine, respiratory, dermatological, reproductive, hematological and other conditions (Table 1). Many inquiries are related to the legality and prudence of using medications for these conditions.

Medication List

Although the *AeroSafety World* article says that "pilots readily can receive FAA advice on prescription and non-prescription medications," the FAA does not publish a list of authorized medications for use by flight crewmembers or air traffic controllers. Flight attendants are not required to hold FAA medical certification/qualification.

The U.S. National Transportation Safety Board (NTSB) has recommended that the FAA publish such a list, but there are drawbacks to doing so, including:

- The primary safety concern related to use of a medication is the underlying condition for which the medication is used. Frequently, relatively safe medications are used for medical conditions that are not compatible with flight safety. Publishing a list might imply that use of the medication is authorized for any purpose. This is not the case; and,
- Maintaining an accurate, up-to-date list would be difficult. Hundreds of new medications and formulations are approved annually by the U.S. Food and Drug Administration (FDA). Many over-the-counter preparations and nutritional supplements are not regulated by the FDA.

As the article mentioned, flight and cabin crewmembers may face supervisory pressures to perform flight duties when they are ill or taking medications. Unfortunately, supervisory personnel rarely have aeromedical expertise or knowledge of current FAA medication policies. Crewmembers who acquiesce to these pressures may be jeopardizing their health, risking their careers or compromising aviation safety.

Individuals seeking information about the safety of flying with a medical condition and the legality of the treatment prescribed for that condition should consult a trained aerospace medicine professional for both personal health and aviation safety reasons. ●

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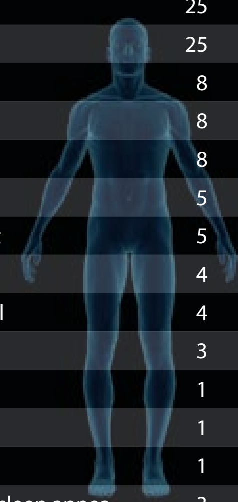
Note

1. DeJohn, C.A.; Wolbrink, A.M.; Archer, J.G. *In-Flight Medical Incapacitation and Impairment of U.S. Airline Pilots: 1993 to 1998,* DOT/FAA/AM-04-16. U.S. Federal Aviation Administration Civil Aerospace Medical Institute. October 2004.

Typical Mix of Inquiries About Medical Certification Issues*

Category of Disease by Organ System	Approximate Percentage of Case Mix
Cardiac	25
Psychiatric	25
Neurological	8
Urological	8
Vision	8
Gastrointestinal	5
Ear/nose/throat	5
Endocrine	4
Musculoskeletal	4
Hematological	3
Dermatological	1
Reproductive	1
Respiratory	1
Miscellaneous (sleep apnea, AIDS virus, dental, etc.)	3



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*Based on calls received by the joint Virtual Flight Surgeons/Air Line Pilots Association, International Aeromedical Office. Percentages vary by year.

Source: Quay Snyder, M.D.

Table 1

Insidious ICE

Basic physics makes slippery-runway issues crystal clear.

BY REINHARD MOOK

The wide range of slippery conditions on runways contaminated by frozen water still challenge even flight crews highly experienced in winter operations. But accident investigators in recent years have been pressing for a wider understanding of the basic ice physics responsible for catching pilots off guard (*ASW,* 2/07, p. 22). Runway-surface temperature — and its relationship with the dew-point or frost-point temperatures of the adjacent air — may indicate either the possibility of water freezing or the current state of the frozen water, and may improve flight crews' assessment of runway-friction properties, including times when the surface seems free of frozen contamination. Because freezing occurs on at least 30 percent of the Earth's non-glaciated land, such knowledge can reduce risk in takeoff and landing.

More realistic estimates of aircraft deceleration performance could be made if flight crews ideally were able to consider the correlation of aircraft braking friction coefficient with runway-surface temperature, the amount of water vapor close to the surface and the exact type of frozen contamination. Significant changes in the type of frozen contamination, such as rapid freezing of water, may happen in the course of minutes. Real-time broadcast of surface temperature for a dry or wet runway could be used to predict the likely freezing of liquid water or formation of frost from water vapor, as well as the microtexture of frozen contaminants.

Findings from recent accident investigations have urgent practical implications. One is that airport surface air temperatures reported to pilots via routine aviation weather reports (METARs) may be misleading with respect to actual runway-surface conditions. Another is that flight crews should interpret conservatively all reports of friction coefficients based

on data collected by the friction-measurement devices carried or pulled by airport vehicles — and consider these reports as qualitative information, not as quantitatively precise measurements.

These cautions are supported by my recent micrometeorological field work as an independent researcher at Norway's Svalbard Airport Longyear and analyses of slippery runway incidents for the Accident Investigation Board Norway (AIBN), SAS Scandinavian Airlines and the former Norwegian airline Braathens SAFE. In my research, the label "frozen contamination" on runways may mean compacted snow, "black ice" — transparent/invisible ice — or ice generated from sintered[1] snow, frozen slush, hoar frost and/or glaze from freezing rain, and may appear in various changing stages or as consecutive layers. Water freezing at 0 degrees C (32 degrees F) is assumed in this article.[2]

Current and accurate runway-surface temperature measurements are proving to be crucial to assessing frozen contamination.

At the International Society of Air Safety Investigators seminar in August 2007, Knut Lande of the AIBN reviewed unresolved issues concerning winter operations and friction measurements. The AIBN says that aircraft operators should not rely solely on runway friction coefficient reports generated by airports if frozen contamination is present or wet/damp conditions exist and the "spread" between dew point and METAR air temperature is 3 kelvins (K; 3 degrees C, 5.4 degrees F) or less. Scientists use the kelvin, formerly called degree Kelvin, as the unit of thermodynamic temperature. Based on an international agreement in 1873 about synoptic observations by weather stations — later including METARs — air temperatures are measured at 2.0 m (6.6 ft) above ground level to represent the general climate and to reduce the influence of the local microclimate.[3] To assess frozen contamination, however, accurate runway-surface temperature information is crucial.[4]

Air temperature at an airport can vary significantly from runway-surface temperature, especially when there are few clouds and the wind is light. In this situation, radiation becomes the dominant factor governing the local thermal state.

Phenomenal Friction

Friction, though not yet understood completely, is believed to be caused by electric force acting between molecules of two surfaces, and affects the interaction of materials on a molecular scale. "Kinetic friction" means the total friction of a "slider," essentially an object moving while in contact with another. For example, friction between an aircraft tire as the slider and a frozen contaminant depends on shear forces transferred by the actual contact area of their microscopic surface elevations, or high spots — which scientists call asperities — so deceleration depends on the microtexture of the frozen contamination. The slipperiness of frozen contamination on the runway also can be differentiated by how ice asperities' microscopic "peaks" and "valleys" vary within the microclimates of frozen contaminants because of adhesion and Kelvin effect, in which maximum evaporation occurs from these peaks, also called tips.

The special case of friction involving frozen contamination seems to deviate from classical laws of physics because it also depends on load and sliding velocity. Because the heat conduction within rubber is poor, most of the heat generated by friction — for example, while the aircraft tire contacts the runway surface — is conducted into the asperities of the frozen contaminant, such as ice. Rather high flash temperatures — maximum temperatures attributable to friction — occur in the contact area, which changes during the landing roll because the asperities of the ice are subject to mechanical deformation and melting as a result of the tire sliding.[5] This friction also is controlled by the volume of liquid water present due to processes such as precipitation and melting, and frictional heat. The size and dispersion of the asperities — each ranging in height from about a micrometer to a millimeter — and the adhesive characteristics of the frozen contamination also play a key role.

The mechanical tendencies of frozen contaminants — for example, that ice easily will creep[6] under load — are governed by the magnitude of the homologous temperature of each specific contaminant. Homologous temperature

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"Black ice" on runways, closely resembling liquid water, surprises unwary pilots.

is the ratio of its absolute temperature to its melting-point temperature, expressed by scientists using kelvins. Expressed in METAR temperatures, ice at minus 30 degrees C (minus 22 degrees F) has a relatively warm homologous temperature of 0.89, its 243 K absolute temperature divided by its 273 K melting-point temperature. By comparison, the homologous temperature of titanium at minus 30 degrees C is 0.13.

One counterintuitive factor is that if the frozen contamination is near its melting-point temperature, the aircraft braking coefficient of friction decreases — that is, braking action becomes worse — with increasing load. Thus, the tires of a heavy aircraft may generate less friction than those of a much lighter aircraft.

Pilots also should be aware that the aircraft braking coefficient of friction decreases significantly in relation to increasing amounts of liquid water on top, inside and at the base layer of the frozen contaminant on the runway due to melting, which submerges the ice asperities and — by water lubrication — reduces their ability to transmit shear stress. As the volume of liquid water increases, this coefficient of friction depends increasingly on sliding velocity and load. Specifically, the water volume from frictional melting increases as a function of the square root of the sliding velocity.

There are exceptions. For example, at a low temperature, a low aircraft braking coefficient of friction may occur if frozen contamination on the runway surface has been "polished" by the vertical skipping and horizontal movements of drifting particles of ice or when the tire lifts because of an air-snow mixture in an intermediate layer.

Wet snow on ice may create a complex, but weak, pattern of transmitting shear stress during braking. The reason is that snowflakes contain liquid water — and near the sea, they may contain dissolved salt — promoting slippery conditions. At 0 degrees C, at least 10 percent of the weight of snow is liquid water, maybe more depending on local topography and the resultant vertical air movement in clouds. By definition, at least 30 percent of the weight of slush is liquid water. So the squeezing of such frozen contaminants under aircraft tires contributes significantly to water lubrication and slipperiness. Adding complexity are the dynamic crystalline and mechanical characteristics of frozen contamination, which change due to factors such as runway maintenance and metamorphism — transformations occurring between forms of frozen water, such as snow to granular ice, caused by a change of external pressure such as from tires — temperature, vapor pressure and ice-particle geometry.

Contact-Free Observations

The temperature of most materials can be measured by direct physical contact between the material and a heat-conducting probe, which senses temperature increases/decreases as changes of liquid volume or deformation of metal or the changes in voltage output from a thermocouple or electrical resistance thermometer. The surface temperature of a runway profile — a line designated for measurements where wheel braking typically occurs — cannot be measured conventionally. Instead, other methods have been developed. For example, the density of infrared radiation emitted from the runway surface depends on its temperature. So the temperature of a large area may be derived indirectly by moving an infrared radiation sensor above the runway profile.

To be reliable and valuable at the microtexture level, however, measuring temperature by sensing infrared radiation — whether at one spot over the runway or all along the runway profile — requires excluding the infrared radiation from extraneous sources. Surface temperatures of a runway profile can be recorded without erroneous readings by eliminating sources such as radiation from the measuring instrument, floodlights, warm exhaust from vehicles or blowing snow between the sensor and the surface.

The method currently used for taking runway-surface temperature readings is to install electrical resistance thermometers into the concrete or asphalt. Besides confining each reading to a fixed site only — not taking into account the thermal and micrometeorological differences along the runway pavement — this method has other inherent problems. Readings are dependent on heat flow through the runway pavement and, in some cases, through the layers of frozen contamination. Therefore, the indicated temperatures on these thermometers are damped, lagging behind actual conditions. Several minutes elapse on average before they reliably indicate a surface-temperature change.

Ground/Air Freezing

Because the ground is the major transformer of heat, from absorbed radiation to heat and from heat to emitted radiation, the microclimate with the most extreme temperature fluctuations actually is found at, or close to, the microtexture of the runway surface. Within this boundary layer of air, just fractions of a millimeter in thickness, vertical temperature gradients equivalent to several thousand kelvins per meter are common.

Many aspects of heat flow that influence changes in runway-surface temperature have to be considered. These include absorbed and emitted solar/terrestrial radiation, sensible heat flow — what people describe as temperature changes — in the air due to convection and shear stress turbulence, latent heat within or released by water vapor, heat absorbed by melting or released by freezing, heat conducted inside the pavement and heat content in the layers of frozen contamination. Other factors also may be significant, such as the heat content in freezing rain and the lateral heat transfer by air.

Scientists for decades have been able to calculate the amount of dew or hoar frost that will be deposited at the Earth's surface from the net radiation, the flow of heat and air temperature, without directly measuring the surface temperature.[7] To routinely monitor all the variables would be too complex and impractical for routine airport operations, but the underlying principles are valuable.

In particular, when the radiation balance between the ground and the atmosphere is negative — as on clear winter nights — the runway pavement cools by radiation deficit with the rate affected by the cooling of the adjacent air and the heat conducted from deep inside the pavement to the cooling runway surface. The air transfers heat to the radiation-emitting surface, and if formed, dew and freezing dew or hoar frost contribute by releasing heat. The resulting temperature inversion in the air layer adjacent to the runway surface easily may produce a surface 10 K (10 degrees C, 18 degrees F) colder than the airport's METAR air temperature.

Dew strongly contributes to melting because the heat released by one unit of dew theoretically can melt 7.5 units of ice at 0 degrees C. But, at this air temperature, ice melts only if the water vapor is saturated. In the early 1950s, one scientist calculated that for snow at 0 degrees C, the onset of melting does not occur at standard sea-level pressure until the air temperature exceeds 2.5 degrees C (36.5 degrees F) at a relative humidity of 60 percent or 4.2 degrees C (39.6 degrees F) at 40 percent because of the latent heat of evaporating water.[8]

Frozen dew or hoar frost reduce runway friction by water lubrication. If freezing is not a factor, dew forms when the dew-point temperature adjacent to the runway surface is warmer than the surface. When conditions conducive to freezing are involved, however, the frost-point temperature becomes most relevant. Because the saturation vapor pressure in relation to solid water — ice — is lower than in relation to liquid water, the saturation vapor pressure can be reached, causing frost formation despite a seemingly wide difference between the METAR air temperature and dew point, which is reported in METARs even at temperatures below freezing.[9]

Predicting Frost and Worse

A practical guideline for flight crews is that the frost point will be 1 degree C (1.8 degrees F) warmer than the airport's reported dew point while the airport's

© Ole M. Rambech/Svalbard Airport Longyear

Reinhard Mook's tire-temperature readings from a Boeing 737-400 factored into slippery-runway analyses.

surface temperature is minus 10 degrees C (14 degrees F), 2 degrees C (3.6 degrees F) warmer at minus 20 degrees C (minus 4 degrees F) and 3 degrees C (5.4 degrees F) warmer at minus 30 degrees C (minus 22 degrees F). That means that a METAR showing a 1 degree C temperature–dew point spread with a surface temperature of minus 10 degrees C already is a saturated vapor condition with respect to ice — so flight crews should expect frost on the runway. In fact, a runway at minus 10 degrees C might be coated with ice.

In the case of solar radiation or warm nocturnal clouds above a cool ground, both the runway pavement and the air gain heat by surplus radiation. On an uncontaminated runway surface, the temperature may exceed the adjacent air temperature. For example, even during summer in the Arctic, the runway-surface temperature may be 20 K (20 degrees C, 36 degrees F) warmer while METARs report the air temperature as freezing; far higher runway-surface temperatures may occur at lower latitudes.

Such transfers of heat to frozen contamination on the runway surface typically cause evaporation and warming to 0 degrees C followed by melting. Solar radiation through a transparent layer of ice can cause melting that begins from the bottom of the layer. In contrast, frozen contamination absorbing heat at its upper surface can attain 0 degrees C and melt beginning from the top layer, although the METAR air temperature is well below freezing.

Conversely, in conditions of warm air and little water vapor, with minimal or zero solar radiation, evaporation from a wet runway surface — combined with the radiation deficit — may result in ice forming on the runway surface despite an apparently large difference of 10 K to 15 K (10 degrees C, 27 degrees F) between METAR air temperature and runway-surface temperature.

In another scenario, lateral heat transfer by air at temperatures above freezing, with the runway surface covered by frozen contamination, may cause the air to cool. Since frozen contamination by definition cannot exceed 0 degrees C, dew formation and the melting process then may cause an extremely slippery runway despite a METAR air temperature well above freezing. ●

Reinhard Mook, Ph.D., who retired in 2006 as a professor at the University of Tromsø in Norway, is an independent consultant and researcher whose main interest is meteorological phenomena near the ground, including practical applications ranging from atmospheric effects on technology to demographic effects. Mook received his doctorate from the University of Innsbruck, Austria, after conducting research on radiation and heat data from Antarctica in 1961. His research in 2004 and 2005 was conducted with encouragement from the staff of Svalbard Airport Longyear and Avinor, the owner and operator.

Notes

1. Sintering is molecular-level bonding/fusion that can occur within clusters of snow grains, causing them to freeze into larger snow crystals; the process also occurs in ice and other aggregates.

2. In micrometeorology, scientists typically study weather-related processes on scales from a millimeter or less above ground level to heights of hundreds of meters — focusing, for example, on the air-ground exchange of heat and moisture at the shallow boundary layer of air next to the ground at a specific site.

3. Cannegieter, H.G. "The History of the International Meteorological Organization 1872–1951," *Annalen der Meteorologie [Annals of Meteorology],* New Series 1 (1953).

4. Lande, K. "Winter Operations and Friction Measurements." In proceedings of the 38th Annual International Society of Air Safety Investigators Seminar, Aug. 27–30, 2007, Singapore.

5. The following sources explain these factors. Bäurle, L. "Sliding Friction of Polyethylene on Snow and Ice." Dissertation no. 16517 (2006), Swiss Federal Institute of Technology, Zurich. Buhl, D.; Fauve, M.; Rhyner, H. "The kinetic friction of polyethylene on snow: The influence of the snow temperature and the load." *Cold Regions Science and Technology,* Volume 33 (2001), 133–140. Colbeck, S.C. "The kinetic friction of snow." *Journal of Glaciology,* Volume 34 (no. 116, 1988), 78–86. Eriksson, R.; Nupen, W. "Friction of Runners on Snow and Ice." *U.S. Army Snow, Ice and Permafrost Establishment* no. 44 (translated). U.S. Defense Technical Information Center. April 1955. Kuriowa, D. "A Study of Ice Sintering." *Tellus,* Volume 13 (1961), 252–259. Kuriowa D. "The kinetic friction on snow and ice." *Journal of Glaciology,* Volume 19 (no. 81, 1977), 141–152. Oksanen, P.; Keinonen, J. "The mechanism of friction of ice." *Wear,* Volume 78 (1982), 315–324. Persson, B.N.J. *Sliding Friction: Physical Principles and Applications,* 2000, Springer Verlag, Berlin. Petrenko, V.F.; Colbeck, S.C. "Generation of electric fields by ice and snow friction." *Journal of Applied Physics,* Volume 77 (no. 9, 1995), 4518–4521. Salm, B. "Mechanical Properties of Snow." *Reviews of Geophysics and Space Physics,* American Geophysical Union, Volume 20 (no. 1, 1982), 1–19. Sinha, N.K. "Grain Boundary Sliding in Polycrystalline Ice." *Journal of Glaciology,* Volume 2 (no. 85, 1979), 457–473.

6. Creep — most familiar in the slow movement of glaciers — also occurs in thin layers of ice; the cause is mutual displacement of ice crystals in response to shear stress.

7. Hofmann, G. *Die Thermodynamik der Taubildung [Thermodynamics of Dew Formation].* Berichte Deutscher Wetterdienst, Volume 18 (no. 3, 1955), Offenbach, Germany.

8. Müller, H.G. "Zur Wärmebilanz der Schneedecke [On the Heat Balance of Snow Cover]." *Meteorologische Rundschau.* Volume 6 (1953), 140–143.

9. Saturation vapor pressure, the maximum water vapor pressure that can exist in air at a given temperature, increases strongly with a rise in air temperature.

Comments Vary on Ice-Protection Proposal

BY MARK LACAGNINA

U.S. certification standards would require new equipment and operating procedures to combat ice-related accidents.

A relatively small but disparate response was received by the U.S. Federal Aviation Administration (FAA) to proposed new certification standards intended to ensure timely activation of airframe ice protection systems (IPSs).[1]

The proposal, issued in April 2007, would require manufacturers seeking icing certification of new transport category airplanes to provide one of the following methods for detecting airframe icing and activating the IPS:

- "A primary ice-detection system that automatically activates the IPS or alerts the flight crew to activate the IPS;
- "A definition [in the airplane flight manual (AFM)] of visual cues for recognition of the first sign of ice accretion on a specified surface, combined with an advisory ice-detection system that alerts the flight crew to activate the IPS; or,
- "Identification [in the AFM] of conditions conducive to airframe icing as defined by an appropriate static or total air temperature and visible moisture for use by the flight crew to activate the IPS."

The proposed additions to Federal Aviation Regulations Part 25.1419, *Ice Protection*, would include a requirement for continuous operation of the IPS after initial activation, a system that automatically cycles the IPS or an ice-detection system that alerts the flight crew each time IPS activation is required.

The FAA said that the proposal partially addresses recommendations by the U.S. National Transportation Safety Board (NTSB) stemming from the investigations of ice-related accidents involving an ATR 72 in October 1994 and an Embraer Brasilia in January 1997.[2,3] The NTSB recommendations included a "means for flight crews to positively determine when they are in icing conditions that exceed the limits for aircraft certification" and "revision of manuals and training [procedures] to emphasize that leading-edge deicing boots should be activated as soon as the airplane enters icing conditions."

The proposal is based on recommendations by an Aviation Rulemaking Advisory Committee working group that was formed after the ATR 72 accident to review in-flight icing safety issues. The FAA said that the working group found subsequent accidents and incidents in which "the flight crew was either completely unaware of ice accretion on the airframe or was aware of ice accretion but judged that it was not significant enough to warrant operation of the IPS."

The FAA received 15 comments on the proposal before the public comment period ended on July 25. The following are partial summaries of the comments:

The NTSB said that although it supports the proposed requirements, the scope should be expanded to include airplanes that already are certified for flight in icing conditions and that current AFM recommendations to delay activation of deicing boots until a specific amount of ice accumulates should be revised. Such recommendations are based, in part, on the belief that premature activation of deicing boots might cause ice to form a bridge over the boots, rendering them ineffective. "Ice bridging does not occur on modern airplanes," NTSB said. "The IPS should be activated as soon as the airplane enters icing conditions."

Comments filed for Airbus, the Air Line Pilots Association International, BAE Systems, Boeing Commercial Airplanes and Bombardier generally supported the proposal.

Boeing recommended one revision: adding words to specify that continuous operation of the IPS is required "while the aircraft remains in icing conditions." Without this clarification, the IPS would have to operate even after the airplane exits icing conditions, Boeing said.

Bombardier took issue with the FAA's definitions of a primary ice-detection system as comprising two ice detectors and an advisory ice-detection system as comprising one ice detector. The systems should be defined by their performance, not by the number of ice detectors they incorporate, Bombardier said.

Comments filed for the Air Crash Victims Families Group also supported the proposal but chided the FAA for not having taken action sooner.

Several comments opposed the requirements for ice detectors. Charter aircraft operator Ameriflight said that an ice detector should be required only if it is shown that the flight crew cannot visually detect ice on a particular airplane. "It is our experience that the onset of icing is easily detectable … in the corners of the windshield, on windshield wiper arms, etc.," the company said.

A similar comment was filed by a former U.S. Air Force pilot, who said, "Each airplane will accumulate ice first on a certain part, and the pilots know where to look for the first indication of ice buildup."

Ameriflight also argued against automatic activation of the IPS at the first sign of ice. "Ice is only partially shed [on initial activation]," the company said. "The remainder on the boot results in 'islands' of ice that are sufficiently well-attached that they are not readily shed on successive cycles and provide a rough surface onto which additional ice accumulates more readily than upon a smooth boot surface."

Automatic IPS operation "at inopportune times could actually *decrease* safety by causing pre-existing ice accumulations to be shed into engine inlets, undesired drawdown of engine bleed air, excess electrical load, etc.," Ameriflight said.

Comments filed for Swan International Sensors and a family member of a passenger killed in an ice-related airplane accident disagreed, saying that no alternatives to ice-detection systems and automatic IPS activation should be allowed. "Simply training flight crews to recognize conditions conducive to icing is not an adequate solution," the family member said. "Such training … has existed for some time, yet these icing-related accidents still occur."

Similarly, Transport Canada said that alternatives to ice-detection systems should either not be allowed or be allowed only in airplanes that have been identified as having "a lower risk of icing-related incidents and accidents."

The founder of Innovative Safety Systems International said that requiring ice detectors would be folly. "They provide warning after the fact," he said. "They are fragile [and] unreliable." He told the FAA that it should simply specify the requirement and allow the industry to design systems that meet the intent of the requirement.

Aerodynamic performance monitoring systems were alternatives proposed by both the Regional Airline Association and by Marinvent Corp. The systems "directly measure the degradation of airfoil performance caused by the roughness and profile changes induced by the contamination of the airfoil," Marinvent said, noting that degradation of airfoil performance is "the root cause of icing accidents."

The FAA will consider the public comments as it progresses toward publication of final rules or withdrawal of the proposal. ●

Notes

1. The notice of proposed rulemaking and the public comments are available by searching for docket no. 27654 at <http://dms.dot.gov/search/searchResultsSimple.cfm>.
2. NTSB. *Aircraft Accident Report: In-Flight Icing Encounter and Loss of Control; Simmons Airlines, d.b.a. American Eagle Flight 4184; Avions de Transport Regional (ATR) 72-212, N401AM; Roselawn, Indiana; October 31, 1994.* July 9, 1996. NTSB/AAR-96/01.
3. NTSB. *Aircraft Accident Report: In-Flight Icing Encounter and Uncontrolled Collision With Terrain; Comair Flight 3272; Embraer EMB-120RT, N265CA; Monroe, Michigan; January 9, 1997.* Nov. 4, 1998. NTSB/AAR-98/04.

Airing It Out

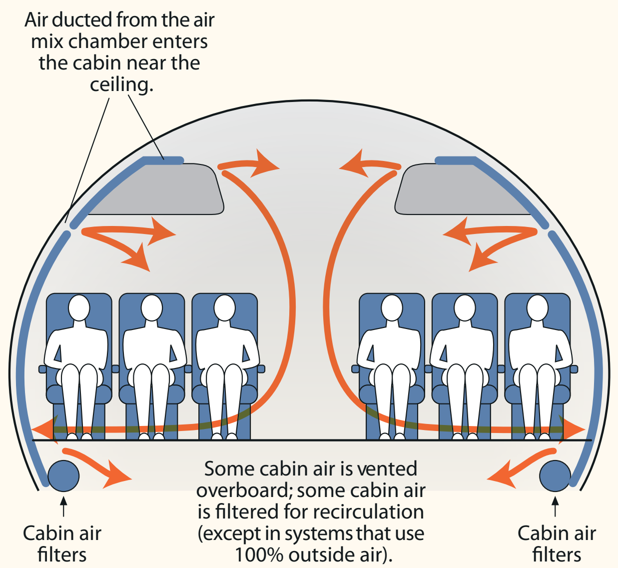
Studies have found no link between cabin air quality and health problems, but some crewmembers and passengers say those studies are wrong.

BY LINDA WERFELMAN

Airplane crewmembers have complained for years about the quality of air on the flight deck and in the cabin. Its uncomfortably low humidity leaves them susceptible to dry skin, eyes and nasal passages, and the dry environment — together with recirculated cabin air — has sometimes been blamed for helping to spread colds and other contagious diseases. Less frequently, complaints have centered on fumes from engine oil, hydraulic fluid or other sources that have permeated the airplane environment, resulting in nausea and respiratory or neurological problems.

The environment of most commercial jet airplanes, like that of an office building, is a mixture of outside air and recirculated air (Figure 1, p. 32). An environmental control system (ECS) maintains temperature, humidity, cabin pressure and ventilation; it also filters harmful contaminants to limit their introduction into

Dominant Cabin Airflow Pattern in Transport-Category Aircraft



Source: Derived from an illustration provided by Pall Corp.

Figure 1

the environment (see "Cabin Climate Control," p. 34). An ECS cannot eliminate all potential problems, however, and many issues have not yet been adequately addressed, the U.S. National Research Council (NRC) said in a 2002 report.[1]

"Environmental factors, including air contaminants, can be responsible for some of the numerous complaints of acute and chronic health effects in cabin crew and passengers," the NRC report said. Nevertheless, the report added, "The complaints tend to be so broad and nonspecific and can have so many causes that it is difficult to define or discern a precise illness or syndrome."

Dry Air and Dirt

A 2006 report based on a survey, conducted in 2000, of more than 600 SAS Scandinavian Airlines System pilots found that complaints about the flight deck environment were common and differed somewhat among different models of airplanes. Overall, 53 percent of pilots complained of dry air, and 48 percent said that they were bothered by dust and dirt. When questioned about medical symptoms, 10 percent reported "dry or flushed facial skin," and 9 percent said they had experienced an "irritated, stuffy or runny nose."[2]

The report, noting discussions of the health aspects of air recirculation, said that the survey also found that pilots of SAS McDonnell Douglas DC-9s — in which there was no recirculated air — experienced colds and other respiratory ailments at about the same frequency as pilots of airplane models with air recirculation.

A 2002 review of studies of the effects of cabin environment on the health of flight attendants found that "dryness symptoms attributable to low humidity" were among the flight attendants' most frequent complaints.[3]

These complaints typically are not associated with illness, said Anthony Evans, M.D., chief of the aviation medicine section at the International Civil Aviation Organization (ICAO).

"Low humidity is related to comfort rather than ill health; humidity levels found on aircraft [have] been demonstrated as not sufficient to cause clinical dehydration," Evans said.

A 2007 study discussed an unexpected factor: The interaction between oils in human skin and ozone in the cabin may produce chemical byproducts that worsen dry eyes and skin and contribute to headache and nasal irritation. Some airplanes have ozone-destroying substances in their ventilation systems; on airplanes that do not, the ozone levels can exceed those recorded in large cities on smoggy days, the study said.[4]

Cabin air quality is the subject of several ongoing studies, including one being conducted for the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). That study is designed to survey passengers on 160 flights about their perceptions of cabin air quality and then to scientifically evaluate the air quality using on-board monitoring instruments. An early phase of the research found that overall cabin air quality was considered "adequate" by passengers on four U.S. domestic flights.[5]

The survey coincides with ASHRAE's effort to develop standards for airplane air quality —

in terms of temperature, humidity and ventilation. The standards are expected to be published late in 2007.[6]

Quay Snyder, M.D., president and CEO of Virtual Flight Surgeons, an aeromedical consulting firm, and an associate aeromedical adviser for the Air Line Pilots Association, International, said that the physicians in his office "very, very rarely hear anything from the pilots regarding cabin air quality. … We occasionally hear about low humidity from pilots with ongoing sinus problems, primarily in the context of inquiries regarding strategies to deal with it, rather than complaints."

The NRC said that although a variety of studies have shown that upper respiratory infections and other contagious diseases are passed from one person to another in airplanes, the ECS apparently is not a factor in transmission. Instead, the most important transmission factors are density of airplane occupants and their nearness to one another, the NRC said.

Contaminants

Sometimes, when airplane systems malfunction, complaints may involve not dry air but contaminated air.

"Although the ECS is designed to minimize the concentrations of contaminants in the cabin, contaminant exposures do occur," the NRC said. "They can originate outside the aircraft, inside the aircraft, and in the ECS itself."

The NRC and other researchers define two types of contaminant exposures:

- Those that occur during routine operating conditions, such as when ozone enters an airplane along with ventilation air during flight at high altitudes, and when chemical residues from cleaning substances and other materials linger in an airplane; and,
- Those that occur during abnormal conditions, such as when engine oil, hydraulic fluid, deicing fluid and other substances enter an ECS and are then dispersed throughout the airplane.

Many specialists say that under routine operating conditions, there are no problems with air quality.

"The air quality is good on board aircraft in comparison to that found in buildings or outside in a city, for example, and the filters used for recirculation are highly efficient at removing viruses and bacteria," Evans said.

Russell B. Rayman, M.D., executive director of the Aerospace Medical Association, agreed.[7]

"Everything that makes an airplane run is toxic — the fuel, the hydraulics — but if an aircraft is properly functioning, there is no problem [with air quality]," he said.

The NRC said that research attempts to collect data on exposure to on-board contaminants have not presented a complete picture.

"The data represent only a small number of flights, and the studies have varied considerably in their sampling strategies, the environmental factors monitored and the measurement methods used," the NRC said. "Consequently, cabin air quality under routine conditions has not been well characterized."

Nevertheless, the NRC said that healthy people probably would not be adversely affected by exposure to reduced air pressure and elevated ozone levels.

Although the NRC said that "no published studies describe quantitative measurements of air quality under abnormal operating conditions," reports by accident/incident investigative boards in a number of countries discuss incidents in which oil fumes or hydraulic fumes have been introduced into the airplane by an ECS.

For example, a report by the Swedish Accident Investigation Board (SHK) described a Nov. 12, 1999, incident in which the captain and copilot of a Braathens Malmö Aviation BAE Systems BAe 146-200 were temporarily incapacitated during a descent from 15,000 ft in preparation for landing at Malmö after a flight from Stockholm.[8]

The SHK said that the probable cause of the incident — in which none of the 73 people in the airplane was injured and the airplane was not damaged — was "the pilots becoming temporarily affected by probably polluted cabin air."

"The air quality is good on board aircraft in comparison to that found in buildings or outside in a city."

Investigators were unable to identify the source of the pollution, however.

The report cited a series of ailments experienced by the crew not only during the incident flight, which was the last of three one-hour flights that day, but also during the two prior flights. Those ailments included the purser's "unpleasant feeling of fainting" during the first flight and a flight attendant's "odd pressure in the head, nasal itching and ear pain" during the second flight, when the purser and another flight attendant also reported discomfort. During the third flight, the captain and the purser briefly detected a burning odor, followed by "more pronounced" discomfort experienced by all cabin crewmembers; later, the captain was dizzy and both flight crewmembers became nauseous. After several minutes of breathing oxygen, they conducted a normal approach and landing "without problems," the report said.

Cabin Climate Control

Commercial jet airplanes typically have an environmental control system (ECS) to establish a safe, comfortable environment by regulating cabin air pressure, air temperature and humidity and limiting the introduction of contaminants.

The ECS maintains cabin air pressure at no less than the atmospheric pressure at 8,000 ft — the limit set by civil aviation authorities. In most airplanes, the ECS uses a combination of engine bleed air — outside air brought into the system through the engines — and recirculated air — cabin air that is filtered and redistributed through the airplane. Some airplanes, such as the McDonnell Douglas DC-9 and the Boeing 787, use no recirculated air.

Outside air enters the jet engine compressors, where it is warmed as it becomes pressurized, then cooled by the engine's heat exchangers and the air conditioning units. Cooled air is mixed with a similar amount of filtered air from the cabin and then enters the cabin through overhead outlets. The air flows through the cabin in a circular pattern before it is either vented overboard or filtered to remove nearly all particles, including bacteria, viruses and liquid droplets of some contaminants, before it is recirculated.[1]

The recirculated air contains slightly more humidity; some airplanes also are equipped with humidifying systems.

— LW

Note

1. Boeing Commercial Airplanes. Cabin Air Systems. <www.boeing.com/commercial/cabinair/>.

In another incident, the U.K. Air Accidents Investigation Branch (AAIB) said that on several days in November 2004, the flight crew and cabin crew of a Boeing 757 had a variety of symptoms on different flights between London Heathrow Airport and several European cities.[9]

"The aircraft experienced several incidents, on different flights, of fumes in the cockpit and cabin, and in some cases, this produced symptoms in the flight and cabin crew," the AAIB report said. "Although evidence was found of leaking hydraulic fluid having migrated inside a bleed air supply duct, the various investigations failed to definitively establish if this was the source of the fumes."

The report cited "numerous other reports of oil smells in the cockpit and/or cabin of the Boeing 757" and said that the fumes in the November 2004 incidents — described by crewmembers as "warm, sweet … but slightly burnt" and similar to "oily sewage" — might have indicated that the hydraulic fluid leak was unrelated.

The symptoms experienced by the crew during three days of problems included the captain's sensation of being "a bit spacey" and feeling "a little unwell," the first officer's "buzzy head and body" and several cabin crewmembers' sore throats, the report said.

The report said that, of the various reports of oil smells, "some of these events have been the result of genuine oil leaks from the engine or [auxiliary power unit] compressor oil seals. In other cases, no definite source of the fumes could be identified. However, service experience shows that overfilling the engines with oil can produce fumes in the aircraft interior."

The AAIB said that after a previous incident involving another 757 belonging to the same operator, that operator took "extensive measures to ensure that the engine oil is serviced correctly." In this incident, there was no indication that the engines were overfilled with oil.

Several years earlier, in 2000, a report by a committee of the Australian Parliament said that cabin air in BAe 146s had been "to use the most commonly used description, 'smelly' since its introduction into passenger service in the mid-1980s." Cabin air quality was a "persistent problem" since the early 1990s, with periodic complaints of oil fumes in the cabin. As a result, the report said, a number of BAe 146 crewmembers experienced an "occupational health effect" that caused some to stop flying.[10]

In 2001, after several incidents involving the partial incapacitation of flight crewmembers, the U.K. Civil Aviation Authority (CAA) began a research program to evaluate cabin air quality. Researchers concluded, in a report published in 2004, that "fumes from engine oil leaking into the bleed air system, and hence into the cabin air supply, is the most likely cause of the incidents. There are over 40 different chemicals contained in oil breakdown products, and many have no published toxicity data, so it is not possible to be certain whether any of these products contribute to, or are the sole cause of, the recorded incidents."[11]

Lasting Symptoms?

The CAA research did not evaluate the long-term health effects of exposure to oil fumes. Some current and former airline pilots and flight attendants, however, say that they have experienced chronic fatigue, brain damage and a variety of respiratory and neurological symptoms and abnormal medical test results, and that they believe their symptoms were caused by repeated exposure to engine oil fumes that entered the airplane when the air supply was turned on.

One of them, Susan Michaelis, a former Australian airline pilot, said in a presentation to the U.K. Parliament in June 2007 that she still experiences these symptoms — 10 years after she stopped flying because of health problems and eight years after losing medical certification. Michaelis, now a researcher for the Global Cabin Air Quality Executive, said that she believes the symptoms result from repeated exposure to an engine oil additive called tricresyl phosphate.[12]

"I am well aware of many other pilots and flight attendants in Australia experiencing almost identical effects and similarly no longer able to fly, in most cases," she said. "I am also aware of the same effects being experienced by many pilots and flight attendants from … other countries. The pattern is remarkable."

Many aeromedical specialists, however, say that there is no scientific evidence to link the symptoms to any exposure to oil fumes in the airplane.

"Cabin air quality is an emotional issue," said Rayman, who noted that, although malfunctioning ECSs can cause medical problems, "I'm not aware of good scientific studies that have linked cabin air with illness."

ICAO's Evans agreed.

"It has yet to be reliably demonstrated that ill health effects claimed to be caused by such events are actually related to them," he said. "Having said that, I am open to the results of further studies … to try and identify the potential contaminants."●

Notes

1. U.S. National Research Council (NRC). *The Airliner Cabin Environment and the Health of Passengers and Crew*. Washington, D.C.: National Academy Press, 2002.
2. Lindgren, Torsten; Andersson, Kjell; Norbäck, Dan. "Perception of Cockpit Environment Among Pilots on Commercial Aircraft." *Aviation, Space, and Environmental Medicine* Volume 77 (August 2006): 832–837. The survey questioned pilots of Boeing 737-600s and 767-300s, and McDonnell Douglas DC-9s, MD-80s and MD-90s.
3. Nagda, Niren L.; Koontz, Michael D. "Review of Studies on Flight Attendant Health and Comfort in Airliner Cabins." *Aviation, Space, and Environmental Medicine* Volume 74 (February 2003): 101–109.
4. American Chemical Society. *Skin Oil–Ozone Interactions Worsen Air Quality In Airplanes*. <www.eurekalert.org/pub_releases/2007-09/acs-so090507.php>.
5. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). *Major Study of Aircraft Cabin Air Quality Launched*. Jan. 10, 2007. <www.ashrae.org/pressroom/detail/16102>.
6. ASHRAE. *ASHRAE Revises Proposed Cabin Air Quality Standard*. Oct. 27, 2006. <www.ashrae.org/pressroom/detail/15950>.
7. Rayman also is a member of the *AeroSafety World* Editorial Advisory Board.
8. FSF Editorial Staff. "Cabin-Air Contamination Briefly Incapacitates Crew." *Cabin Crew Safety* Volume 37 (January–February 2002).
9. U.K. Air Accidents Investigation Branch. *AAIB Bulletin 7/2005*, Report nos. EW/G2004/11/08 and EW/G2004/11/12.
10. Parliament of the Commonwealth of Australia, Senate Rural and Regional Affairs and Transport References Committee. *Air Safety and Cabin Air Quality in the BAe 146 Aircraft*. 2000.
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12. Michaelis, Susan. *Memorandum: Air Travel and Follow-Up Inquiry*, presentation to U.K. Parliament, Science and Technology Select Committee. June 26, 2007.

Technology Can Reduce Runway Mishaps

BY JOHN W. DOUGLASS

Even a quick scan of aviation-related news over the last few months reveals several high-profile reports of near-collisions on runways. Data show that serious incidents are more frequent as U.S. airports and skies become more crowded and passenger numbers climb toward unprecedented levels.

The news underscores the importance of aggressively pursuing the transformation and modernization of the U.S. air transportation system that is under way by the Joint Planning and Development Office, authorized by the U.S. Congress to coordinate a major air traffic control system upgrade involving several government agencies. (See InfoScan, p. 54.)

ADS-B moving map displays will cut through bad visibility and provide pilots not only with their position on the airport grounds, but also with information about all other ground traffic and the positions of other aircraft flying near the runways.

The Next Generation Air Transportation System, or NextGen, includes advanced technology that, along with enhanced training and awareness, can go a long way toward dramatically increasing runway safety.

It is clear the no-end-in-sight increase in demand for air travel is a major factor in runway incidents. A 2000 study by Transport Canada, which included U.S. Federal Aviation Administration (FAA) data, found that a 20 percent increase in traffic volume represents a 140 percent jump in runway incursion potential.

Building on the excellent work of the Commercial Aviation Safety Team (CAST), the FAA and aviation community responded to the recent events with swift and strong measures, instituting a number of immediate changes to make runways safer. They include thorough reviews at the 20 airports with the greatest history of problems or risk factors, improved procedures for pilots, and expedited lighting and signage upgrades at dozens of airports. These actions are excellent steps that directly improve situational awareness and should lead seamlessly into long-term fixes.

It is critical that we remain diligent in pursuing those long-term fixes within NextGen. This sweeping transformation of the air traffic control system holds extremely promising technologies for both flight crews and controllers that could make runway incidents a thing of the past.

This is not something in the distant future — it is already in the works. The FAA recently awarded a contract for one of the building blocks of NextGen, the automatic dependent surveillance-broadcast (ADS-B) system. The US$1.8 billion contract, which went to a team led by ITT Corp., calls for development and deployment of ADS-B over the next three years, with full implementation by 2013.

ADS-B has proven itself effective in early implementation in Alaska under the Capstone program, where its use has cut the accident rate in half. So clearly, ADS-B proves capacity enhancements and safety enhancements can go hand-in-hand.

ADS-B will be a huge leap forward because it incorporates global positioning system (GPS) technology into the air transportation system for the first time.

ADS-B uses GPS to provide quick and accurate aircraft position information, a major upgrade from the decades-old radar-based system in use today. The information is much more precise, and can provide additional data on weather and traffic to both pilots and air traffic controllers. The system can vastly increase situational awareness both in the air and on the ground, which can make it the first line of defense against runway accidents.

When implemented, ADS-B will enable full-capability moving map displays to help guide pilots around the often confusing airport environment. The displays will cut through bad visibility and provide pilots not only with their position on the airport grounds, but also with information about all other ground traffic and the positions of other aircraft flying near the runways. Full implementation of this capability may take years.

In the interim, we must maximize the use of other existing technologies, such as own-ship moving map displays, to provide crews with enhanced situational awareness, improved alerting and reduced distractions. These steps will go a long way toward making airport operations safer.

It is very important that we do not see initial incremental advancements like the ADS-B contract and conclude that we've solved all our problems.

Right now, NextGen represents tremendous potential. NextGen will be a remarkable accomplishment for the United States, adding desperately needed capacity to the system while making air travel safer in the skies as well as on the ground. But we must move forward aggressively to ensure its implementation.

This will require strong and consistent advocacy from the aviation community to ensure that leaders make the investment and commitment to fully implement NextGen, both in the near-term and long-term. We must take advantage of all the safety capabilities provided by ADS-B and other capacity-increasing building blocks. As NextGen planning and implementation continue, we must ensure that the safety improvements remain a priority central to the plan. ●

John W. Douglass will retire next month after nine years as president and CEO of the Aerospace Industries Association.

Beyond

Business jet accident shows the value of exceeding regulatory requirements for flight attendants.

BY WAYNE ROSENKRANS

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Some operators of corporate, charter and private flights in business jets use flight attendants to perform safety and service duties when this is not required by aviation regulations.[1] Other operators say that a flight attendant would not be appropriate in the context of their overall safety strategy — and they instead train passengers to cope with cabin emergencies or depend entirely on the flight crew. Making someone responsible only for service-related duties in the cabin, however, falls short of the best safety practices currently recommended.

Circumstances of the February 2005 runway overrun at Teterboro, New Jersey, U.S., by a chartered Bombardier Challenger 600 brought into sharp focus the value of a flight attendant in corporate/charter operations (*ASW,* 3/07, p. 30).[2] The aircraft was destroyed by crash forces and postcrash fire after colliding with vehicles on a freeway and a warehouse. The flight crew received serious injuries. The nine passengers, including one "cabin aide" — a customer service representative provided by the operator — received minor injuries.

One of the U.S. National Transportation Safety Board (NTSB) findings said, "The cabin aide did not perform a seat belt compliance check before the accident flight, which resulted in two passengers being unrestrained during the accident sequence." Another said, "The cabin aide's training

Passenger Service

did not adequately prepare her to perform the duties with which she was tasked, including opening the main cabin door during emergencies." One of the accident report's four safety recommendations focused on the risk of passenger confusion about any cabin employee's role and qualifications.[3]

Several passengers — because of differences compared with flying on their own company's Challenger — were surprised to be greeted by a person who the NTSB found was "dressed in a crewmember-appearing uniform," served them beverages and occupied the cockpit jump seat for takeoff but did not conduct a pre-takeoff safety briefing.[4] The passengers assumed that the cabin aide was a flight attendant trained to conduct an evacuation, but — after the airplane stopped moving — they initially could not find her, they heard no evacuation commands, and they heard no answer when they asked her how to open the main cabin door. A separate survival factors report also cited the cabin aide's departure from the aircraft and accident scene before accounting for everyone on board.[5]

"We were concerned when we heard that passengers were thrown out of their seats and were unable to locate seat belts on the divan. We asked our regional investigators to notify us if they find those problems in future accidents because we would like to investigate and document that type of information," said Nora Marshall, chief, NTSB Survival Factors Division. "If there is someone on board the aircraft who could be perceived as a trained crewmember, that person should have proper training. The NTSB did not ask for cabin attendants to be required; it said that if on board, they should be trained and effective for emergencies."

"When there is a cabin aide on board, flight crews may be tempted to delegate some of their safety-related responsibilities — such as the safety briefing — to this 'crewmember' when, in fact, he or she may only be a caterer or server with absolutely no safety training," said Jason Fedok, the NTSB survival factors investigator for this accident. The NTSB has watched the airline industry, over a period of decades, shift the balance of in-flight service from cabin crews focusing too much on passenger comfort issues to currently putting safety first as safety professionals. "The same evolution needs to happen in the corporate/charter world," Marshall said.

Not As Expected

Flight Safety Foundation safety auditors discourage the use of cabin aides for one main reason. "You cannot tell passengers that the person serving them is less than fully qualified — that would only confuse them," says Darol Holsman, FSF manager, safety audits. The same principle applies to substituting in this role any pilot or maintenance technician who has not been cross-trained as a flight attendant.

Holsman said that he has been disappointed lately by some corporations' reluctance — in spite of FSF awareness efforts — to voluntarily integrate a flight attendant into the crew complement of the larger business jets for the sake of passenger safety. Corporate/charter operators typically consider a flight attendant only if they fly something like a Challenger 600, 601, 604 or Global Express; a Gulfstream GIV/4 or GV/450/550; or a Dassault Falcon 50, 2000 or 900, he said.

The FSF audit team has promoted

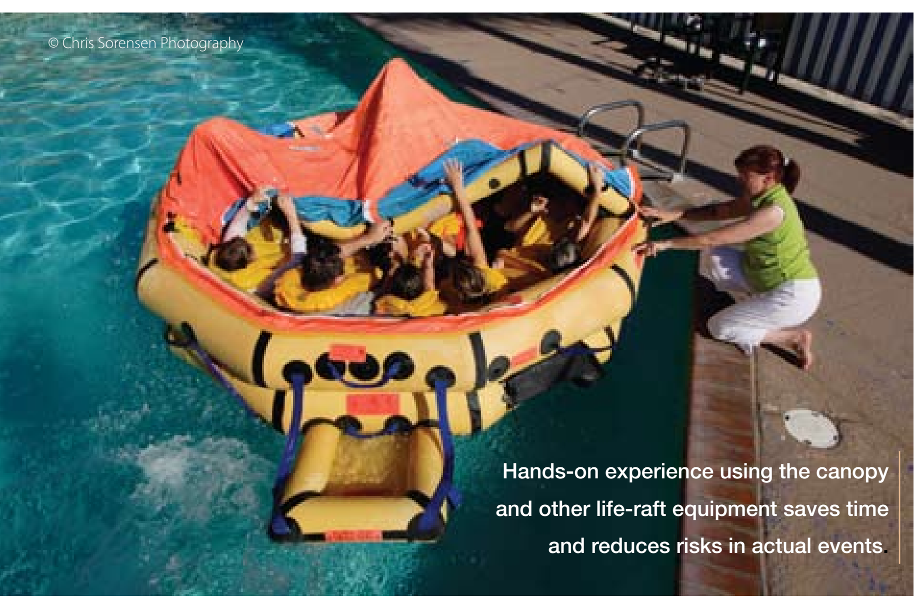
Defense of crewmembers, passengers or the aircraft against unexpected threats may require training tailored to confined spaces.


© Chris Sorensen Photography

Confidence gained boarding a life raft from the water extends to other aspects of coping with a ditching.

hands-on cabin emergency training for frequent-flier corporate executives especially when a flight attendant cannot be assigned. "But what is lacking then is any guarantee that those who receive training have the discipline in an emergency to get people off the airplane in a hurry," Holsman said. "More than 90 percent of pilots we interview have a high level of confidence that the flight attendant could evacuate the passengers if something happened to the flight crew."

At the global level, a voluntary code of best practices, the International Standard for Business Aircraft Operations (IS-BAO), positively influences operators' attitudes about the voluntary use of flight attendants, according to Peter Ingleton, director, International Civil Aviation Organization liaison, of the International Business Aviation Council. The IS-BAO says, "The minimum number of cabin crewmembers shall be in accordance with national requirements" and operators "shall ensure that each cabin crewmember has fulfilled the requirement of the operator's ground and flight training program [with initial and annual training covering aircraft type training, safety procedures training, emergency procedures training initially and every two years, first aid training and aircraft-surface contamination training]."



Hands-on experience using the canopy and other life-raft equipment saves time and reduces risks in actual events.

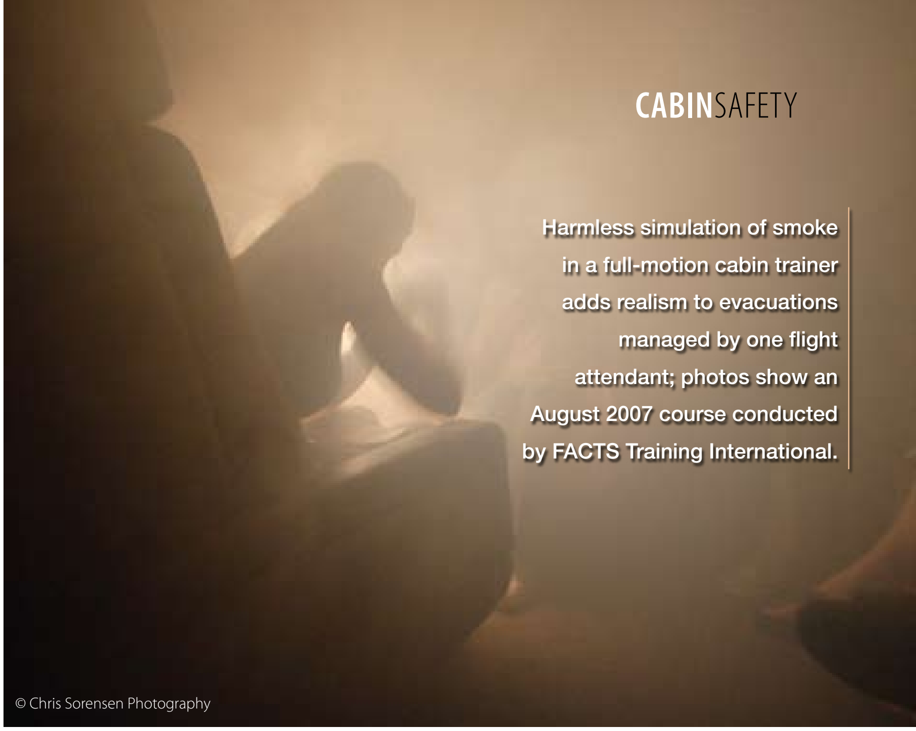
Flight attendant training already is a major part of the U.S. National Business Aviation Association (NBAA) Standards of Excellence in Business Aviation (SEBA) program, which encourages continuing education within the business aviation community. It establishes a set of common expectations between flight attendants and aviation department pilot-managers, says Jay Evans, director, operations, and staff committee liaison to the NBAA Flight Attendants Committee.

The NBAA has promoted the voluntary use of flight attendants by awarding them a total of 261 scholarships since 2000, identifying training organizations and attracting flight attendants to business aviation. Flight attendants also have been strongly encouraged to complete the NBAA certified aviation manager program, Evans said.

Endorsement of professional training of flight attendants has permeated NBAA activities, he said. "The NBAA *Management Guide* also emphasizes that a flight attendant is aboard for safety — ensuring that the flight crew is briefed properly, exits are managed properly, emergency equipment is prepared, and the passengers briefed and ready to go," Evans said. "In so many instances, we know that a properly trained flight attendant responded properly and saved lives. Being there and handling the situation made a difference."

One Person's Commitment

Voluntarily implementing a three-person crew in a business jet can begin with just one manager's commitment to the value of having a flight attendant, says Doug Schwartz, manager, Global Aviation Services at ConocoPhillips. His company takes the position that within the logistical confines of the size of the airplane, the minimum crew for a business jet with a flat floor and wide cabin is two pilots and a flight attendant. Logistics come into play because in some airplane types, there is no room in a full cabin for a flight attendant to walk back and forth or even to stand up, he said.


© Chris Sorensen Photography

Harmless simulation of smoke in a full-motion cabin trainer adds realism to evacuations managed by one flight attendant; photos show an August 2007 course conducted by FACTS Training International.

This commitment also implies a mindset that, just like the pilots, the flight attendant is a necessity, regardless of regulations. "If cabin safety is going to be an integral part of flight operations, the interactions between the flight attendant and pilots need to be just as well scripted as between the flight crewmembers," Schwartz said.

An aviation department manager typically must be able to explain to senior corporate executives why the company should use flight attendants and how the new function will be managed. This means being ready with answers to many questions. "If you use flight attendants, how do you recruit them?" he said. "What characteristics and qualifications are required? Do you network or outsource? Full-time or part-time people? Do you have different qualifications for full-time and part-time people? In any case, if you use a flight attendant, how does the flight attendant fit into the crew? Is he/she just an additional person in the back of the airplane or an integral part of the crew? Procedurally, how do the pilots and flight attendant communicate and interrelate? What kind of briefing do [the pilots] conduct for the flight attendant?"

Judith Reif, president and contract flight attendant for JR Flight Services and a member of the NBAA Flight Attendants Committee, argues that business aviation operators' crewing decisions should be based on safety issues, not arbitrary factors. "Flying domestically, some operators feel that a flight attendant is not needed and that the pilots can attend to the passenger needs," Reif said. "Anything could go wrong at any moment, however. We are an asset to the pilots, and we can be their eyes and ears in the cabin."

Except for breaks on long flights, pilots need to be in the cockpit. "Once a pilot steps out of the cockpit, the flight is a single-pilot operation, which becomes a safety issue," Reif said.

Empowering Decision Makers

Because few regulatory requirements govern the training of most flight attendants in business aviation, some training organizations aim to empower them with more aviation education than in the past, says Colette Hilliary, program manager for cabin safety and flight attendant training, FlightSafety International. A strong focus on crew resource management, understanding dynamic variables and informed decision making under the stress of an emergency situation or outside the normal scope of responsibility constitute the new model.

Examples include sufficient understanding of fire extinguishers to knowledgeably override simple rules for extinguishing different classes of fire; familiarization with the general operation of aircraft radios; how to use a quick-donning oxygen mask; jump seat adjustment and harness release for extrication of an incapacitated pilot from the cockpit; and vigilance looking for hazards outside the airplane during ground operations, especially while taxiing and while in the hangar.

Some operators train corporate flight attendants to shut down the aircraft engines and/or auxiliary power unit in an emergency. Medically approved mixed-gas training equipment — an alternative to the hyperbaric chamber —

Today's drills on fighting cabin fires in business jets cover informed decision making for unfamiliar scenarios.


© Chris Sorensen Photography

also has been installed inside the cabin trainer to provide corporate flight attendants an optional training enhancement to experience their individual symptoms of hypoxia. This training has been highly effective, Hilliary said.

Increasingly, corporate flight attendant trainees already have earned a U.S. Federal Aviation Administration (FAA) certificate of demonstrated proficiency through airline training or U.S. Federal Aviation Regulations (FARs) Part 135, commuter and on-demand, operator training.[6] About half of the trainees in FlightSafety International corporate flight attendant courses have the certificate, and many of them work concurrently for airlines and business aircraft operators.

Because of increased FAA surveillance of the operational control of charter flights, such as under FAA Notice 8000.355, *Inspector Guidance for Part 142 Training Centers,* operator responsibility for ensuring training — including Part 135 flight attendant training — has come to the forefront in 2007 and operators are expected to be more diligent in identifying all personnel who need training before flying charter trips, Hilliary said.

The current standard in business jet flight operations is flight attendant training specifically designed for corporate/charter flights, says Doug Mykol, president and CEO of AirCare Solutions Group, which includes FACTS Training. The solution has become advanced full-motion simulators for flight attendants with representative galleys, actual exit-opening mechanisms, standard emergency equipment, smoke and fire simulation, and realistic sounds, Mykol said.

Training organizations also have been advocates for wider use of flight attendants in business aviation. "My estimate is that 60 to 70 percent of the cabin-class business jets have a third crewmember on every flight," Mykol said. "Our position is that any time operators have a stand-up cabin — whether six or 14 passengers — they really should have a trained third crewmember."

In her experience, most passengers flying on corporate/charter aircraft have shown respect for the duties and responsibilities of the flight attendant, said Mary Lou Gallagher, owner of Beyond & Above Corporate Flight Attendant Training. Since the Challenger overrun at Teterboro, a greater number of cabin aides have completed the company's corporate flight attendant course — typically at their own expense as freelance contractors. The comprehensiveness and demands of this training often were not appreciated beforehand by the cabin aides or their employers. "By the end, we will have put them through a ditching in which they had to put on a life vest, jump in the water, inflate the life raft and get into the raft," Gallagher said. "They are excited then because they feel very confident about using all the equipment on board."

Demand for wider voluntary use of flight attendants could depend somewhat on passenger awareness, however. "Because there has been an explosion of people buying their own aircraft, and other people managing these aircraft, I do not think the people sitting in the back are as educated as they should be about who actually is in the cabin and their credentials," she said. They are still assuming they know, Gallagher said. ●

For an enhanced version of this article, see <www.flightsafety.org/asw/oct07/cabinaide.html>.

Notes

1. FARs Part 135.107 — similar to regulations in many countries — requires that an airplane with a passenger seating configuration of more than 19 passengers have a flight attendant in commuter and on-demand operations. There is no equivalent for corporate or private aircraft that operate under Part 91. Relatively few operators are believed to have a flight attendant aboard smaller jets and turboprop airplanes.
2. NTSB. *Runway Overrun and Collision, Platinum Jet Management, LLC, Bombardier Challenger CL-600-1A11, N370V, Teterboro, New Jersey, February 2, 2005.* Accident Report NTSB/AAR-06/04, Oct. 31, 2006.
3. Safety recommendation A-06-69 says, "Require that any cabin personnel on board … Part 135 flights who could be perceived by passengers as equivalent to a qualified flight attendant receive basic [FAA-]approved safety training in at least the following areas: preflight safety briefing and safety checks; emergency exit operation; and emergency equipment usage. This training should be documented and recorded by the Part 135 certificate holder." In January 2007, the FAA said, "The FAA is reviewing all current regulations and the recommendations of the Part 125/135 Aviation Rulemaking Committee (ARC) to identify possible method(s) of requiring that cabin personnel provided by the certificate holder, who could be perceived by passengers as equivalent to a qualified flight attendant, are appropriately trained in the identified safety areas." Initial plans to address the issue with a Safety Alert for Operators and a notice to FAA personnel were revised, and in September 2007, the NTSB recommended that such guidance await revisions to Part 135, called the FAA's efforts "responsive" and classified these steps as an "open acceptable" response.
4. FSF Editorial Staff. "Assigning Seats to Flight Attendants Requires Care in Business Aircraft." *Cabin Crew Safety* Volume 38 (May–June 2003).
5. NTSB. "Survival Factors Group Chairman's Factual Report." Accident no. DCA05MA031. Aug. 26, 2005.
6. FAA. "Flight Attendant Certification." *Flight Standards Information Bulletin for Air Transportation* no. FSAT 04-07, Dec. 10, 2004.

MembershipUPDATE

Flight Safety Foundation welcomes the following new members in 2007. Because of their support and participation, the Foundation is able to make aviation safer for all.

If you would like information on the benefits of membership or would like to join, please contact Ann Hill, director, membership and development, hill@flightsafety.org or +1 703.739.6700, ext. 105.

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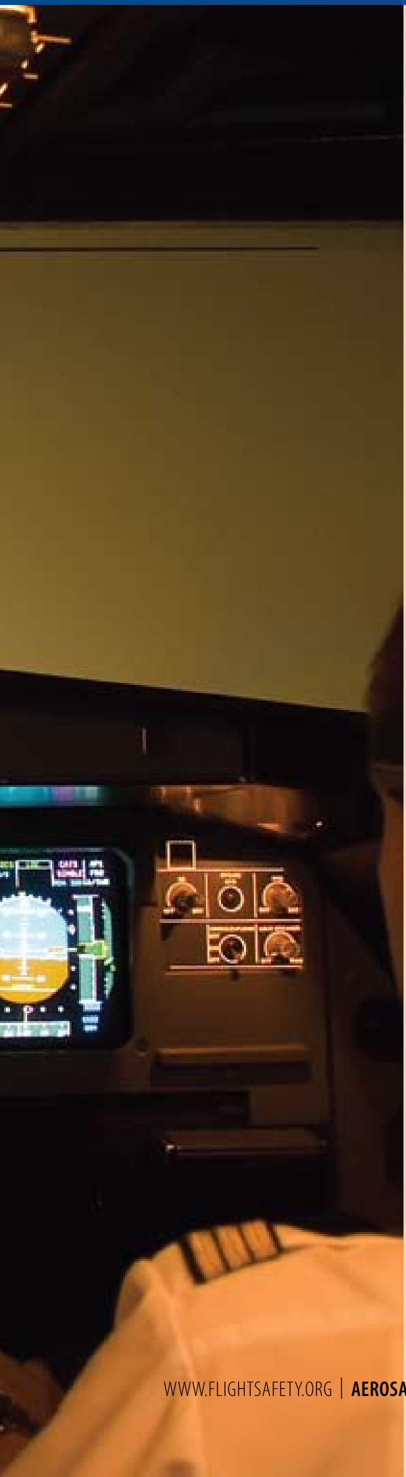
INTO THE BLACK SEA

A go-around goes awry in Sochi, Russia.

@ Guy Daems/Airliners.net



BY MARK LACAGNINA

Spatial disorientation, inadequate control inputs by the captain, lack of monitoring by the copilot and the failure of both pilots to respond to a terrain awareness and warning system (TAWS) warning were among the factors that led to the crash of an Airbus A320 during a missed approach to Sochi (Russia) Airport, according to the final report by the Russian Air Accident Investigation Commission (AAIC).

The accident occurred in nighttime instrument meteorological conditions on May 3, 2006. The aircraft was destroyed, and all 105 passengers and eight crewmembers were killed.

The aircraft, operated as Flight RNV-967 by Armavia Airlines, was en route to Sochi from Yerevan, Armenia. Sochi is a resort city on the Black Sea, about 560 km (302 nm) northwest of Yerevan. Estimated flight time was one hour.

The captain, 40, had 5,458 flight hours, including 1,436 flight hours in A320s. He began his aviation career as a copilot in Antonov An-2s and Yakovlev Yak-40s. He served as a Yak-40 captain for Ararat Airline for about six years before being hired by Armavia as an A320 copilot in May 2004. He transitioned to A320 captain in September 2005.

The copilot, 29, had 2,185 flight hours, including 1,022 flight hours in A320s. After receiving primary training at a civilian flight school, he served as an ATR 42 and Tupolev Tu-154 copilot for Armenian Airlines. He was hired by Armavia in October 2004.

Both pilots were based in Yerevan and had a rest period of more than 24 hours before the accident flight. "It should be noted that it was difficult for the crew to take adequate rest during the day before the night flight due to impairment of biorhythms," the report said. "That is most likely why, in their cockpit conversations, the crewmembers mentioned that they had not [had] enough sleep."

The flight crew's preflight documents indicated that weather conditions at Sochi included calm surface winds, visibility of 2,700 m (1.7 mi) and a broken ceiling at 1,200 m (3,937 ft); temperature and dew point both were 11 degrees C (52 degrees F). Forecast conditions included visibility greater than 10 km (6 mi) in light rain showers and mist, and a broken ceiling at 450 m (1,476 ft), with visibility occasionally 800 m (0.5 mi) and vertical visibility occasionally 60 m (197 ft) in fog.

The aircraft departed from Yerevan at 0047 local time with 10,000 kg (22,046 lb) of fuel, which the report said was sufficient to fly to Sochi and then either divert to the alternate airport in Rostov, Russia, or return to Yerevan.

The cruise portion of the flight was conducted initially at Flight Level (FL) 300 (approximately 30,000 ft) and later at FL 340. The aircraft remained above the clouds during cruise, and icing conditions were not encountered during the flight.

Unstable Weather

The report said that a cold front was nearing Sochi, and weather conditions at the airport were unstable.

At 0104, a Tbilisi (Georgia) Regional Centre controller told the crew that Sochi Airport was reporting 2,000 m (1.2 mi) visibility and a 170-m (558-ft) ceiling. "This weather was below the established minimums for the landing aerodrome," the report said.

The published minimum visibility and ceiling for the instrument landing system (ILS) approach to Runway 06 at Sochi were 2,500 m (1.6 mi) and 170 m; the published minimums for the ILS approach to Runway 02 were 3,000 m (1.9 mi) and 220 m (722 ft).[1]

While under Tbilisi's control, the crew established radio communication with a Sochi approach controller and asked if the weather conditions at the airport were expected to improve. The controller said that the forecast for the next two hours was for a visibility of 1,500 m (0.9 mi) and a ceiling at 150 m (492 ft). However, the controller failed to note that these were forecast as occasional conditions.

Based on this information, the crew told the Tbilisi controller that they wanted to return to Yerevan. At the time, the aircraft was 180 km (97 nm) from Sochi. The Tbilisi controller cleared the crew to turn back toward Yerevan.

'Around the Limit'

About 10 minutes after turning back toward Yerevan, the crew again contacted the Sochi controller and asked for the current weather conditions. "While waiting for the results, the crew told the Sochi controller that they had deputies aboard," the report said. "This information was not true. Analysis of the crew conversations … shows that the crew intentionally misinformed the controller in order to obtain a positive weather forecast."

The Sochi controller said that visibility was 3,600 m (2.2 mi) and the ceiling was at 170 m (558 ft). "The weather is around the limit but OK so far," the controller noted.

The crew requested and received clearance from the Tbilisi controller to resume the flight to Sochi. The cockpit voice recorder (CVR) then recorded discussion about the Runway 06 ILS approach procedure and missed approach procedure.

"Analysis of internal communications … shows that the situation in the cockpit was getting complicated," the report said. "The crew (especially the captain) appeared to be eager to land in Sochi and nowhere else. Further conversations show that the crew did not even wish to bother the Sochi approach controller once more, so as not to get an unfavorable weather forecast from him."

The crew began the descent at 0152. The report said that statements by the captain, who was flying the aircraft with the autopilot and autothrust systems engaged, indicated that he was annoyed that the descent rate — about 1,000 fpm — was not as high as he expected. "This fact shows that either the captain did not fully understand the autopilot work algorithm in the 'DESCENT' mode or was in a state of high psycho-emotional strain with an imperative to land at Sochi as soon as possible," the report said.

While discussing autopilot operation during the initial descent, the copilot voiced an expletive and said, "Who operates such flights with the jitters and not enough sleep?" After the crew changed the autopilot and autothrust modes, the descent rate increased to 2,000 fpm.

At 0200, the Tbilisi controller told the crew to establish radio communication with Sochi approach control. The crew reported that they were descending to 3,600 m (11,812 ft). The Sochi controller told the crew that they were "flying too high" and to continue the descent to 1,800 m (5,906 ft).

"During descent and approach, the crew of Flight RNV-967 was kept informed of the observed weather conditions," the report said. At about 0202, the controller advised that visibility was 4 km (2.5 mi) and the ceiling was overcast at 800 m (2,625 ft).

The approach to Runway 06 is conducted over the sea. The aircraft was at 3,120 m (10,237 ft) and about 45 km (24 nm) from the runway when the crew began the turn to final. The aircraft overshot the turn, and the crew turned right to a heading of 090 degrees to intercept the extended centerline.

'Negative Overreaction'

At 0207, the controller told the crew that the cloud base was at 160 m (525 ft) and visibility was 4,000 m (2.5 mi), and to descend no lower than 600 m (1,969 ft).

"The information about the deteriorated weather conditions caused a negative overreaction, with the use of expletives," the report said. "The crew [discussed] the issue for *three* minutes, swearing about the controller's action even between [conducting] the items of the checklist. Such behavior by the crew inevitably must have resulted in an increase of their psycho-emotional strain."

During this time, the autopilot captured the localizer and the selected altitude, 600 m. The crew reduced airspeed and began extending the flaps and slats.

At 0209, the approach controller advised that weather conditions were "4,000 by 190" and told the crew to establish radio communication with the tower controller. The aircraft was about 10 km (5 nm) from the airport when the crew reported that the landing gear was extended and told the tower controller that they were ready to land.

The tower controller said that visibility was 4,000 m (2.5 mi) in light rain showers and the ceiling was at 190 m (623 ft), and cleared the crew to land.

During this time, the autopilot captured the glideslope, and the aircraft began to descend at about 800 fpm; indicated airspeed was 140 kt. The aircraft was descending through 465 m (1,526 ft) at 0211, when the crew selected full flaps. "The aircraft was stabilized on the glideslope, in the landing configuration and was completely ready for landing," the report said.

'Abort Descent'

The report said that the ceiling dropped abruptly as the aircraft neared the runway. Soon after the controller cleared the crew to land, he was told by a weather observer that the ceiling was at 100 m (328 ft).

The A320 was 7 nm (13 km) from the runway and descending through 390 m (1,280 ft) when the controller said, "Flight RNV-967, abort descent, clouds at 100 meters, right-hand climbing turn to 600 meters."

Among the initial go-around actions prescribed by the A320 flight crew operating manual are to move the thrust levers to the "TOGA" — takeoff/go-around — position, retract the flaps and slats to the go-around setting, and retract the landing gear after a positive rate of climb is achieved.

"Not a single action of those required in the go-around procedure … was performed by the crew, [indicating] that they were unable to

Airbus A320

Development of the A320 began in 1984, and deliveries began in 1988. It is the first subsonic commercial airplane with major primary structures manufactured from composite materials, a "fly-by-wire" control system and sidestick manual controls.

The A320 accommodates two flight crewmembers and up to 180 passengers. The engines are either CFM International CFM56s or IAE V2500s. Fuel capacities are 23,859 liters (6,304 gal), standard, and 29,659 liters (7,836 gal), maximum optional.

Maximum standard takeoff weight is 73,500 kg (162,038 lb). Maximum standard landing weight is 64,500 kg (142,197 lb). Maximum operating speed is Mach 0.82. Optimum cruising speed is Mach 0.78. Service ceiling is 39,000 ft. Range in standard configuration is 4,807 km (2,596 nm).

Source: *Jane's All the World's Aircraft* evaluate the current situation adequately," the report said.

Instead, the crew used the push-to-level-off button on the flight control unit to stop the descent and selected a heading of 172 degrees. "As a result, the aircraft entered a turn to the right with a roll angle up to 25 degrees, maintaining an altitude of 1,114 ft (340 m)," the report said. Figure 1 shows the aircraft's flight path.

The crew then set 3,200 ft in the altitude selector and engaged the autopilot's open-climb mode. As a result, the aircraft pitched nose-up and began to climb at about 2,400 fpm.

The aircraft was in a climbing turn, in landing configuration, at 1,150 ft when an aural low-energy warning was generated at 0212:04. The report said that the crew responded by moving the thrust levers to the TOGA position. This resulted in deactivation of the autothrust system and engagement of the autopilot go-around modes.

A few seconds later, however, the autopilot was disengaged. The report said that the crew likely had been surprised by the aircraft's maneuvering behavior and the low-energy warning, and disengaged the autopilot because they doubted that it was functioning properly.

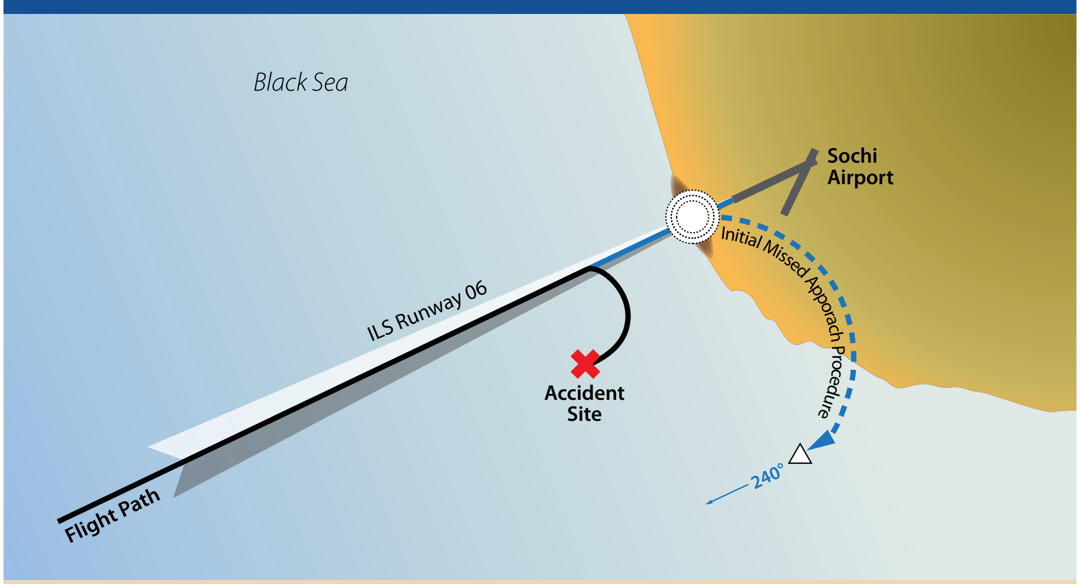
Using his sidestick, the captain reduced the pitch angle from 21 degrees to 4 degrees and the bank angle from 25 degrees to about 20 degrees. Indicated airspeed increased from 129 kt to 140 kt, and the rate of climb decreased to about 400 fpm.

The rudder pedals in an A320 do not have to be used to make a coordinated turn, but recorded flight data showed that forces up to 15 kg (33 lb) were applied to the right pedal. "The pedal inputs … might have been caused by transfer [of the captain's] knowledge of flying another previous aircraft type, while under stress," the report said.

At 0212:20, the altitude-selector setting was changed to 1,969 ft (600 m), and the captain began to move his sidestick forward. The report said that the captain might have overreacted to the downward movement of the flight director pitch-command bars in his primary flight display (PFD) when the selected altitude was reduced. The sensation of acceleration and the absence of external visual cues might have caused the somatogravic illusion that the aircraft was pitching nose-up. Another possibility was that the captain moved the sidestick forward in reaction to an indication on the PFD that airspeed was nearing the limit for the aircraft's configuration — landing gear extended and flaps/slats in the landing configuration.

"The actual reason for such actions by the captain could not be determined," the report said. "However, it can be stated that such inadequate piloting

Armavia A320 Flight Path



ILS = instrument landing system

Source: Susan Reed

Figure 1

was caused by a lack of monitoring of flight parameters — in particular, pitch and roll angles."

Crossed Controls

The aircraft was descending through 1,626 ft in a steep right turn when the captain told the copilot to retract the flaps and slats. Indicated airspeed was 186 kt and increasing.

At 0212:45, the captain made sidestick inputs that increased the aircraft's nose-down pitch attitude and right bank angle. Two seconds later, a TAWS "pull up" warning was generated, and the copilot said, "Level off." The aircraft was descending at about 4,300 fpm, and bank angle had increased to 39 degrees.

"At this moment, the copilot intervened and moved [his] sidestick to the left stop position to counter the increasing right bank, while the captain continued making control inputs to increase the right bank," the report said. "Apparently, the copilot was trying to counter the bank, only. However, while moving the sidestick sideways to the stop position, he had made forward control inputs on it as well."

The copilot had not called out his control intervention or engaged the take-over pushbutton on his sidestick, which would have deactivated the captain's sidestick. The captain apparently was not aware of the copilot's sidestick inputs. As a result, the A320's autoflight system "added and averaged" the captain's and copilot's uncoordinated control inputs, the report said. A "DUAL CONTROL" warning usually is generated in this situation; however, because of the higher-priority TAWS warning that was being generated, the dual-control-input warning was not generated, the report said.

"The captain twice moved the sidestick halfway backward, possibly reacting to the [TAWS warning]," the report said. "But, at the same time, the copilot was inadvertently making nose-down inputs, which might have led the captain to believe that the aircraft's response to the control inputs in the pitch channel was not adequate."

In the final seconds of the flight, both pilots made nose-up control inputs. The bank angle was about 10 degrees, and pitch attitude was about 5 degrees nose-down when the A320 struck the sea at 0213, at an indicated airspeed of 285 kt. (The accident occurred less than 80 seconds after the crew received the "abort descent" instruction.)

The aircraft sank in 1,540 ft of water. "Only a small portion of the wreckage, less than 5 percent, was found and recovered from the water surface," the report said. Examination of the 52 bodies and numerous body parts that were recovered led to the conclusion that the cause of death of the occupants was "severe trauma incompatible with life," the report said.

Based on the findings of the investigation, the AAIC made several recommendations. Among them were that the aviation administrations in the Commonwealth of Independent States should "draw the attention of A320 crews to the necessity of immediate response to activation of [a TAWS] warning (even if other warnings are on at the same time) in the case of instrument flight or flight in difficult weather conditions or in the mountains, [and] introduce relevant exercises in simulator training programs to practice these actions."

The report included comments and recommendations by the French Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile (BEA). One comment noted that the tower controller was authorized by Russian aviation regulations to refuse the landing. "This flight was, however, an international flight governed by different regulations, which specifically allow the captain to descend to [the ILS decision height] before deciding on a go-around," the BEA said. "Thus, it would be desirable for the Russian Civil Aviation Authority to clarify its doctrine on interventions by ATC in relation to the responsibilities that normally fall on the captain." ●

This article is based on the English translation by the BEA of the AAIC's "Final Report on the Investigation Into the Accident Involving the Armavia A320 Near Sochi Airport on 3 May 2006." The 57-page report contains appendixes.

Note

1. Russia measures altitude in meters. The A320 can display altitude in meters as well as in feet.

Separation Maintained

No loss-of-separation incidents in U.K. commercial aviation in 2006 involved risk of collision.

BY RICK DARBY

The 2006 rate of "risk-bearing" aircraft proximity incidents — airproxes — in U.K. commercial air transport, in which aircraft separation was compromised, was the lowest in a decade.[1] The most common causal factor in those airproxes was attributed to air traffic controllers, according to a newly released report by the U.K. Airprox Board (UKAB).[2]

In 2006, there were no Risk Category A, "risk of collision" airproxes, in this industry sector (Table 1). It was the first time since 2003 that no Category A airproxes occurred. Six events fell into Risk Category B, "safety not assured," in which "the safety of the aircraft was compromised." That number was the lowest in the period beginning in 1997. Categories A and B combined are known as "risk-bearing" airproxes.[3]

The UKAB found no "common thread" among the six Category B events. One occurred over Scotland, the others over various parts of England. "In airspace terms, two of the six airprox [incidents] occurred

No "Risk of Collision" Airproxes in 2006

U.K. Commercial Air Transport Airproxes by Risk Category, 1997–2006

Risk Category	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Category A	9	1	4	6	0	1	0	1	1	0
Category B	20	14	12	8	14	7	12	7	7	6
Category C	67	82	83	85	65	70	54	67	78	68
Category D	0	1	0	1	4	4	0	4	1	0
Total	96	98	99	100	83	82	66	79	87	74

Category A = risk of collision; Category B = safety not assured; Category C = no risk of collision; Category D = risk not determined

Source: U.K. Airprox Board

Table 1

in terminal control areas and one each on an airway; an ADR [advisory route]; [and] in Class D and Class G airspace," the report said.[4] "The conclusion is that such wide variability does not point to a common theme with the need for concerted action in a particular area of operations."

Figure 1 and Table 2 show the airprox rates for 1997 through 2006. The 2006 rate of 0.37 risk-bearing airproxes per 100,000 flight hours is a decrease from 0.52 in the previous year, an improvement of 29 percent. The rate had been as high as 2.46 per 100,000 flight hours in 1997.

Of the 74 total airproxes involving at least one commercial air transport aircraft in 2006, the most common causal factor — "did not separate/poor judgment" — was attributed to controllers. Table 3 (p. 52) lists causal factors assigned four or more times.[5]

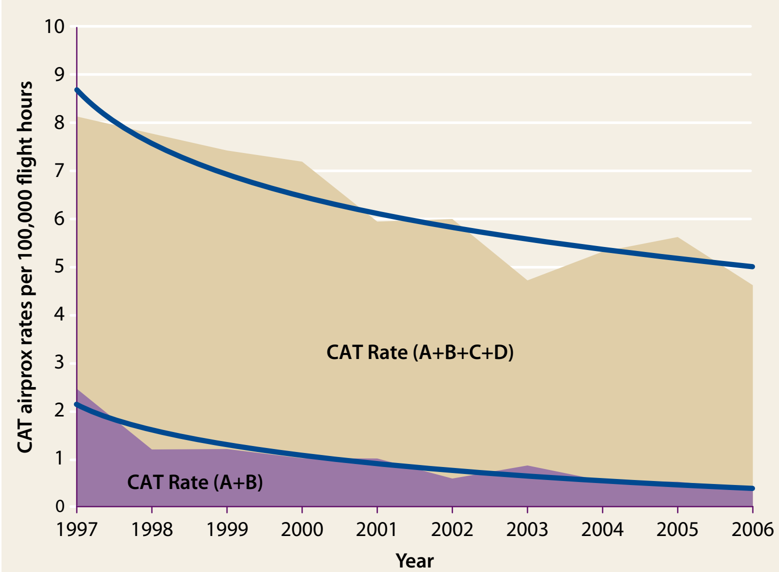
The second most frequent causal factor, "sighting report," was considered irrelevant. The report said, "An informal definition of this causal factor might be 'without the slightest doubt a Risk Category C airprox.'"

The third- and fifth-ranked causal factors were significant in terms of industry concerns about "infringements" of airspace and level busts, respectively, the report said.

The UKAB investigates airproxes involving general aviation and military aviation aircraft, including helicopters, as well as commercial air transport. Table 4 (p. 52) shows total airproxes by civil and military aircraft involvement. The report says that the reduction in civil-military aircraft encounters in 2006 is "of particular note," with the 46 in 2006 in contrast to an annual average of 72 in the prior years of the period, 1997–2005. The year 2006 ended with a total of 159 airproxes, compared with the previous five-year average of 198, a 20 percent reduction. ●

Hull Loss Fatalities Down

Accidents by Injury and Damage, Worldwide Commercial Jet Fleet



CAT = commercial air transport; Category A = risk of collision; Category B = safety not assured; Category C = no risk of collision; Category D = risk not determined

Note: Figure includes logarithmic trend lines. CAT rate A+B represents risk-bearing airproxes.

Source: U.K. Airprox Board

Figure 1

Airprox Rate Down

U.K. Commercial Air Transport Airproxes per 100,000 Flight Hours, 1997–2006

Rate	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Risk category A + B	2.46	1.19	1.20	1.01	1.00	0.59	0.86	0.54	0.52	0.37
Risk category A + B + C + D	8.14	7.78	7.43	7.20	5.95	6.00	4.72	5.32	5.63	4.62
Flight hours (thousands)	1,179	1,259	1,332	1,389	1,395	1,366	1,398	1,485	1,546	1,602

Category A = risk of collision; Category B = safety not assured; Category C = no risk of collision; Category D = risk not determined

Note: Flight hours are supplied by the U.K. Civil Aviation Authority and Eurocontrol.

Source: U.K. Airprox Board

Table 2

Separation Loss Most Common Factor

Most Common Airprox Causal Factors, U.K. Commercial Air Transport, 2006

Rank	Causal Factor	Total	Attributed to
1	Did not separate/Poor judgment	19	Controller
2	Sighting report	9	Other
3	Penetration of CAS/SRZ/ATZ without clearance	8	Pilot
4	Not obeying orders/Not following advice from ATC	7	Pilot
5	Climbed/Descended through assigned level	7	Pilot
6	Inadequate avoiding action/Flew too close	6	Pilot
7	Did not adhere to prescribed procedures	4	Pilot
8	Did not pass or late passing of traffic information	4	Controller
9	Controller perceived conflict	4	Controller

CAS = controlled airspace; SRZ = special rules zone; ATZ = aerodrome traffic zone; ATC = air traffic control

Note: An airprox could be assigned more than one causal factor.

Source: U.K. Airprox Board

Table 3

Fewer Civil-Military Airproxes in 2006

U.K. Airprox Totals by User Category, 1997–2006

User Category	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Civil-civil	115	129	113	100	97	109	87	109	99	95
Civil-military	78	53	81	78	73	77	67	69	74	46
Military-military	14	16	13	18	20	31	23	22	8	13
Other	1	3	1	2	5	4	4	7	7	5
Totals	**208**	**201**	**208**	**198**	**195**	**221**	**181**	**207**	**188**	**159**

Source: U.K. Airprox Board

Table 4

Notes

1. The U.K. Civil Aviation Authority (CAA) defines an airprox as "a situation in which, in the opinion of a pilot or a controller, the distance between aircraft as well as their relative positions and speed [were] such that the safety of the aircraft involved [were] or may have been compromised." Airproxes in the data occurred in U.K. airspace and included airplanes and helicopters.

2. U.K. Airprox Board (UKAB). *Analysis of Airprox in UK Airspace*. Report no. 17, July 2006–December 2006. Available via the Internet at <www.airprox-board.org.uk/default.aspx?catid=423&pagetype=68&gid=430>. Although the report provides an update that includes the second half of 2006, it compares the entire year 2006 with previous years.

   The UKAB is an independent organization jointly sponsored by the CAA and the Ministry of Defence.

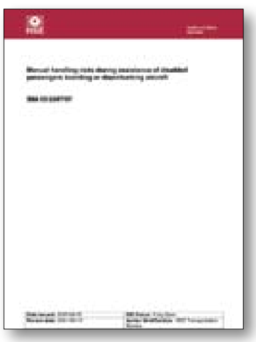
3. Other risk categories are C, "no risk of collision," and D, "risk not determined." Risk Category D comprises incidents in which there is insufficient, or conflicting, evidence that precludes determining the degree of risk.

4. An advisory route is defined as "a designated route along which air traffic advisory service is available." Class D in the United Kingdom is controlled airspace. Class G is uncontrolled airspace.

5. An airprox could have more than one causal factor, and the 74 commercial air transport airproxes were assigned 126 causal factors.

Handle With Care

Appropriate equipment is the key to helping disabled passengers board and exit the aircraft.



REPORTS

Manual Handling Risks During Assistance of Disabled Passengers Boarding or Disembarking Aircraft

U.K. Health and Safety Executive Transportation Section. Sector Information Minute (SIM) 05/2007/07. August 2007. 15 pp. References, appendixes. Available via the Internet at <www.hsenews.com/2007/08/22/manual-handling-risks-assisting-disabled-aircraft-passengers>.

Transferring disabled passengers to and from aircraft usually presents no significant problems when boarding or exiting through an airbridge. However, as the report notes, "Not all gates have this facility, some smaller aircraft are incompatible with airbridges and in some cases airlines may choose not to use the airbridge. In these cases, passengers are required to embark by walking (or traveling by bus) across the ramp and ascending steps up into the aircraft." Passengers unable to manage the alternative means of transit must be accommodated, according to the law in the United Kingdom and some other countries.

"Handlers are required to raise (or lower) a passenger and possibly their wheelchair, which may total in excess of 100 kg [220 lb], through several meters," the report says. "Given these facts, it is clear that some form of mechanical assistance is required and training and communication are of particular importance if team handling is involved."

The report says that secure and efficient transfer of disabled passengers is enhanced by using:

- A scissor-lift vehicle. "The wheelchair passenger is pushed into the vehicle at ground level, [and] the lift is then raised mechanically to a height level with the aircraft entrance and the passenger can be wheeled into the aircraft," the report says. "This removes any requirement for manually lifting the passenger."
- A boarding chair. "Boarding chairs are specifically designed to be used for aircraft boarding," the report says. "Generally they will be much narrower than a standard wheelchair to enable access down the aisle once aboard the aircraft."
- Battery-powered wheelchairs and stair climbers, "some of which are designed specifically with compact dimensions which enable them to maneuver in limited space and negotiate the aircraft steps and aisle," the report says. "They are also fitted with harnesses and head rests."

Manually carrying the passenger is the worst option. "This presents a high risk to the handler (and the passenger), cannot be performed by less than two people and must be avoided, except in emergency situations if no alternative is available."

Even the recommended equipment is not ideal, says the report. For example, with a scissor-lift, "the height range of the platform on which the passenger is lifted will not be compatible with all

aircraft. If the device is mounted on the back of a vehicle and the lifting platform extends over the top of the vehicle cab, the cab restricts the minimum height, and this can be a problem for small aircraft. … For larger aircraft, the maximum platform height may not reach the aircraft entrance."

The report says, "The successful use of lifting aids will depend on the equipment available, the efficient maintenance of the equipment, and the communication between aircraft/airline and the ground handlers, to ensure the equipment is available at the gate."

Specifications and standards for equipment are listed, as is guidance for inspectors of airline practices for conveying disabled passengers on and off aircraft.

Prediction and Classification of Operational Errors and Routine Operations Using Sector Characteristics Variables

Pfleiderer, Elaine M.; Manning, Carol A. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-07/18. Final report. July 2007. 16 pp. Tables, references. Available via the Internet at <www.faa.gov/library.reports> or from the National Technical Information Service.*

In the U.S. air traffic control system, an operational error (OE) is any violation of aircraft separation standards as defined by the FAA. Logic suggests that variations among airspace sectors play a part in the relative frequency of OEs in different sectors — otherwise, over time, the numbers would be essentially equal. But "some sectors are more prone to OEs than others," the report says.

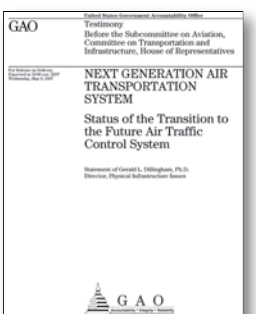
Many studies have looked at the relationship between sector characteristics and the occurrence of OEs. "Most of this work has been done without reference to routine operations (ROs)," the report says. "Yet, for every OE that occurs in a sector, there are hundreds (possibly thousands) of hours in which an OE did not occur. To truly understand the environmental and contextual factors that contribute to OEs, it is necessary to identify what was different about the sector environment at the time the OE occurred."

This report describes a study of the ability of selected measures to predict and classify OEs and ROs using logistic regression analysis. Logistic regression is a statistical technique designed to predict whether an event of interest will occur.

Sector characteristics were derived for traffic samples from high-altitude and low-altitude sectors. In the high-altitude sector sample, variables included the number of heading changes, the number of transitioning aircraft and average control duration. In the low-altitude sector sample, variables were the number of point-outs [transferring the radar identification of an aircraft to another controller without transferring radio communication because the aircraft will be in the other's airspace only briefly], the number of handoffs and the number of heading changes.

"In the high-altitude [sector] sample, every heading change that occurred increased the likelihood of an OE by 128 percent, every transitioning aircraft increased the likelihood of an OE by 26 percent and every one-second increase in average control duration increased OE likelihood by 2 percent," the report said.

In the low-altitude sector sample, "every point-out that occurred increased the likelihood of an OE by 230 percent, every handoff increased OE likelihood by 54 percent and every heading change increased OE likelihood by 49 percent."



Next Generation Air Transportation System: Status of the Transition to the Future Air Traffic Control System

Dillingham, Gerald L. Testimony before the Subcommittee on Aviation, Committee on Transportation and Infrastructure, U.S. House of Representatives. U.S. Government Accountability Office (GAO). GAO-07-784T. May 9, 2007. 31 pp. Available via the Internet at <www.gao.gov> or from the GAO.**

The Next Generation Air Transportation System (NextGen) is intended to provide state-of-the-art technologies and procedures for air traffic control in U.S. airspace ("Technology Can Reduce Runway Mishaps," p. 36, and "Seeking Guidance," *ASW*, 9/07, p. 12). The congressionally authorized Joint Planning and Development Office (JPDO) was established to facilitate NextGen activities. Dillingham's testimony focused on the progress the U.S. Federal Aviation Administration (FAA) is making in implementing a foundation for managing the transition to NextGen, the status of the JPDO's planning for NextGen, and the challenges that the FAA and the JPDO face.

"During the last few years, FAA has made significant progress in implementing business-like operations and procedures for managing and acquiring air traffic control systems which have improved FAA's management of the current system and should better position the agency to manage the enormously complex transition to NextGen," Dillingham said. "However, further work remains to fully address past problems in acquiring systems and institutionalizing changes throughout the agency."

By creating the Air Traffic Organization — a performance-based office to administer and improve the FAA's modernization plan — and appointing its chief operating officer, the FAA has established a new management structure and adopted business best practices to address "the cost, schedule and performance shortfalls that have plagued air traffic control acquisitions," Dillingham said.

The JPDO has made progress on its key planning documents such as a concept of operations, an enterprise architecture — the technical description of NextGen, similar to blueprints for a building — and an integrated work plan, Dillingham said. Nevertheless, "JPDO is fundamentally a planning and coordinating body that lacks authority over the key human and technological resources of its partner agencies" such as the departments of Transportation, Commerce, Defense and Homeland Security.

Dillingham said, "Of critical importance in the area of NextGen research is human factors research, given the fundamental changes that NextGen envisions in the roles of air traffic controllers and pilots due to automation and changes in surveillance technologies and communications. JPDO has suffered from a lack of stable leadership and is now functioning under its third director. The issue is exacerbated by JPDO's senior policy committee, which has met only four times and has not met at all as a formal body since November 2005.

"Finally, JPDO faces a continuing challenge in ensuring the involvement of all key stakeholders, such as active air traffic controllers and technicians. Our work on past air traffic control modernization projects has shown that a lack of stakeholder or expert involvement early and throughout a project can lead to costly increases and delays."

WEB SITES

NASA Icing Branch, <icebox-esn.grc.nasa.gov/index.html>

The Icing Branch, part of the U.S. National Aeronautics and Space Administration (NASA) research and technology organization, has developed numerous education and training aids concerning aircraft icing safety for pilots and aircraft operators. Its opening Web page describes the organization's purpose and projects. The Web site provides information on education, training aids and multimedia resources produced by the Icing Branch.

The education and training aids section describes computer-based and Web-based products about ground and in-flight icing. Most education products resulted from the collaborative efforts of government, industry and academia — including NASA, the U.S. Federal Aviation Administration and the Air Line Pilots Association, International. Sources for obtaining products, individually and in bulk, are given.

Additional resources include a list of icing-related documents with links to free, full-text articles, ground icing checklists and a decision-making flow chart that may be downloaded at no cost.

Some training products are fee-based. Others are free online, such as two Web-based training courses: "A Pilot's Guide to In-Flight Icing" and "A Pilot's Guide to Ground Icing," which its creators say is "primarily intended for pilots who make their own operational deicing and anti-icing decisions [including] private pilots as well as those who fly business, corporate, air taxi, or freight operations in fixed-wing aircraft."

According to the course description, "A Pilot's Guide to Ground Icing" covers:

- Risks and problems created by ground icing;
- Anticipating and detecting ground icing;
- Aircraft deicing/anti-icing fluids; and,
- Deicing operations.

The course introduction says experienced pilots can reinforce knowledge acquired during many years of commercial and airline flights, expand their knowledge base in specific areas or dispel erroneous icing theories.

The course is self-paced, requiring one to three hours, depending on the number of course topics (modules) and related information that users explore. The program design is user-friendly and allows customization to create a personal training syllabus. This multimedia course uses computer-based training techniques, such as interactive animation, videos and multiple pop-up screens.

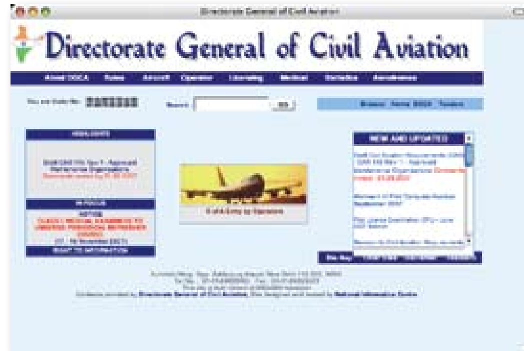
The online tutorial and help icon provide assistance with navigation, special features, system requirements and operational issues.

Directorate General of Civil Aviation (DGCA) India, <dgca.gov.in>

The explanatory note on the Web site says, "The Directorate General of Civil Aviation is the regulatory body in the field of civil aviation primarily dealing with safety issues. It is responsible for regulation of air transport services to/from/within India and for enforcement of civil air regulations, air safety and airworthiness standards."

The DGCA India Web site contains the following full-text materials:

- India's Civil Aviation Requirements;
- Annual accident summaries from 1990 through 2005 in English and Hindi;



- Advisory information circulars categorized by airport, flight crew, operations, air transport, air safety and airworthiness;
- Handbooks and manuals, such as the *Handbook on Medical Assessment of Civil Flight Crew*;
- A list of regulatory materials and airworthiness directives that link electronically to civil aviation authorities in Australia, Canada, France, the United Kingdom, the United States and several other countries;
- Annual *India Air Transport Statistics* reports from 1997 through 2006 in English and Hindi; and,
- Bilateral air service agreements for 2005, 2006 and 2007.

The annual statistical reports contain comparative statistics by airline, showing domestic and international flights, fleet strength and aircraft utilization. Additional tables depict scheduled and nonscheduled, passenger and cargo operations; passenger and traffic movements; financial results; and staffing.

Most information at this Web site is specific to India. ●

Sources

* National Technical Information Service
5385 Port Royal Road
Springfield, VA 22161 U.S.A.
Internet: <www.ntis.gov>

** Government Accountability Office
441 G St. NW, Room LM
Washington, DC 20548 U.S.A

— Rick Darby and Patricia Setze

Hammered by Hail

Flight crew faulted for inadequate use of radar information.

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

'Supercell Storms' on Departure Route

Boeing 737-300. Substantial damage. No injuries.

The aircraft took off from Geneva International Airport with 126 passengers for a scheduled flight to London the morning of Aug. 15, 2003. The 737 was climbing through about 8,500 ft on a standard instrument departure route when the flight crew requested clearance to fly west of course, on a heading of 310 degrees, for about 15 nm (28 km) to avoid thunderstorm cells, said the final report published in June 2007 by the Swiss Aircraft Accident Investigation Bureau.

"A few minutes later, the aircraft passed through a shower of hail, which seriously damaged it," the report said. The hail encounter lasted about five seconds and occurred as the aircraft was climbing through 15,400 ft over Oyonnax, France, about 35 km (19 nm) west of Geneva.

"The hail cell which caused the accident was part of a broad thunderstorm zone displayed with good resolution by the on-board weather radar," the report said.

"[Ground radar] showed returns characteristic of supercell storms with a maximum intensity level," the report said. "At the time and in the region of the accident, violent storms accompanied by hail were observed at several locations. According to eyewitnesses, the hailstones were as big as ping-pong balls (40 mm [1.6 in]); some were even 50 mm [2 in] in diameter."

The commander declared an emergency, reporting that the aircraft had encountered a "very heavy hailstorm," and received clearance from air traffic control (ATC) to return to Geneva.

The windshield in front of the copilot was cracked, and the commander told the copilot to don his oxygen mask and goggles, and to conduct the "Window Damage" checklist.

The report said that the hail did not adversely affect engine operation. The aircraft was landed about 14 minutes after the hail encounter and taxied to a stand, where the passengers were disembarked normally. Hail damage was found on the leading edges of the wings and tail, engine nacelles, windshield and radome.

The report concluded that the accident was caused "by the aircraft flying into a shower of hail embedded in a thunderstorm cell, following inadequate utilization of the information provided by the on-board weather radar." It noted that the crew of an aircraft following five minutes behind the 737 on departure avoided the thunderstorms by diverting farther to the west.

The report also said that soon after the 737 returned to Geneva, the crew of a departing Hawker Siddeley 125 was instructed to fly the same departure route. ATC did not tell the Hawker crew about the hazardous weather that the 737 had encountered. The captain of the Hawker said that the aircraft encountered "heavy rain" during the departure. After the Hawker arrived at its destination in England, the radome and the leading edges of its wings and tail were found to have been damaged.

The aircraft was past the point where it had sufficient fuel to divert.

Committed to Land

Airbus A330. No damage. No injuries.

The airplane was en route from Singapore and was scheduled to land in Perth, Australia, at 0020 local time on Sept. 16, 2006. Visual meteorological conditions (VMC) had been forecast for Perth, with a 30 percent probability of fog forming after 0200.

"In accordance with the operator's fuel policy, fuel was not specifically carried for a diversion from the destination to an alternate aerodrome," said the Australian Transport Safety Bureau (ATSB) report. The en route alternate was Learmonth, which is 599 nm (1,109 km) from Perth. The report said that Learmonth had no significant weather.

About 2308, the flight crew received an amended trend-type forecast (TTF) for Perth, indicating that fog would begin to form at 0030.

The aircraft was past the point where it had sufficient fuel to divert to Learmonth when the crew began the descent to Perth at 2350. "Once the crew commenced the descent, they were committed to a landing at Perth," the report said.

About 10 minutes later, the TTF again was amended to indicate that fog would form before the aircraft arrived at the airport. Fog actually began forming at about 0015, and visibility decreased from 2,000 m (1 1/4 mi) to 300 m (less than 1/4 mi) within the next 15 minutes.

The crew began an instrument landing system (ILS) approach to Runway 21 at 0010. "The crew reported that at the 250-ft [altitude] minimum, the visibility was less than the required 800 m [1/2 mi], and they initiated a missed approach," the report said.

The crew of a departing aircraft reported that visibility at the approach end of Runway 03 was better, and the A330 crew was radar-vectored by ATC for the ILS approach to that runway. "At the 320-ft minimum, the visibility was less than the required 1,500 m [about 1 mi], so the crew initiated another missed approach," the report said.

The crew declared an emergency and reported that they would conduct the ILS approach to Runway 21 and use the A330's autoland system to land. The pilot-in-command (PIC) said that at the decision height, visibility was about 400 m (1/4 mi) and he could see some of the approach lights. About 100 ft above the runway, the PIC saw the runway threshold lights. "The landing was reported to be normal, and the crew had sufficient visibility to navigate to the terminal," the report said.

After the incident, the aircraft operator changed its flight-planning fuel policy to require designation of an alternate airport for all flights to Perth when fog is forecast.

Parking Brake Not Set Correctly

Boeing 767. Substantial damage. No injuries.

After a flight from Calgary, Alberta, Canada, on Oct. 11, 2006, the aircraft was landed at London Heathrow Airport and taxied toward the assigned stand. However, the crew could not taxi the 767 onto the stand because a handling agent was not there to activate the visual docking guidance system and monitor the aircraft's arrival, the U.K. Air Accidents Investigation Branch (AAIB) report said.

"As the aircraft was blocking the taxiway, a member of the airport's airside staff was dispatched to marshal the aircraft onto stand; this he did without event," the report said. "Once the aircraft was on the stand, the marshaller left the area without placing any chocks in front of its wheels."

The commander believed that he had set the aircraft's parking brake correctly by pulling the parking-brake T-handle on the center console while depressing the toe brakes on top of the rudder pedals. The crew then shut down the engines. Because a handling agent still had not arrived, the passengers were told to remain seated.

About 15 minutes later, the aircraft began to roll forward. "At first, the pilots thought the pier [airbridge] was being moved into position, but soon the commander realized that the aircraft was moving forward and gathering speed quite quickly," the report said. "He applied the toe brakes and noticed the parking-brake T-handle was retracted."

Noticing that accumulator pressure was low, the copilot activated the hydraulic pumps. The 767 was stopped after rolling about 12 ft (4 m). The cowling on the left engine was dented when it struck the pier as the aircraft came to a stop.

"In an open and frank report, the commander admitted that the cause of the accident was his failure to set the parking brake correctly," the report said.

Steep Turn During Circling Approach

Learjet 35A. Destroyed. Two fatalities.

The airplane was on a positioning flight from Twin Falls, Idaho, U.S., to pick up passengers at Truckee–Tahoe (California) Airport the afternoon of Dec. 28, 2005. Reported weather conditions included 2 1/2 mi (4,000 m) visibility, variable between 1/2 mi and 5 mi (800 m and 8 km), a broken ceiling at 1,500 ft and winds from 220 degrees at 15 kt, gusting to 22 kt, according to the U.S. National Transportation Safety Board (NTSB) report.

The flight crew conducted the global positioning system (GPS) approach, which had a final approach course of 104 degrees, and established the Learjet on a left downwind for Runway 28. The minimum descent altitude for the circling approach was 8,200 ft — 2,300 ft above airport elevation — and the published minimum visibility was 3 mi (4,800 m).

The Learjet was about 400 ft above the ground when it overshot the turn to final for Runway 28 and entered a steep left turn, which one witness described as banked nearly 90 degrees. The airplane then descended and struck the ground left-wing-first about 0.3 nm (0.6 km) from the runway threshold.

Struck by a Runaway Baggage Cart

Bombardier CRJ900. Substantial damage. No injuries.

While taxiing to the runway at McCarran International Airport in Las Vegas the night of April 30, 2006, the captain noticed a train of baggage carts moving rapidly toward the airplane from the left.

The captain swerved right of the taxiway centerline in an effort to evade the carts, but the first cart in the train struck the CRJ's left wing, became wedged between the wing and the taxiway, and was dragged about 150 ft (46 m), the NTSB report said.

After the accident, the airline issued an employee memorandum that reiterated the importance of ensuring that the braking system is engaged before leaving baggage carts unattended.

TURBOPROPS

Wing Separates After Storm Encounter

Mitsubishi MU-2B-35. Destroyed. One fatality.

Before departing from Tulsa, Oklahoma, U.S., for a positioning flight to Panama City, Florida, on Sept. 1, 2006, the pilot — who had more than 30,000 flight hours, including about 10,000 flight hours in MU-2s — was told that there were no adverse weather conditions along the route.

The airplane was over northern Florida, descending from Flight Level (FL) 190 (about 19,000 ft) two hours later, when a warning was issued for thunderstorm activity southwest of the pilot's route. Thunderstorm activity also had been detected along the pilot's route, but no warning had been issued, the NTSB report said.

The pilot lost control of the MU-2 in a thunderstorm. "A witness located approximately one mile south of the accident site reported he heard a 'loud bang,' looked up and observed the airplane in a nose-down spiral," the report said. "The witness reported there were parts separating from the airplane during the descent. The witness said it was raining and there was lightning and thunder in the area."

Investigators found that the left wing had separated after the front and rear spars failed from "catastrophic static up-bending overstress."

The report noted that the airplane was equipped with weather radar and that the pilot had not requested any deviations or asked ATC about the weather ahead. ATC radar had detected intense to extreme precipitation in the area of the accident. "During the flight, the pilot was given no real-time information of the weather ahead," the report said.

As they taxied the Twin Otter to a stand, the lower section of the nose landing gear, including the wheel, separated.

Corrosion Causes Nosewheel Separation

De Havilland DHC-6. Substantial damage. No injuries.

The flight crew felt a "slight thump" during the landing roll at Glasgow (Scotland) Airport the evening of March 22, 2007. As they taxied the Twin Otter to a stand, the lower section of the nose landing gear, including the wheel, separated.

The lower fuselage was damaged by the separated landing gear components. "The aircraft rapidly came to a standstill, resting on the projecting remains of the nose leg," the AAIB report said. None of the nine occupants was injured.

Investigators found that the separation was caused by corrosion of the locknut that secures the wheel fork to the strut. The nose landing gear assembly had accumulated 6,566 hours and 11,184 cycles since overhaul. The report noted that the Twin Otter was frequently operated on beach landing strips.

After the accident, the aircraft operator revised several maintenance procedures, including a requirement for an annual inspection of the strut and locknut assembly for corrosion.

No Reason Found for Loss of Control

Beech Super King Air 200. Destroyed. Six fatalities.

The NTSB was unable to determine why the pilot, who had an airline transport pilot certificate and about 3,400 flight hours, failed to maintain control of the airplane during approach to Grand Strand Airport in North Myrtle Beach, South Carolina, U.S., the night of Feb. 3, 2006.

A weather observation about an hour before the accident indicated that the airport was clear of clouds and had 7 mi (11 km) visibility; however, temperature and dew point both were 13 degrees C (55 degrees F), indicating the possibility of fog.

The King Air, arriving on a private flight from Trenton, New Jersey, was observed to make two approaches to Grand Strand's Runway 23, which is 5,996 ft (1,828 m) long. "During the first approach, the airplane was observed 'fish-tailing' while about 30 ft over the runway," the report said. The pilot told the airport tower controller that he was going around.

"The controller asked the pilot if he had problems with the sea fog," the report said. The pilot said no and explained that the left engine was producing "a little too much [power] and would not come back."

Witnesses said that during the second approach, the airplane climbed, rolled left, descended in an inverted nose-down attitude and struck terrain left of the runway. "Examination of the airplane, airplane systems, engines and propellers found no abnormal pre-impact condition that would have interfered with the normal operation of the airplane," the report said.

NTSB said that the probable cause of the accident was "the pilot's failure to maintain control during the landing approach for undetermined reasons."

Destabilized Approach Ends in Tail Strike

De Havilland DHC-8-300. Minor damage. No injuries.

The commander was the pilot flying the trip from Dublin, Ireland, to Cornwall, England, the afternoon of Dec. 31, 2006. He conducted a visual approach to Runway 12 at about 123 kt, or about 15 kt above VREF, the calculated reference landing speed, to account for surface winds from the southwest at 25 to 30 kt, gusting to 36 kt, the AAIB report said.

"The flight data showed that a stable approach was achieved initially but that this became unstable at a late stage, probably due to a combination of the gusty conditions and the associated large control inputs," the report said. "During the final stage of the approach, the airspeed decayed to 94 kt, significantly below both VREF and the target approach speed."

The commander believed that the Dash 8's pitch attitude was not excessive on touchdown, but he noticed a caution light indicating that the pitch attitude was more than 6 degrees. "Aircraft technical publications alerted crews to the possibility of a tail strike if the pitch attitude exceeded 6 degrees during the landing," the report said.

During the landing roll, a "TOUCHED RUNWAY" warning light illuminated. Examination of the aircraft showed that the frangible fairing on the tail-strike sensor was broken and that there was light abrasion damage to the bottom of the rear fuselage.

PISTON AIRPLANES

Fuel Loss Leads to Ditching

Piper Seminole. Destroyed. No injuries.

The aircraft — one of two Seminoles that were being ferried from the United States to Australia — departed from Santa Barbara, California, for the first leg to Hilo, Hawaii, on June 9, 2006. During the flight, the pilot noticed that more fuel than expected was being drawn from the ferry tank; he also saw a scorch mark on the left engine cowling.

"Following discussion with the pilot of the accompanying Seminole, the pilot decided to shut down the left engine," the ATSB report said. About 7.5 hours into the flight, the pilot told ATC that the aircraft would have to be ditched because it was seven flight hours from Hilo and had enough fuel for only five more hours of flight.

The Seminole was intercepted by U.S. Coast Guard and Navy aircraft and escorted toward a ship. The pilot restarted the left engine and ditched the aircraft in calm seas 980 km (529 nm) northeast of Hilo. "The pilot and copilot exited the aircraft uninjured and were rescued by the nearby ship," the report said. "The aircraft sank [within four minutes] and was not recovered."

A 568-liter (150-gal) ferry tank had been installed behind the pilots' seats, with the electric pump switch and on/off valve within reach of the pilot. The ferry tank fed fuel to the left wing tank, and fuel was transferred from the left wing tank to the right wing tank through the aircraft's crossfeed valve.

"There was no fuel quantity gauge fitted to the ferry tank, and neither the aircraft nor ferry tank was fitted with a fuel flow gauge," the report said. "The ferry fuel system was designed to be turned on in the cruise phase of flight after one hour of flight. Fuel transfer was to cease when the left wing tank had reached no more than 95 percent of its capacity." Continued fuel transfer could cause fuel to be vented overboard.

Because the aircraft was not recovered, investigators were unable to determine what caused the cowling scorch mark reported by the pilot. The cause of the fuel loss also was not conclusively determined. "However, from the available information, it is likely that the left fuel tank was being overfilled by the ferry fuel system and was venting fuel overboard," the report said. The overfilling might have been caused by improper operation or malfunction of the ferry tank system, or a malfunction of the aircraft's fuel crossfeed system.

The other Seminole, which was equipped with the same ferry tank system, was landed in Hilo with enough fuel remaining for more than three hours of flight.

Out of Supplemental Oxygen at FL 270

Beech 56TC Baron. Destroyed. One fatality.

Night VMC prevailed for the personal flight from Glendive, Montana, U.S., to St. Paul, Minnesota, on March 17, 2006. The NTSB report said that the flight appeared to progress without incident until ATC observed the airplane climb 400 ft above its assigned altitude, FL 240.

"After being notified of the deviation, the pilot responded that he was attempting to look at his contrails," the report said.

The pilot then requested and received clearance to climb to FL 270. About 30 minutes later, the pilot asked ATC, "Did you hear me call in a few times?" This was the last radio transmission from the pilot, and attempts by ATC to reestablish radio contact were unsuccessful.

The airplane had been airborne about two hours when it overflew the destination. ATC requested assistance from the North American Aerospace Defense Command, which scrambled fighters to intercept the Baron. The fighter pilots observed that the airplane's exterior lights were illuminated, but they could not see the pilot. "Multiple attempts to gain the pilot's attention by firing flares and doing an afterburner flyby were unsuccessful," the report said.

The Baron had been airborne about four hours when it began to descend. Witnesses said that they heard a sound similar to a bomb exploding when the airplane struck a hill in Winfield, West Virginia, about 2250 local time.

The supplemental oxygen system installed in the unpressurized airplane and a portable oxygen bottle found in the cockpit were depleted. The report said that the probable cause of the accident was the pilot's failure to ensure that he had an adequate supply of supplemental oxygen, his inadequate in-flight planning and decision making, and his incapacitation by hypoxia.

Narrow Pass, Low Ceiling

De Havilland DHC-2. Destroyed. Two fatalities.

The Beaver was the first in a flight of two float-equipped airplanes en route from Galena, Alaska, U.S., to Anchorage on Sept. 15, 2006. The pilot of the second airplane told investigators that they were between 4,000 and 5,000 ft when they entered Mystic Pass in Denali National Park and then descended because of worsening weather conditions.

The pilot of the second airplane said that he radioed the Beaver pilot that he was not comfortable with the deteriorating visibility and was turning around. The Beaver pilot replied, "Turn around if you can. … I'm not able to."

"The second pilot reported that the last time he saw the accident airplane was just before it entered a cloud bank, as the flight neared the narrowest part of the pass," the report said.

A search was launched after the Beaver was reported overdue in Anchorage. The wreckage was found in the pass two days later. The airplane had struck terrain at 3,700 ft — 300 ft below the ridge of a steep slope.

Engine Fails on Maintenance Ferry Flight

Piper Twin Comanche. Destroyed. Three fatalities.

The airplane had been parked outdoors and flown about 15 hours in the past 10 years. The owner obtained a special flight permit to have the airplane ferried 152 nm (282 km) from Raymond, Mississippi, U.S., to New Albany, Mississippi, where an annual inspection would be performed before the airplane was sold to a new owner, the NTSB report said.

The pilot had a commercial certificate and about 4,000 flight hours, but "there was no evidence found to verify any flight time for the last 24 years," the report said.

Although the permit specified that only minimum crew could be aboard for the ferry flight, there were two passengers aboard when the Twin Comanche was taxied for departure from Raymond on Dec. 1, 2005.

Winds were from 340 degrees at 12 kt, gusting to 15 kt, when the airplane took off from Runway 30, which was 3,992 ft (1,217 m) long. The airplane was about 100 ft above ground level (AGL) when the right engine lost power. The report said that the pilot did not retract the landing gear or maintain minimum single-engine control speed, VMC. The Twin Comanche banked steeply right and struck the ground in a near-vertical attitude.

HELICOPTERS

Survey Flight Ends With Wire Strike

Bell 206B-3. Destroyed. Three fatalities.

The JetRanger was engaged in a noxious weeds survey flight in Parkes, Australia, on Feb. 2, 2006. A witness driving on a road said that the helicopter was about 200 ft AGL when it passed his automobile on the right. The helicopter then turned around and flew over the road at 50–60 ft AGL.

"The driver described that, at that time, the helicopter was 'under full control, nothing wrong with it and flying level,'" the ATSB report said.

The helicopter was being flown at about 61 kt when its left landing gear skid struck a powerline that crossed the road. "The helicopter was observed by the driver … abruptly changing attitude before rotating as it fell to the left of its original direction of travel and striking the ground adjacent to the road," the report said.

The pilot and the two weeds-control officers were killed, and the JetRanger was destroyed by the impact and fuel-fed fire. "There was no damage to the powerline or its associated facilities and structures," the report said. "The power-supply company described the [powerline] as being very strong, having a breaking load of 25 kN [5,622 lb] and being under high tension."

The powerline was not marked and was not required to be marked because it was less than 90 m (295 ft) above terrain. "There is presently no single source of information available to pilots on the location of known powerlines or tall structures that might represent a hazard to low-level operations," the report said.

The helicopter was not equipped with a wire-strike protection system. "Due to the large number of variables associated with wire-strike accidents, the effect that the fitment of such equipment may have had in this instance cannot be determined," the report said.

'Go Back Up … It's Too Low'

Robinson R44. Destroyed. Three fatalities.

The R44 and a Bell 206B were on positioning flights Aug. 13, 2006, from Vancouver, Washington, U.S., to Long Beach, California, where they were to engage in aerial photography. A fuel stop was planned in Astoria, Oregon; but when the helicopters arrived, the airport was reporting a 400-ft overcast and 5 mi (8 km) visibility in mist, the NTSB report said.

The 206B pilot told the R44 pilot, "I'm going to go through it. Stay right behind me." The pilot later told investigators that he had planned to fly westbound, over water, and find a break in the overcast.

A passenger aboard the 206B said that the R44 was behind and above the 206B when they entered the fog. The R44 pilot radioed, "How fast are you descending?" The 206B pilot answered, "Very slow." About 30 seconds later, the R44 pilot said, "Go back up. It's much lower than we thought. Go back up right now."

The 206B pilot conducted a climb and landed — the report did not say how — at the Astoria airport. He notified emergency personnel that he had lost radio contact with the R44 pilot and believed that the helicopter had crashed.

The report said that the R44 had descended into the water at about 0825 local time. At 0845, U.S. Coast Guard search-and-rescue personnel found two life vests and other debris about 1 mi (2 km) offshore; weather conditions at the accident site included 1 mi visibility and a 100-ft overcast. The bodies of the three occupants were recovered later that day.

"There is presently no single source of information available to pilots on the location of known powerlines or tall structures that might represent a hazard to low-level operations."

Ice Ingestion Likely Caused Flameout

Eurocopter AS 350-B3. Substantial damage. No injuries.

The pilot warmed the engine for about six minutes before taking off to spread powdered limestone on an ice-covered lake in Eringsboda, Sweden, the morning of March 1, 2006. A relatively low power setting was used during the overwater departure, said the Swedish Accident Investigation Board (AIB) report.

The helicopter was climbing through about 130 ft when the engine flamed out. "The pilot immediately initiated an autorotation, at the same time beginning a steep right turn into the wind toward land," the report said. "The helicopter came down onto the ice, about 20 meters [66 ft] from the shore, at low forward speed but at a high rate of descent. The pilot was unhurt and [exited] the helicopter without assistance."

Examination of the engine revealed damage to three compressor blades. Noting that the helicopter had been parked outside in falling snow before the flight, the report said that the engine likely flamed out when it ingested a buildup of ice.

The AIB recommended that the Swedish Civil Aviation Authority "point out to operators of this category of helicopter the importance of ensuring that ice, packed snow and water cannot be drawn into the engine, since even small amounts can cause the engine to stop." The board also recommended that an autoignition system be required as standard equipment in AS 350-B3 helicopters. ●

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Aug. 1, 2007	Fort Lauderdale, Florida, U.S.	Piper Aerostar 601P	substantial	3 none
The right engine failed on final approach, and the airplane struck a traffic light and crashed on a road during the forced landing.				
Aug. 2, 2007	Easton, Washington, U.S.	Robinson R44 II	destroyed	4 fatal
The helicopter was departing in VMC for a charter flight when witnesses saw the tail section move left and right. The R44 then pitched down and descended into mountainous terrain.				
Aug. 3, 2007	Eket, Nigeria	Bell 412EP	destroyed	1 fatal
The helicopter crashed while maneuvering at Qua Ibom Terminal Airfield.				
Aug. 5, 2007	Ruidoso, New Mexico, U.S.	Beech King Air E90B	destroyed	5 fatal
The airplane was departing in nighttime VMC for an air ambulance flight when it struck terrain about 4 nm (7 km) southeast of the airport.				
Aug. 9, 2007	Moorea, French Polynesia	de Havilland Canada DHC-6	destroyed	14 fatal, 6 NA
Both engines failed soon after the Twin Otter departed Moorea for a scheduled flight to Papeete. The airplane crashed and sank in a lagoon. Six passengers were not found.				
Aug. 11, 2007	Melville Hall, Dominica	Learjet 35A	substantial	6 none
The airplane was on a charter flight from Antigua in daytime VMC when it overran the runway, traveled down an embankment and came to a stop on a road.				
Aug. 12, 2007	Pusan, South Korea	de Havilland Canada Q400	substantial	74 NA
The airplane veered off the runway on landing and came to a stop in a drainage ditch. No fatalities were reported.				
Aug. 13, 2007	Moscow	Tupolev Tu-134	substantial	25 NA
A landing gear collapsed when the airplane, operated by the Russian air force on a nonscheduled passenger flight, overran the runway.				
Aug. 16, 2007	Ketchikan, Alaska, U.S.	de Havilland Canada DHC-2	destroyed	5 fatal, 4 serious
Strong, gusty winds were reported when the float-equipped Beaver struck terrain during takeoff from a bay about 20 nm (37 km) north of Ketchikan. The airplane was on a chartered sightseeing flight.				
Aug. 16, 2007	Gulf of Mexico	Bell 407	substantial	1 minor, 1 none
The engine failed during a charter flight between two offshore platforms. The pilot deployed the emergency floats and landed on the water. A large wave then broke the windshield and rolled the helicopter inverted. The occupants exited the helicopter and were rescued by the crew of a shrimp boat. Initial examination of the engine revealed an uncontained failure of the third-stage turbine wheel.				
Aug. 20, 2007	Okinawa, Japan	Boeing 737-800	destroyed	165 NA
A fuel leak was observed when the airplane was taxied to the gate after landing at Naha Airport. All the occupants evacuated on slides before a fire erupted and an explosion occurred. No fatalities were reported. Preliminary investigation indicated that a bolt had separated from a wing slat assembly and pierced a fuel tank.				
Aug. 22, 2007	Curitiba, Brazil	Embraer EMB-110P1	destroyed	2 fatal
The Bandeirante struck terrain at 0035 local time while departing for a domestic flight to Jundiaí.				
Aug. 22, 2007	Pasto, Colombia	Antonov An-26B	destroyed	53 NA
The airplane was en route from Cali to Villagarzón when the flight crew reported engine problems and diverted to Pasto. The twin-turboprop airplane overran the runway and traveled down an embankment. No fatalities were reported.				
Aug. 22, 2007	Houston	Mitsubishi MU-2	none	1 serious
A lineman was removing a wheel chock when his head was struck by a rotating propeller.				
Aug. 26, 2007	Kongolo, Democratic Republic of Congo	Antonov An-32	destroyed	14 fatal, 1 NA
The flight crew was attempting to return to the airport, after encountering engine problems on takeoff, when the airplane struck trees and crashed short of the runway.				
Aug. 31, 2007	Port-au-Prince, Haiti	Cessna 208 Caravan	destroyed	1 minor, 5 none
The airplane overturned during a forced landing soon after takeoff.				

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.