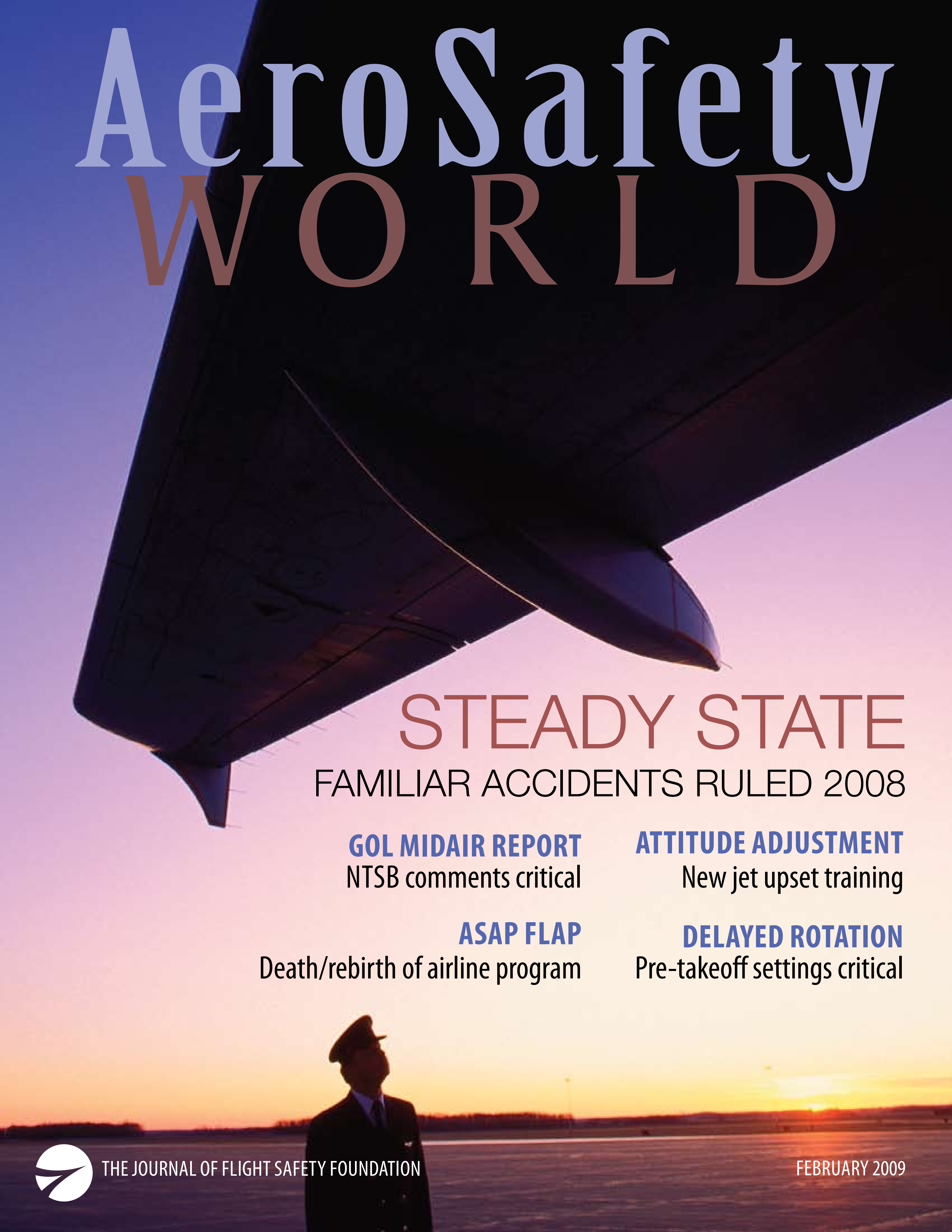

AeroSafety WORLD

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THE JOURNAL OF FLIGHT SAFETY FOUNDATION

FEBRUARY 2009

WHEN THE SUN DOESN'T Shine

This year is expected to be very tough for our business all over the world. Fewer people are flying, but a lot of people still are. The International Air Transport Association (IATA) estimates that the world's airlines last year flew about 2.3 billion passengers. This year they will fly about 2.2 billion passengers, IATA predicts. Revenues will take a serious tumble, and, with staffs reduced, overworked people will be stretched even further. This isn't the easiest time to dedicate resources to aviation safety; in the absence of an obvious safety threat, it is not the first thing people think about.

It is a funny thing about our business: Those 2.2 billion passengers flying this year still expect to arrive safely. We have to find a way to continue doing our jobs. Lucky for us there are some people who know that the continual pursuit of safety cannot stop when the sun refuses to shine. The Flight Safety Foundation owes a profound thanks to our members who keep contributing during difficult times. We also owe a very special thanks to a major new benefactor who has made a lasting gift to support aviation safety.

The Foundation has received a major gift from the estate of Manuel Maciel, a modest and hard-working man known to his friends as Manny. Manny was born in the Azores and immigrated to the United States in the 1940s. He worked nearly all his adult life at California's Sonoma County Airport. He started as a ramp service employee and eventually ran his own fixed base operation, Sonoma Aviation Fuel Services. Pilots from all over the U.S. knew him for his outstanding service and friendly manner. Even though he owned the place, he didn't think twice about working the ramp and pumping gas himself. After living on that ramp for 54 years, he sold the business and started a small restaurant on the airport where he could remain with his aviation family.

Few people realized that this frugal and industrious man was also an astute investor. He amassed a significant estate that ultimately he left to the aviation community he considered his family. When he died not long ago his will revealed that he had dedicated several million dollars for aviation safety research. His trustees distributed this substantial gift to the Aircraft Owners and Pilots Association's Air Safety Foundation, the American Bonanza Society and the Flight Safety Foundation.

The Foundation will use his gift to fund two programs. First, some of it will be used to support some near-term work on the safety of helicopter emergency medical services (HEMS). In the U.S. there has been an alarming increase in HEMS accidents, and we intend to help by bringing some of the data gathering and analysis techniques from airline and corporate aviation to bear on the problem. In funding this work, Manny's gift will help people stay safe on the worst day of their lives.

The remainder of the gift will launch an endowment, its earnings indefinitely funding research programs. I'll ask the Foundation's think tank — the Icarus Committee — to identify key aviation safety issues requiring targeted research. That work will be conducted under the auspices of the Manuel S. Maciel Chair for Aviation Safety Research.

Thanks to our members, and dedicated people like Manny, we can keep doing what is needed to support safety in our industry — even when the sun doesn't shine.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafety WORLD

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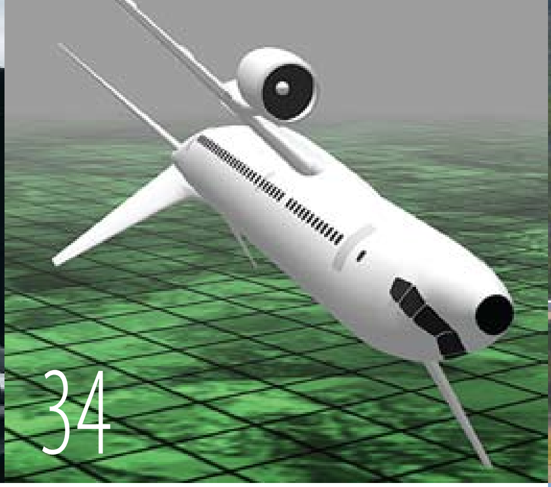

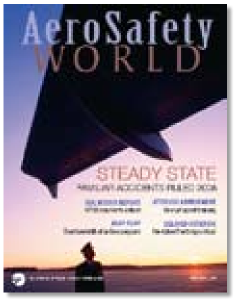

About the Cover
Most accidents in 2008 were familiar types.
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Share Your Knowledge

If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about aviation safety, we will be glad to consider it. Send it to Director of Publications J.A. Donoghue, 601 Madison St., Suite 300, Alexandria, VA 22314-1756 USA or donoghue@flightsafety.org.

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Serving Aviation Safety Interests for More Than 60 Years

Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 1,170 individuals and member organizations in 142 countries.

Member**Guide**

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ABSOLUTELY Nuts

It is ironic when governments, often on the lookout for risky airline behavior, invent new rules that pressure airlines into making unsafe decisions. The European Union (EU) has done this, and seems very satisfied with its actions.

There always has been and always will be a potential tug of war between aviation safety and money. For the most part, it stays that way, just a potential conflict, especially in the world's developed aviation markets where that threat is clearly recognized.

In the developing world, we see every year the catastrophic results of failing to spend money on aviation safety basics, but most of the time, the financial pressures are more subtle. However, the EU now has moved far from subtlety to a rule of law that says if an airline cancels a flight, even due to a mechanical problem, it will owe the flight's passengers tens of thousands of euros, regardless of whether the operation of the flight would have been unsafe.

It isn't a new thing for governments to set up situations that might increase risk. For example, noise abatement procedures can call for tailwind landings, increasing the risk of a runway excursion, and evening curfews might push crews to rush to beat the clock, possibly creating an unstabilized approach.

But the EU, in a misguided effort to protect consumers from airline abuses, has opened a new front in the battle between government rules and safe operations.

A recent court case based on the EU's Air Passenger Compensation Regulation, which took effect in early 2005, set a new precedent. A family trying to make a connection in Rome had their first leg canceled because of an engine problem discovered the night before. In the end, it took 10 days to repair the engine and return the aircraft to service, but the Commercial Court of Vienna, later affirmed by the European Court of Justice, ruled that the airline was not protected by the rule's exemption for "extraordinary circumstances which could not have been avoided even if all reasonable measures had been taken."

Even though the rule states that one of the "extraordinary circumstances" is "unexpected flight safety shortcomings," the Vienna court said the airline owed the passengers €250. Compensation for denied boarding can go as high as €600 per passenger, depending on the flight length.

The engine problem in question was so bad that no one would have considered flying with that engine, so safety was not at issue, at least in this case. But now, as predicted when the regulation was adopted, airlines face the threat of having to pay a hefty penalty to hundreds of passengers if a flight is canceled, adding yet another financial pressure to the go/no-go decision.

Not our problem, the court ruled: "The resolution of a technical problem caused by failure to maintain an aircraft must [therefore] be regarded as inherent in the normal exercise of an air carrier's activity. Consequently, technical problems which come to light during maintenance of aircraft or on account of failure to carry out such maintenance do not constitute, in themselves, 'extraordinary circumstances.'"

The European Commission "welcomed" the ruling, with European Commission Vice-President Antonio Tajani adding, "The effective respect of passenger rights is one of our major priorities." Too bad the safety of flight is not so highly regarded.

A friend had the right words to describe the EU's position: "That's absolutely nuts."

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

Another checklist reminder

The recent article entitled "Deadly Omissions" [*ASW*, 12/08, p. 10] was a great review regarding checklist use and design. While we know how easy it is to become complacent about such a critical function as running checklists, a reminder every now and then is certainly worthwhile.

After reading the article, I believe there is one more mitigation strategy that is worth suggesting. At the risk of promoting a piece of equipment or any vendor, there is a device we have had in our cockpits for years that does a very nice job in addressing some of the issues.

Compared to so much of what we have in the cockpit today, the "Heads-Up" voice checklist is relatively low tech and relatively low cost. It includes a light-emitting diode (LED) readout as well as the generated voice annunciation of each item, backed up for minimum equipment list purposes by a paper checklist.

While nothing is foolproof, this equipment makes it quite difficult to simply skip an item and nearly impossible to skip an entire checklist such as the "Taxi" checklist. One area it does not address is the problem of "expectation bias." It seems that most of the industry considers the "say-look-touch" confirmation technique as just that, pilot technique.

Perhaps it's time to consider making it part of the SOP.

Keith Baumgart
Aviation Services
Kraft Foods Global
Milwaukee

Honorific from the Pacific

I just wanted you all to know how much I enjoy seeing and reading *AeroSafety World.*

I consider it to be — without question — the best aviation publication of any kind that I have ever seen. It is always extremely readable and interesting (even subjects with the potential to be as dull as ditchwater are made readable and interesting … as they should be).

Furthermore, it is always attractive to look at and brilliantly laid out.

Thanks very much to all involved for such an outstanding publication. Keep up the great work.

Rob Neil
Pacific Wings Magazine
Amberley, New Zealand

AeroSafety World encourages comments from readers, and will assume that letters and e-mails are meant for publication unless otherwise stated. Correspondence is subject to editing for length and clarity.

Write to J.A. Donoghue, director of publications, Flight Safety Foundation, 601 Madison St., Suite 300, Alexandria, VA 22314-1756 USA, or e-mail <donoghue@flightsafety.org>.

FEB. 3–4 ➤ Aviation Crisis Management 2009. *International Airport Review*. Abu Dhabi, United Arab Emirates. Georgina Hooton, <ghooton@russellpublishing.com>, <www.regonline.com/builder/site/Default.aspx?eventid=665587>, +44 (0)1959 563.311.

FEB. 9–12 ➤ Annual International Aircraft Cabin Safety Symposium. Southern California Safety Institute. Torrance, California, U.S. <www.scsi-inc.com>, +1 310.517.8844.

FEB. 10–12 ➤ Aviation Ground Safety Seminar. National Safety Council, International Air Transport Section. Orlando, Florida, U.S. B.J. LoMastro, <B.J.LoMastro@nsc.org>, <www.nsc.org>, +1 630.775.2174.

FEB. 14 ➤ Semi-Annual Investigative Symposium. International Society of Air Safety Investigators, Southeast Regional Chapter. Savannah, Georgia, U.S. Daniel M. McCune, <mccun711@erau.edu>, <www.isasi.org/SERC-index.php#>, +1 386.226.4926.

FEB. 17–19 ➤ Airside Safety Training Course. European Joint Aviation Authorities. Hoofddorp, Netherlands. <training@jaat.eu>, <www.jaa.nextgear.nl/courses.html?action=showdetails&courseid=209>, +31 (0)23 567.9790.

FEB. 22–24 ➤ Heli-Expo. Helicopter Association International. Anaheim, California, U.S. <heliexpo@rotor.com>, <www.heliexpo.com>, +1 703.683.4646.

FEB. 23–26 ➤ Flight Data Monitoring for Airlines and Flight Operational Quality Assurance in Commercial Aviation. Cranfield University and U.K. Civil Aviation Authority. Bedford, England. Lesley Roff, <shortcourse@cranfield.ac.uk>, <www.cranfield.ac.uk/soe/shortcourses/atm/page3796.jsp?id=redirect>, +44 (0)1234 754192.

MARCH 1–4 ➤ 2nd Asian Ground Handling International Conference. Ground Handling International. Bangkok. Jean Ang, <jean@groundhandling.com>, <www.groundhandling.com/GHI%20Conf%202/index.html>, +44 1892 839203.

MARCH 2–4 ➤ NATCA Communicating for Safety Conference. National Air Traffic Controllers Association. Las Vegas. Steve Hansen, <shansen@natca.net>, <www.natca.org/safetytechnology/communicating.msp>, +1 505.715.3979.

MARCH 11–13 ➤ AAMS Spring Conference. Association of Air Medical Services. Washington, D.C. Natasha Ross, <nross@aams.org>, <www.aams.org/AM/Template.cfm?Section=Education_and_Meetings>, +1 703.836.8732, ext. 107.

MARCH 15–18 ➤ Operations and Technical Affairs Conference. Airports Council International–North America. San Diego. <meetings@aci-na.org>, <www.aci-na.org/conferences/detail?eventId=141>, +1 202.293.8500.

MARCH 16–18 ➤ 21st annual European Aviation Safety Seminar (EASS). Flight Safety Foundation, European Regions Airline Association and Eurocontrol. Nicosia, Cyprus. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org/seminars.html#eass>, +1 703.739.6700, ext. 101.

MARCH 17–19 ➤ ATC Global Exhibition and Conference. Civil Air Navigation Services Organisation, Eurocontrol, International Federation of Air Traffic Controllers' Associations and International Federation of Air Traffic Safety Electronics Associations. Amsterdam. Joanna Mapes, <atcevents@cmpi.biz>, <www.atcevents.com>, +44 (0)20 7921 8545.

MARCH 18–20 ➤ MBAE 2009 and Heli-Mex. Mexican Business Aviation Exhibition and Heli-Mex. Toluca, Mexico. Agustin Melgar, <exposint@prodigy.net.mx>, <www.mbaeexpo.com>, +52 333.647.1134.

MARCH 23–27 ➤ Safety Management System Principles Course. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Page McCanless, <mpthomps@mitre.org>, +1 703.983.6799.

MARCH 24–26 ➤ Safety Manager Course. Aviation Research Group/U.S. Trenton, New Jersey, U.S. Kendra Christin, <kchristin@aviationresearch.com>, <www.aviationresearch.com/press_detail.asp?id=46>, +1 513.852.5110, ext. 10.

MARCH 26–27 ➤ ADS-B Management Forum. *Aviation Week*. Washington. Alexander Moore, <alexander_moore@aviationweek.com>, <www.aviationnow.com/forums/adsbmain.htm>, +1 212.904.2997.

MARCH 26–28 ➤ Annual Repair Symposium. Aeronautical Repair Station Association. Pentagon City, Virginia, U.S. Keith Mendenhall, <keith@arsa.org>, <www.arsa.org/2009SymposiumInfo>, +1 703.739.9488.

MARCH 29–APRIL 1 ➤ CHC Safety and Quality Summit. CHC Helicopters. Vancouver, British Columbia, Canada. Adrienne White, <awhite@chc.ca>, +1 604.232.8272.

MARCH 30–31 ➤ SAR 2009: Search and Rescue Conference and Exhibition. The Shephard Group. Washington. Kathy Burwood, <kb@shephard.co.uk>, <www.shephard.co.uk/events>, +44 1753 727019.

MARCH 30–APRIL 2 ➤ International Operators Conference. National Business Aviation Association. San Diego. Dina Green, <dgreen@nbaa.org>, <www.nbaa.org/events/ioc/2009>, +1 202.783.9000.

MARCH 31–APRIL 1 ➤ Aviation Human Factors Conference: Real-World Flight Operations and Research Progress. Curt Lewis, Flight Safety Information; U.S. Federal Aviation Administration Safety Team, Southwest Region, and Fort Worth Flight Services District Office; International Society of Air Safety Investigators. Dallas/Fort Worth. Kent Lewis, <lewis.kent@gmail.com>, <www.signalcharlie.net/Conference>, +1 817.692.1971.

APRIL 21–23 ➤ 54th annual Corporate Aviation Safety Seminar (CASS). Orlando, Florida, U.S. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org/seminars.html#cass>, +1 703.739.6700, ext. 101.

APRIL 25–26 ➤ Regional Advanced Airport Safety and Operations Specialist School. American Association of Airport Executives. Buffalo, New York, U.S. Stacey Renfroe, <stacy.renfroe@aaae.org>, <www.aaae.org/meetings/meetings_calendar/mtgdetails.cfm?MtgID=090416>, +1 703.824.0500.

APRIL 28–30 ➤ World Aviation Training Conference and Tradeshow. Halldale Media Group. Orlando, Florida, U.S. Fiona Greenyer, <fiona@halldale.com>, <www.halldale.com/WRATS.aspx>, +44 (0)1252 532000.

MAY 4–6 ➤ 6th International Aircraft Rescue Fire Fighting Conference and Exhibits. *Aviation Fire Journal*. Myrtle Beach, South Carolina, U.S. <avifirejnl@aol.com>, <www.aviationfirejournal.com/myrtlebeach/index.htm>, +1 914.962.5185.

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

Concorde Trial Set

A manslaughter trial is scheduled for February 2010 for Continental Airlines, two Continental employees and three former aviation officials charged in connection with the July 25, 2000, crash of an Air France Concorde after takeoff from Paris Charles de Gaulle International Airport. The crash killed all 109 people in the airplane and four on the ground.

French prosecutors say the trial of Continental, a Continental maintenance technician, the airline's chief of maintenance, a former French civil aviation official and two former officials of the Concorde manufacturing program is expected to last about three months in a criminal court in Pontoise, a suburb of Paris.

The French Bureau d'Enquêtes et d'Analyses (BEA) said in its final report on the accident that the Concorde ran over a strip of metal that had fallen from a Continental McDonnell Douglas DC-10 during takeoff from the same runway several minutes earlier. The resulting tire failure sent pieces of tire into one of the Concorde's engines and a fuel tank; the subsequent fire and loss of control preceded the crash.

The BEA report said that the metal strip was a stainless steel wear strip from the DC-10's no. 3 engine. Maintenance records showed that wear strips on the engine fan reverser cowl had been replaced during scheduled maintenance performed by Israel Aircraft Industries in Tel Aviv on June 11, 2000. On July 9, maintenance personnel in Houston noticed that the lower left wear strip was twisted and sticking out of the cowl, and they replaced it. The BEA report said that the replacement was not performed in compliance with manufacturer specifications.

Wikimedia

Flight Safety Foundation and other aviation organizations have denounced the decision to proceed with criminal prosecutions.

"Absent willful intent or highly egregious conduct, we seriously question the basis for putting companies and aviation professionals through the ordeal of criminal prosecutions," said Foundation President and CEO William R. Voss. "In addition, we're very concerned that criminal prosecutions will discourage the free flow of information from operators to management to regulators, to the detriment of aviation safety."

Simulator Requirements

The U.S. Federal Aviation Administration (FAA) is proposing to require the use of flight simulators to enhance traditional air carrier training programs for flight crewmembers.

In a notice of proposed rulemaking (NPRM), the FAA said that the proposed change would require crewmembers to be trained and evaluated in "a complete flight crew environment." The proposal would require line oriented flight training (LOFT) in a full flight simulator during recurrent training, as well as training, testing and checking of flight crewmembers using a flight simulation training device.

Other requirements would include special hazard training on loss of control and controlled flight into terrain, additional training in crew resource management and annual performance drills for flight attendants using emergency equipment and procedures.

In addition, training and experience requirements for check dispatchers and dispatcher instructors would be standardized, supervised operating experience requirements would be put in place for aircraft dispatchers, and requalification training would be developed for aircraft dispatchers and crewmembers.

Another provision addresses runway safety goals with a requirement for operators to ensure that flight crewmembers use an airport diagram to help maintain positional awareness, obtain proper clearances before crossing or entering active runways, observe runway hold lines and other markings and lighting intended for surface movement guidance, and ensure that their takeoff calculations have been performed using the correct runway information.

© Boeing

The changes prescribed by the proposal "make a significant contribution to the FAA's accident-reduction goal," the agency said.

The FAA said it would accept comments on the proposal until May 12.

Icing Warnings

A new safety alert from the U.S. National Transportation Safety Board (NTSB) says that pilots should activate leading-edge deice boots as soon as icing is encountered, unless the aircraft flight manual or pilot operating handbook specifically tells them not to do so (*ASW*, 12/08, p. 20).

"For 60 years, pilots have been taught to wait for a prescribed accumulation of leading-edge ice before activating the deice boots because of the believed threat of ice bridging," the NTSB said, referring to a theory that early activation of the boots might push the ice into a frozen "bridge" around the boot, making it ineffective.

However, the safety alert said, "ice bridging is extremely rare, if it exists at all. Early activation of the deice boots limits the effects of leading-edge ice and improves the operating safety margin."

The safety alert also cautioned pilots to "maintain extremely careful vigilance" about airspeed and aircraft handling qualities, especially if the aircraft flight manual or pilot operating handbook says that deice boots should not be activated until a specific amount of ice has accumulated.

The National Business Aviation Association (NBAA), however, urged operators to "continue to base their decisions about de-icing on their experience and judgment, because proving the existence of ice bridging after an accident is difficult, and many documented cases resulted in successful outcomes due to the skill and professionalism of the flight crew."

U.S. National Aeronautics and Space Administration

In a related appeal, the U.K. Civil Aviation Authority (CAA) cautioned pilots and ground crew "to not underestimate the dangers posed to aircraft of ice and ground frost this winter."

The CAA added, "Ultimately, an aircraft should never take off with any form of contamination on its surfaces, particularly ice, snow and frost, although some types may be permitted some frost on lower wing surfaces."

The CAA cited the January 2002 crash of a Bombardier Challenger 604 during takeoff from Birmingham International Airport, noting that the U.K. Air Accidents Investigation Branch had said in its final report on the accident that the airplane's left wing had stalled at "an abnormally low angle-of-attack due to flow disturbance resulting from frost contamination of the wing." All five people in the airplane were killed.

New Beacons

Now that the international program that coordinates the detection of distress signals has stopped monitoring signals from 121.5/243 MHz emergency locator transmitters (ELTs), civil aviation authorities are requiring aircraft to be equipped with 406 MHz ELTs.

The long-planned action by the International Cospas-Sarsat Programme took effect Feb. 1. Cospas-Sarsat said it made its decision in the 1990s in response to recommendations from the International Civil Aviation Organization and the International Maritime Organization, which several years ago acknowledged the superior speed and accuracy of 406 MHz beacons in relaying position information of aircraft and ships in distress.

"With a 121.5/243 MHz beacon, only one alert out of every 50 alerts is a genuine distress situation," Cospas-Sarsat said. "This has significant effect on the resources of search and rescue services. With 406 MHz beacons, false alerts have been considerably reduced (about one alert in 17 is genuine), and when [beacons are] properly registered, [signals from 406 MHz beacons] can normally be resolved with a telephone call to the beacon owner using the encoded beacon identification. Consequently, real alerts can receive the attention they deserve."

ICAO previously required 406 MHz beacons on all international commercial passenger aircraft and now recommends their use on all other aircraft. In recent months, civil aviation authorities worldwide have begun changing their regulations to require a switch to 406 MHz ELTs.

The Cospas-Sarsat decision affects all ELTs; all maritime beacons, known as emergency position-indicating radio beacons (EPIRBs); and all personal locator beacons. Homing transmitters, man-overboard systems and other 121.5 MHz devices that do not require satellite detection are not affected.

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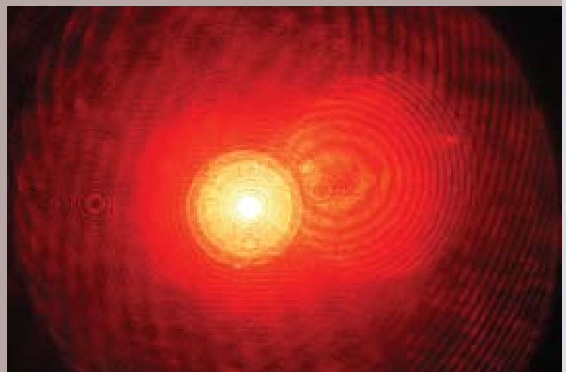
Increase Reported in U.K. Laser Incidents


Wikimedia

Citing a "marked increase" in incidents in which powerful hand-held lasers have been pointed at aircraft in flight, the U.K. Civil Aviation Authority (CAA) has issued guidance to air navigation service providers (ANSPs) on reporting the events to law enforcement authorities.

"The CAA has become aware of a significant increase in the misuse of hand-held, high-powered lasers against aircraft in flight," the CAA said in an Air Traffic Services Information Notice (ATSIN). "Such lasers represent a danger not only to the safety of the aircraft but also to the health of the flight crew. To date, 150 instances have been reported to the CAA's Safety Investigation and Data Department."

The CAA said that, although detection, arrest and prosecution are handled by the appropriate law enforcement officials, ANSPs must promptly notify police of laser incidents. The ANSPs should "liaise with the local police force in order to establish the most expedient and appropriate means of contact between the [air traffic services] unit and the relevant police authority."

Filling the Gap

Automatic dependent surveillance-broadcast (ADS-B) air traffic surveillance technology has helped eliminate an 850,000-sq-km (382,187-sq-mi) gap in Canadian radar coverage over the Hudson Bay, Nav Canada says.

Nav Canada, which operates Canada's civil air navigation service, says that the use of ADS-B will provide for more efficient use of airspace over the bay for about 35,000 flights every year, as well as shorter flight times, lower fuel costs and reduced emissions of greenhouse gases.

The first flight across the bay using ADS-B was an Air New Zealand flight from London to Los Angeles on Jan. 15. Using ADS-B, controllers tracked the airplane on their displays as it was flown through Hudson Bay airspace, which previously had been without radar coverage.

In Other News …

Australia, one of the first countries in the world to develop **multi-crew pilot license** (MPL) training, has graduated the first six students from an MPL program. The six cadets, from two Chinese airlines, completed flight assessments in December 2008. … The U.S. Federal Aviation Administration has lowered **Israel's** aviation safety standard rating following a 2008 evaluation of the Israeli civil aviation authority. The Category 2 rating is given to countries that lack laws or regulations to oversee air carriers in accordance with International Civil Aviation Organization (ICAO) standards or countries that do not meet ICAO standards in specified areas such as technical expertise and inspection procedures.


© Steven Day/Associated Press

Passengers on a US Airways Airbus A320 wait on the wings to be rescued by Hudson River ferries after the airplane was ditched on Jan. 15 following takeoff from LaGuardia Airport in New York. None of the 155 people in the airplane was killed; one person received serious injuries. Preliminary reports said that both engines lost power following multiple bird strikes.

Compiled and edited by Linda Werfelman.

U.S. National Aeronautics and Space Administration

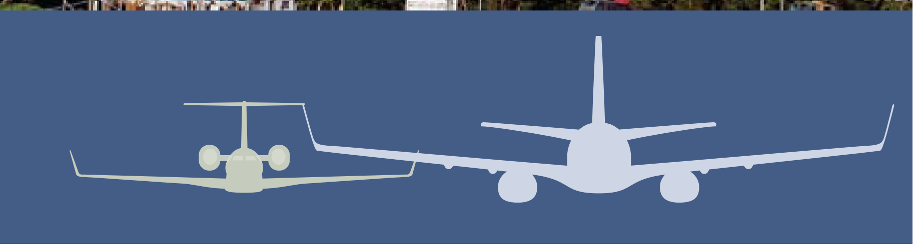
BY MARK LACAGNINA

The airplanes converged nearly head-on, striking their left wings first. The business jet lost most of its left winglet and the tips of the left horizontal stabilizer and elevator, but it remained controllable and was landed without injury to the seven people aboard. The airliner initially lost about a third of its wing and then broke up during a spiral dive into the Amazon rain forest; all 148 passengers and six crewmembers were killed.

The 282-page final report by the Brazilian Aeronautical Accident Investigation and Prevention Center — the Centro de Investigação e Prevenção de Acidentes Aeronáuticos (CENIPA) — concludes that loss of situational awareness by the Embraer Legacy 600 pilots and by the air traffic

Midair over the Amazon

Controversial Brazilian report cites loss of situational awareness by pilots and controllers.



The Legacy pilots experienced control difficulties after the collision but were able to land the airplane. The 737 descended out of control after losing the outer portion of its left wing.

Photo: Agência Brasil/Wikipedia.org; illustration: CENIPA and Susan Reed

controllers handling the flights were among several factors that led to the business jet proceeding out of radar and radio contact — and with a nonfunctioning transponder and traffic alert and collision avoidance system (TCAS) — at a flight level that placed it in conflict with the Boeing 737-800.

The report's findings and conclusions have been questioned by organizations that include the U.S. National Transportation Safety Board (NTSB), a party to the investigation. NTSB said, for example, that although the report acknowledges air traffic control (ATC) safety deficiencies, it does not provide sufficient analysis of the deficiencies or include them in conclusions about the cause of the accident.

The collision occurred in visual meteorological conditions at Flight Level (FL) 370 (approximately 37,000 ft) the evening of Sept. 29, 2006. Both airplanes were nearly brand-new. The Legacy, N600XL, had been purchased by ExcelAire Services, a U.S.-based charter and aircraft management company, and was en route from the Embraer factory at São José dos Campos to Fort Lauderdale, Florida, U.S., with an overnight technical stop at Manaus, Brazil. The 737, PR-GTD, had entered service with Gol Transportes Aéreos the month before the accident and was on a scheduled flight from Manaus to Rio de Janeiro, with a technical stop at Brasília.

Partial Clearance

The report said that because of their haste to depart — to avoid flying over the Amazon at night — the Legacy flight crew did not have adequate knowledge of the flight plan that had been prepared for them by Embraer personnel. It also concluded that transmission of an incomplete departure clearance by the ground controller at the São José dos Campos airport "favored the understanding by the pilots that they had to maintain FL 370 all the way to Manaus."

The Brasília Area Control Center (ACC) had given the ground controller a clearance that specified three flight levels: FL 370 on Airway UW2 to the Brasília VHF omnidirectional radio (VOR), FL 360 from the VOR to an intersection on Airway UZ6, and FL 380 thereafter. When the ground controller relayed the clearance to the Legacy pilots, he included only the initial flight level, saying, in part, "clearance to Eduardo Gomes [the Manaus airport], Flight Level three seven zero."

"As a result, the pilots understood that FL 370 was cleared up to Manaus," the report said. "In an interview … the pilots of N600XL confirmed this understanding."

The Legacy departed at 1751 coordinated universal time (1451 local time). The airplane was on Airway UW2, which has a centerline track of 006 degrees, and 52 nm (96 km) south of the VOR about one hour later when it was handed off by the Brasília ACC Sector 5 controller to the Sector 7 controller. The Sector 5 controller did not tell the Sector 7 controller or the pilots that a change from FL 370 to FL 360 was to be made before the airplane crossed the VOR and began navigating on the 335-degree centerline track of UZ6.

Noting that the Brasília VOR is well within Sector 5 airspace, NTSB said that the hand-off was made "unusually early" and that it was the Sector 5 controller's responsibility to instruct the crew to descend to FL 360. "Alternatively, he should have either changed the data [shown on the ATC radar displays] to accurately reflect the clearance [i.e., the assigned altitude] or advised the Sector 7 controller of the actual clearance."

The report said that the Sector 7 controller assumed that the crew already had been instructed to descend to FL 360 even though the copilot reported that they were maintaining FL 370 when they established radio communication with him. After the controller told the crew that the airplane was in radar contact and the copilot acknowledged the information, there was no further communication between the crew and ATC until after the collision.

'Bad System Design'

NTSB said that a change on the controller's radar display when the airplane neared the VOR at 1855 likely contributed to the controller's misunderstanding of the assigned flight level. The aircraft data blocks on Brazilian ATC radar displays show two flight levels, side by side and separated by a symbol. On the left is the Mode C flight level transmitted by the aircraft's transponder; next to it is the "cleared flight level" that has been issued, and entered in the data block, by a controller. Normally, the symbol "=" appears between the two flight levels.

However, the cleared flight level automatically changes to the "requested flight level" about two minutes before the aircraft crosses a navigation fix at which a level change should be made. Thus, when the Legacy neared the Brasília VOR, the flight level information displayed in its data block changed from "370=370" to "370=360." Nevertheless, the controller did not notice that the airplane was "flying at a flight level that was different from the flight level requested in the active flight plan," the report said.

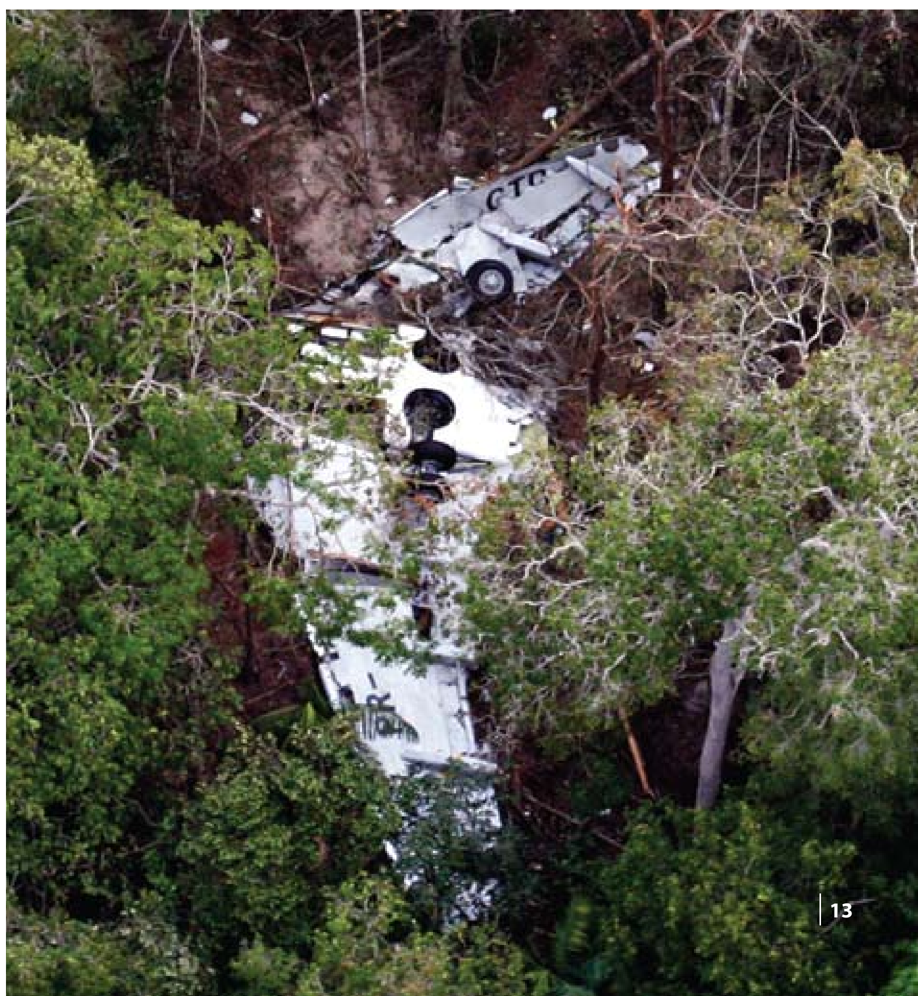
Noting that the report did not fault the flight level display itself, NTSB said that "a design in which two distinctly different pieces of information — that is, requested altitude and cleared altitude — appear identical on the display is clearly a latent error." A similar opinion was expressed by the International Federation of Air Traffic Controllers' Associations, which called the flight-level-display feature "non-error-tolerant … and a bad system design" that was not adequately addressed by the report (see "Missed Opportunity," p. 14).

Squawk Stopped

Seven minutes after the airplane crossed the VOR — its transponder stopped replying to ATC radar interrogations. The report said that neither the pilots nor the controller noticed this, and that cockpit voice recorder data indicated that the attention of both pilots was focused on conducting performance calculations for the landing and takeoff at Manaus. "With adequate planning, this task should have been finished on the ground before departure," the report said, noting that the pilots had found after they were under way that the preflight paperwork assembled by Embraer included a notice to airmen about a reduction of the available runway length at the Manaus airport.

Investigators were unable to determine conclusively how the transponder had been switched to the standby mode, which requires pressing the transponder/TCAS button — one of 12 buttons on the sides of a radio management unit (RMU)

All 154 people aboard the 737 were killed when the airplane broke up during descent and crashed in the rain forest.



Eraldo Peres/Associated Press

‘Missed Opportunity’

The final report on the midair collision failed to provide “clear conclusions” about known problems in the Brazilian air traffic control (ATC) system and how they contributed to the accident, said a position statement issued in January by the International Federation of Air Traffic Controllers’ Associations (IFATCA).

“Whereas the inquiries in regard to the events in the cockpit of the Legacy private jet seem to have received a lot of attention and were done with rather detailed care by CENIPA [the Brazilian Aeronautical Accident Investigation and Prevention Center], the same cannot be said for investigations on the ATC side,” said the federation, which represents more than 50,000 controllers in 130 countries.

For example, IFATCA noted a “non-error-tolerant” ATC software feature that occasionally changes the flight level shown on the controller’s radar display, with no input by the controller. The federation called this a “bad system design” that created a trap for the pilots and controllers involved in the collision. The accident report discusses this feature but includes no recommendation about it.

“IFATCA thinks the identified shortcomings in the CENIPA report are a missed opportunity for the Brazilian aviation authorities to restore trust and safety in the national aviation system. This final accident report could have served as the starting point for an extensive and desperately needed healing process. … This has unfortunately not occurred, as CENIPA — an integral part of the same Brazilian Air Force that is responsible for the provision of air traffic control — has chosen to put the main responsibility for the midair collision of 2006 on the front-line operator only. This CENIPA decision appears driven by a reluctance to expose staff and departments situated in its own organization.”

— ML

— twice within 20 seconds. The report said that the most likely explanation is that the pilot inadvertently switched the transponder to standby while using other RMU features for the performance calculations.

Among other possibilities considered was that a laptop computer accidentally struck the transponder/TCAS button on one of the RMUs when it was passed between the pilots. However, it was determined that the control yoke would have prevented this.

Another possibility is that the button was accidentally struck when the pilot placed a foot on the footrest at the bottom of the panel. However, “the footrest has a metal plate, called a foot protector, designed to keep the foot away from delicate instruments which could be damaged if contacted inadvertently,” the report said.

NTSB said that misuse of the footrest is another possibility. “In certain forward seat positions, there appeared [during observation flights] to be a very comfortable resting position that involved resting the feet on top of the footrest guards rather than inside the designated footrest areas,” the board said. “This … located the captain’s right foot in the area of the RMU so it could make unintended contact without the captain’s awareness.”

Warnings Undetected

While briefing his relief controller at 1918, the Sector 7 controller said that the Legacy was maintaining FL 360. At this point, the flight level display in the data block would have changed from “370=360” to “370Z360,” to indicate that the airplane was being tracked by primary radar with an altitude sweep. This system is intended to be used only for military aircraft in emergency or air-defense situations. However, the “Z” also is automatically displayed when a civil aircraft stops replying to radar interrogations.

“Although the system presented the prescribed indications for the loss of the N600XL transponder, they did not draw the attention of the controller to the need for changing the flight level,” the report said. It also said that during the 57 minutes preceding the collision, the Legacy pilots failed to notice a transponder “STANDBY” indication on the RMUs and a “TCAS OFF” indication on the primary flight displays.

At 1926 — 34 minutes after the last radio communication — the Sector 7 relief controller made the first of seven calls to the Legacy, which had by then flown beyond the area covered by the last assigned radio frequency. The controller’s calls were made simultaneously on six radio frequencies. However, NTSB said that he “never attempted to try a relay through other flight crews, the emergency frequency or any other means to treat the flight under lost-communication procedures.” The board said that the controller also failed to inform the Amazonic ACC, which was handling the 737, about the loss of radio and radar contact with the Legacy.

At 1948, the copilot began using the five Sector 7 frequencies shown on his navigation chart in an attempt to re-establish radio communication with ATC; he made 19 calls. However, only one of the frequencies shown on the chart actually was usable. Two of the frequencies had not been selected at the controller’s console, one was erroneous, and one had not been "connected" to the center's audio equipment, the report said.

The copilot heard part of the controller's last transmission at 1956. He requested that the controller repeat the message, but his call was not heard. The collision occurred one second later.

The Legacy rolled left and began to descend, but the crew was able to regain control. They used the emergency frequency, 121.5 MHz, to relay a message to Amazonic ACC through the crew of a Polar Air Cargo aircraft that they were declaring an emergency because of flight control difficulties and would conduct an emergency landing at the military airport in Cachimbo, about 100 nm (185 km) ahead.

"After landing, the N600XL crew reported that their airplane had collided in flight with an unknown object," the report said. "The wreckage of the [737] was found the next day … in a region of thick forest in the county of Peixoto de Azevedo, Mato Grosso State."

Misplaced Blame?

Among the report's conclusions was that the Legacy crew had not been trained adequately and had not prepared properly for the delivery flight, and that their limited experience with the airplane and its avionics equipment was a likely factor in the inadvertent deactivation of the transponder and TCAS.

NTSB said that the facts do not support these conclusions. "The crew flew the route precisely as cleared and complied with all ATC instructions," it said. "Although the transponder outage was likely because of an inadvertent action, no evidence in the factual record indicates that a lack of familiarity with the avionics is related to the outage."

The pilot, 42, had 9,388 flight hours, including 5.5 hours in the Legacy. The copilot, 34, had 6,400 flight hours, including 3.5 hours in type and nearly 400 flight hours as pilot-in-command of Embraer regional jets, which are similar to the Legacy.

Brazilian investigators considered the possibility that the Legacy's transponder might have been deactivated when the captain's foot, when placed on the footrest shown by the arrow, inadvertently touched the radio management unit above and to the right of the footrest.

Benjamin Schuhmann/Jetphotos.net

The report also concluded that the pilots were distracted by the performance calculations and lost situational awareness. "Although they were maintaining the last flight level authorized by [ATC], they spent almost an hour flying at a nonstandard flight level for the heading being flown and did not ask for any confirmation from ATC," it said.

The controllers were faulted for failing to provide proper traffic separation. "The air traffic control units involved … did not correct the flight level and did not perform the prescribed procedures for altitude verification when they stopped receiving essential information from [the Legacy's] transponder," the report said. "The controllers assumed that the traffic was at a different flight level without even being in two-way radio contact with N600XL for confirmation."

NTSB said that its analysis of the facts led to the conclusion that the probable causes of the accident were "ATC clearances which directed [the pilots of both airplanes] to operate in opposite directions on the same airway at the same altitude. … The loss of effective air traffic control [resulted from] a combination of numerous individual and institutional ATC factors which reflected systemic shortcomings."

A separate investigation was conducted by the Brazilian Federal Police and resulted in criminal charges against the Legacy pilots and several of the controllers (see "Investigation Turns Criminal," p. 16).

This article is based on Final Report A-00X/CENIPA/2008, available online at <http://ntsb.gov/Aviation/Brazil-CENIPA.htm>.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BY EDVALDO PEREIRA LIMA

Investigation Turns Criminal

Pilots, controllers indicted in wake of collision that rocked Brazil.

More than two years after the crippled Gol Boeing 737-800 crashed in the Amazon rain forest, the global aviation community received much-anticipated news about legal cases resulting from the midair collision that downed the 737, killing 154 people.

A few days before the Aeronautical Accident Investigation and Prevention Center (CENIPA, a unit of the Brazilian Air Force) made public its final report on the collision in December 2008, federal judge Murilo Mendes pronounced his first verdicts in a parallel investigation by federal police that indicted the two pilots of the ExcelAire Embraer Legacy business jet that collided with the 737, and two air traffic controllers (ATCOs) and two assistant ATCOs who were on duty when the accident occurred.

His decisions to drop some charges and amend others related to a federal policy inquiry that was initiated immediately after the accident and later turned into a criminal investigation by federal prosecutor Thiago Lemos de Andrade. Contrary to the traditional global aviation paradigm of non-criminalization of air accidents, the justice system in Brazil went by the letter of the law, Article 261 of its penal code. The article paves the way for criminal punishment of people "who expose aircraft to peril" with imprisonment for six months to 36 years, depending on whether the person's actions resulted in a crash and loss of life.

Other articles of the penal code establish two different degrees of guilt, depending on whether the event is judged to have resulted from intentional or unintentional criminal behavior. Unintentional behavior includes poor airmanship (the lack of proper professional skills), negligence (careless performance) and imprudence.

The ExcelAire pilots, Joseph Lepore and Jan Paul Paladino, faced charges of unintentional guilt for neglecting prescribed procedures when radio communication problems with the Brasília Area Control Center (ACC) began, but Mendes dropped those charges. However, the pilots still face charges of imprudence for not following a flight plan that designated a descent from Flight Level 370 to FL 360 soon after crossing the Brasília VOR (VHF omnidirectional radio) and poor airmanship for allegedly inadvertently turning off their transponder. Lepore and Paladino are likely to continue being judged *in absentia* through a legal treaty between Brazil and the United States that has allowed them to testify before U.S. court officers who are cooperating with their Brazilian counterparts.

Mendes dropped all charges against Brasília ACC assistant ATCOs Felipe Santos dos Reis and Leandro José de Barros, and reduced the charge against ATCO Jomarcelo Fernandes dos Santos from intentional to unintentional guilt in his handling of the Legacy and for providing incorrect flight level information when handing off the flight to ATCO Lucindo Tibúrcio de Alencar. Alencar is now free from a charge of unintentional negligence but still is to be judged on charges of imprudence, or poor professional performance, in not trying to re-establish radio communication with the Legacy pilots through alternate frequencies.

Mendes now wants to bring a fifth ATCO to court. João Batista da Silva was in charge of ground control at the São José dos Campos airport when the Legacy departed on its flight to the United States via Manaus. The contention is that Silva issued an instrument flight rules clearance that included the initial flight level, 370, but did not clarify that a descent to FL 360 was required after crossing the Brasília VOR and that a climb to FL 380 was required for a later flight segment. This allegedly caused the pilots to believe that they would maintain FL 370 all the way to Manaus. The Gol 737 was en route from Manaus to Brasília at FL 370 when the collision occurred. Silva contends that the clearance he relayed to the Legacy pilots adhered to standard operating procedure.

The ATCOs are all sergeants in the Brazilian Air Force, which manages both civilian and military air traffic control in the country. Their attorney, Roberto Sobral, points out that the dismissed charges against two of the controllers prove his defense thesis, that the real problem is systemic, involving poor management by the military.

The collision stirred a reaction by ATCOs that nearly dragged the Brazilian air transport system to its knees on three different occasions when they slowed down or stopped air traffic and publicly denounced poor working conditions and safety threats (*ASW*, 11/07, p. 18). The air force took the position that because ATCOs are members of the military by the free choice of their enlistment, they are subject to military ruling, and thus placed many of them on trial. About 98 members of the Brazilian Federation of ATCO Associations have been sued, fired or jailed since then, actions that attorney Sobral sees as retaliation.

For this and other reasons, Sobral has sent statements to the Supreme Court of Brazil denouncing Lt. Air Brig. Juniti Saito, commander of the air force, and his predecessor, Lt. Air Brig. Luís Carlos Bueno. He says that if the ATCOs are judged guilty, he will appeal to the Supreme Court and, if that does not work, his next move will be to appeal to the United Nations International Court of Justice for violation of human rights.

As these legal proceedings move forward, it is apparent that the issues resulting from the collision include criminalization versus the nonpunitive standard designed to protect the free flow of aviation safety information and, in Brazil, the effectiveness of military control of the ATC system. Brazil is approaching crossroads on both issues.

Edvaldo Pereira Lima is an aviation journalist living in Brazil.

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

Steady State

BY JAMES M. BURIN

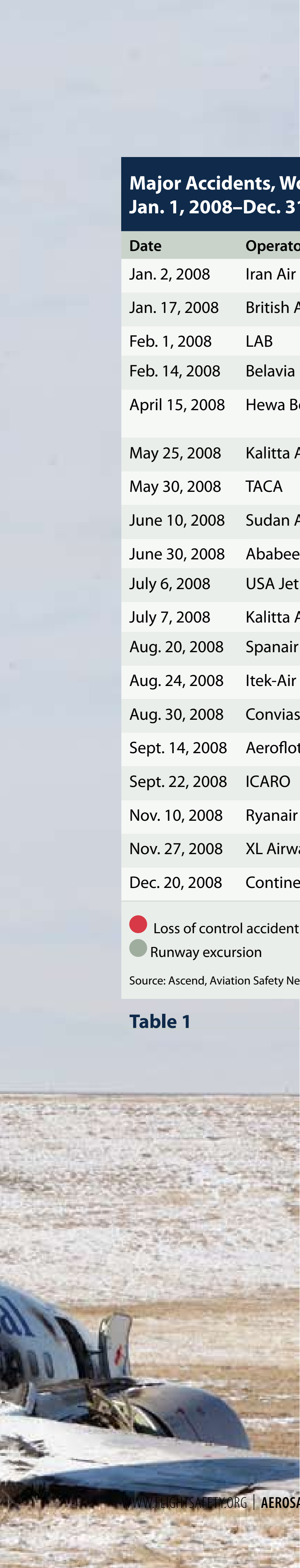
Accident categories in 2008 were mostly familiar, including the unwelcome return of the no-flaps takeoff.

A Boeing 737 was destroyed in a runway excursion on takeoff at Denver International Airport.

"Average to below average" is the best way to describe the year 2008 in terms of safety performance for all segments of professional aviation, including commercial and corporate jets and commercial turboprops. The big killers remain, particularly loss of control in commercial jets and controlled flight into terrain (CFIT) in commercial turboprops. Even though there are occasionally new types of accidents — for example, the British Airways Boeing 777 landing accident at London Heathrow — the majority of accidents in 2008 are types we have seen before, including CFIT, runway excursion and no-flap/no-slat takeoff. This raises the question, why are we failing to fully benefit from aviation safety lessons learned? The total fatality count in all commercial jet, commercial turboprop and corporate jet major accidents was 688, down from 763 in 2007 and well under the 903 deaths reported in 2006.

Last year, the commercial jet fleet grew approximately 3 percent over 2007 numbers, while the commercial turboprop fleet stayed virtually unchanged. The corporate jet numbers showed the largest change, with a 9 percent increase. Some 8 percent of the world's commercial jet fleet is Eastern-built, while approximately one-third of the turboprop fleet is Eastern-built.

The active fleets, the aircraft actually in service, are somewhat smaller. Approximately 7 percent of the jet fleet is inactive, while 14 percent of the turboprop fleet is inactive.



Major Accidents, Worldwide Commercial Jets
Jan. 1, 2008–Dec. 31, 2008

Date	Operator	Aircraft	Location	Phase	Fatalities	
Jan. 2, 2008	Iran Air	F-100	Tehran, Iran	Takeoff	0	Loss of control
Jan. 17, 2008	British Airways	777	London, England	Landing	0	Approach and landing
Feb. 1, 2008	LAB	727	Trinidad, Bolivia	En route	0	
Feb. 14, 2008	Belavia	CRJ-100	Yerevan, Armenia	Takeoff	0	Loss of control
April 15, 2008	Hewa Bora Airways	DC-9	Goma, Democratic Republic of Congo	Takeoff	3	Runway excursion
May 25, 2008	Kalitta Air	747	Brussels, Belgium	Takeoff	0	Runway excursion
May 30, 2008	TACA	A320	Tegucigalpa, Honduras	Landing	3	Approach and landing; Runway excursion
June 10, 2008	Sudan Airways	A310	Khartoum, Sudan	Landing	29	Approach and landing; Runway excursion
June 30, 2008	Ababeel Aviation	Il-76	Khartoum, Sudan	Takeoff	4	
July 6, 2008	USA Jet Airlines	DC-9	Saltillo, Mexico	Approach	1	Loss of control; Approach and landing
July 7, 2008	Kalitta Air	747	Bogotá, Colombia	Takeoff	0	
Aug. 20, 2008	Spanair	MD-82	Madrid, Spain	Takeoff	154	Loss of control
Aug. 24, 2008	Itek-Air	737	Vishkek, Kyrgyzstan	Approach	65	Controlled flight into terrain; Approach and landing
Aug. 30, 2008	Conviasa	737	Toacaso, Ecuador	En route	3	Controlled flight into terrain
Sept. 14, 2008	Aeroflot Nord	737	Perm, Russia	Approach	88	Loss of control; Approach and landing
Sept. 22, 2008	ICARO	F-28	Quito, Ecuador	Takeoff	0	Runway excursion
Nov. 10, 2008	Ryanair	737	Rome, Italy	Approach	0	Approach and landing
Nov. 27, 2008	XL Airways Germany	A320	Perpignan, France	Approach	7	Loss of control; Approach and landing
Dec. 20, 2008	Continental Airlines	737	Denver, Colorado, U.S.	Takeoff	0	Runway excursion

● Loss of control accident ● Controlled flight into terrain accident ● Approach and landing accident
● Runway excursion

Source: Ascend, Aviation Safety Network

Table 1

Reviewing 2007 data for commercial jet major accidents in all scheduled and unscheduled passenger and cargo operations for Western- and Eastern-built commercial jet aircraft, there were 17 major accidents, 16 involving Western-built aircraft, killing 583 people. Of the 17 accidents, 12 were approach and landing accidents, two were CFIT accidents and four were loss of control accidents.

In 2008, there were 19 major accidents, one of which was an Eastern-built jet; fatality totals declined to 357 (Table 1). Only eight of the 2008 accidents were approach and landing accidents, and two were CFIT accidents. Six of the 19 major accidents were runway excursions, four occurring on takeoff. There were six commercial jet loss of control accidents in 2008, nearly one of every three accidents.

The major accident rate for Western-built commercial jet aircraft in losses per million departures for the last 10 years had been decreasing but now has leveled (Figure 1, p. 20). The rate is only for Western-built aircraft because, even though we know the number of major accidents for Eastern-built aircraft, we do not have reliable worldwide exposure data to calculate rates for them.

There were 12 major accidents involving corporate jet aircraft in 2008, killing 39 people (Table 2, p. 21). Reliable worldwide exposure data is not available to calculate rates for corporate jets, but assuming that exposure has been increasing along with the annual increases in aircraft in the corporate jet fleet and their number of departures, the accident rate is estimated to be decreasing slightly. There also were 12 corporate jet accidents in 2007; 21 people died as a result.

In 2008, there were 29 major accidents involving Western- and Eastern-built turboprop aircraft with more than 14 seats, causing 292 deaths, compared to 24 accidents in 2007 that killed 159 (Table 3, p. 22). Eight of this year's 29 major turboprop accidents were CFIT accidents, more than one of every four.

Focusing on specific high-risk accident categories shows that CFIT, loss of control, and

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A Fokker F-28 ran off the runway during takeoff at Quito, Ecuador.

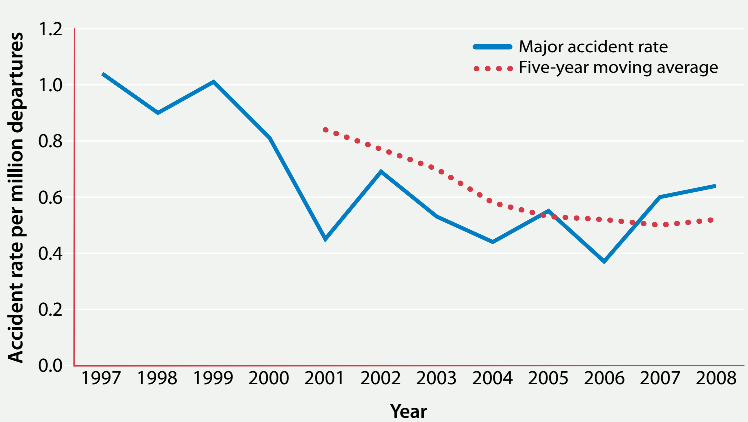
approach and landing accidents continue to claim the majority of the aircraft and account for the majority of the commercial aircraft fatalities. There were two commercial jet CFIT accidents in 2008. The CFIT accident record over the years shows the difficulty the industry has encountered in eliminating CFIT as an accident class.

Although fewer than 10 percent of commercial jets in the world during the past four years did not have a terrain awareness and warning system (TAWS) installed, we still suffered 10 CFIT accidents during that period. There has never been a CFIT accident involving an aircraft equipped with a functional TAWS.

Last year was the first in recent memory that fewer than half of the commercial jet and corporate jet accidents occurred during approach or landing. Flight Safety Foundation and its CFIT and Approach and Landing Action Group (CAAG) team started their worldwide approach and landing accident reduction (ALAR) campaign in 2001. There are now more than 40,000 FSF *ALAR Tool Kits* distributed, and the CAAG team has conducted 30 ALAR workshops around the world — four in 2008, including one in Tripoli, Libya. It is hoped that some of the success we are now seeing in reducing the incidence of approach and landing accidents is the result of the CAAG team's efforts. The Foundation is updating its ALAR data, and an updated *ALAR Tool Kit*, to include a module on reducing the risk of runway excursions, will be available in 2009.

The loss of control accident category, however, has taken over from CFIT as the leading killer in commercial jets (Figure 2, p. 23). The term "loss of control" is somewhat misleading, since many times in this type of accident the flight crew has full control of the aircraft. The

Western-Built Commercial Jet Major Accident Rates, 1997–2008



Note: Total departure data are not available for Eastern-built aircraft.

Source: Ascend

Figure 1

FSF definition for a loss of control accident is "an accident in which an aircraft is unintentionally flown into a position from which the crew is unable to recover due to either aircrew, aircraft, environment or a combination of these factors."

There are basically two types of loss of control accidents. First, there is the type in which upset recovery training will reduce the risk and if possible prevent the accident. In most of these cases the crew has full control of the aircraft at all times, such as the Adam Air and Flash Air accidents. The second type of loss of control accident is one in which no amount of upset recovery training will help — for example, taking off with ice on the wings, or taking off with retracted flaps and slats. As the data show, we are not making much progress in reducing the risk of these high-fatality accident types.

To help reduce risk, there are many challenges that need to be addressed. One of these is safety culture. Safety culture is a very popular topic these days, and rightfully so. It is a critical element in reducing risk. There are multiple

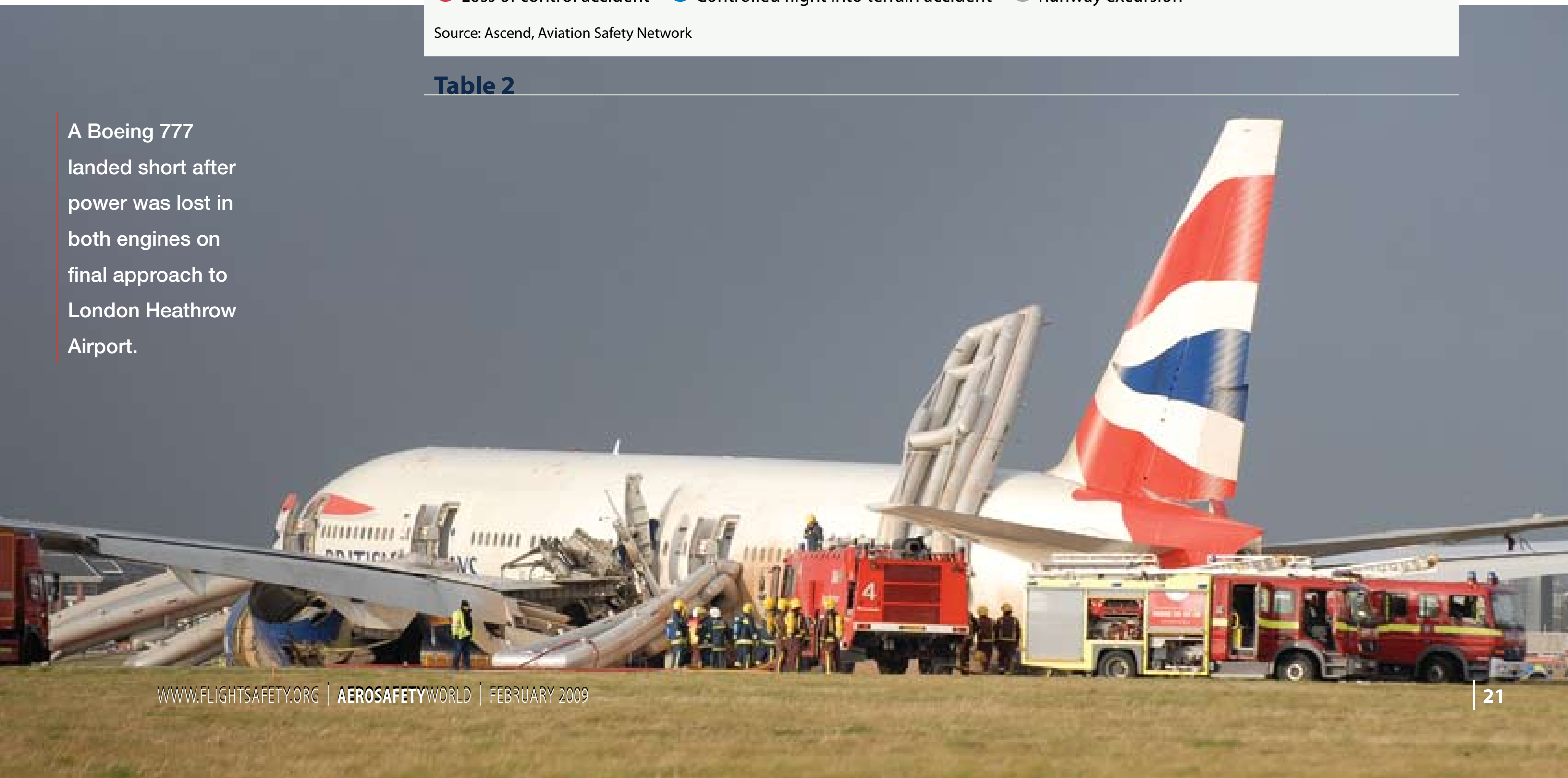
Major Accidents, Worldwide Corporate Jets, Jan. 1, 2008–Dec. 31, 2008

Date	Operator	Aircraft	Location	Phase	Fatalities	
Feb. 1, 2008	Symons Living Trust	Citation I	Augusta, Maine, U.S.	Climb	2	Loss of control accident
Feb. 18, 2008	Avion Sales	Citation III	Venezuela	En route	3	
March 4, 2008	Southwest Sports Clinic	Citation I	Oklahoma City, Oklahoma, U.S.	Takeoff	5	
March 4, 2008	Confort Vuela	HS125-800	Monterrey, Mexico	Landing	0	
March 30, 2008	Relton Muse Aviation	Citation I	London, England	Climb	5	
June 12, 2008	FAI Rent-a-Jet	Lear 35	Kisangani, Democratic Republic of Congo	Takeoff	0	Runway excursion
July 30, 2008	My Aviation	Eclipse 500	West Chester, Pennsylvania, U.S.	Takeoff	0	Runway excursion
July 31, 2008	East Coast Jets	Hawker 800	Owatonna, Minnesota, U.S.	Approach	8	Controlled flight into terrain accident
Aug. 18, 2008	Corus Hardware Corp.	Citation I	Santo Domingo, Dominican Republic	Climb	1	Runway excursion
Sept. 19, 2008	Inter Travel and Services	Lear 60	Columbia, South Carolina, U.S.	Takeoff	4	
Nov. 4, 2008	Mexican Government	Lear 45	Mexico City, Mexico	Approach	9	
Dec. 7, 2008	Tlaxcala State Government	Lear 23	Tlaxcala, Mexico	Approach	2	

● Loss of control accident ● Controlled flight into terrain accident ● Runway excursion

Source: Ascend, Aviation Safety Network

Table 2



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A Boeing 777 landed short after power was lost in both engines on final approach to London Heathrow Airport.

definitions of safety culture, such as "the shared values, beliefs, assumptions and norms that govern decision making that may affect individual and group attitudes about risk, safety and the proper conduct of hazardous operations"; or "the way we do things around here"; or even "what you do when nobody is looking." Many people stress the need for a safety culture, or express the desire to establish a safety culture in their organization. Those sorts of discussions are misguided.

Every organization has a safety culture — it is impossible not to have a safety culture. What is needed is a positive safety culture. Likewise, a strong safety culture is not necessarily desirable. An organization can have a very strong safety culture, and it can be all negative. What we want to do to reduce risk is to create and maintain a positive safety culture.

A positive safety culture is unique in many ways, and here are two. First, it cannot be purchased. No matter how much money your chief executive officer (CEO) is willing to spend, you cannot buy a positive safety culture. It must be created. Second, a positive safety culture is the single most important element of a successful safety program. You cannot have a successful flight operational quality assurance program, an aviation safety action program or establish a just culture without the cornerstone of a positive safety culture.

Major Accidents, Worldwide Commercial Turboprops
Jan. 1, 2008–Dec. 31, 2008

Date	Operator	Aircraft	Location	Phase	Fatalities	
Jan 4, 2008	Transaven	LET-410	Caracas, Venezuela	Descent	0	
Jan. 14, 2008	Alpine Aviation	Beech 1900	Lihue, Hawaii, U.S.	Landing	1	
Jan. 25, 2008	Aero Servis	AN-12	Point Noire, Congo	Landing	0	Runway excursion
Jan. 26, 2008	Dirgantara Air Services	CASA 212	Indonesia	En route	3	Controlled flight into terrain accident
Feb. 21, 2008	Santa Barbara Airlines	ATR-42	Venezuela	Climb	46	Controlled flight into terrain accident
March 6, 2008	Manunggai Air	Transal C-160	Vamena, Indonesia	Landing	0	
March 15, 2008	Wings Aviation	Beech 1900	Nigeria	En route	3	
March 19. 2008	Cirrus Airlines	DO-328	Mannheim, Germany	Landing	0	Runway excursion
April 3, 2008	Blue Wing Airlines	AN-28	Benzdrop, Suriname	Approach	19	Controlled flight into terrain accident
April 9, 2008	Avtex Aviation	Metroliner III	Bundeema, Australia	Climb	7	
April 11, 2008	Kata Air Transport	AN-32	Chisinau, Moldova	Landing	8	Controlled flight into terrain accident
April 21, 2008	RICO Linhas Aéreas	Bandeirante	Coari, Brazil	En route	0	Runway excursion
May 2, 2008	Flex Air	Beech 1900	Rumbek, Sudan	En route	21	
May 23, 2008	Alpine Aviation	Beech 1900	Billings, Montana, U.S.	Takeoff	1	
May 26, 2008	Moskovia Aviation	AN-12	Chelyabinsk, Russia	Climb	9	
May 26, 2008	Great Lakes	AN-32	Goma, DRC	Landing	0	Runway excursion
June 15, 2008	China Flying Dragon	Y-12	Chifeng, China	En route	3	Controlled flight into terrain accident
June 18, 2008	Wiggins Airways	DHC-6	Hyannis, Massachusetts, U.S.	Takeoff	9	Loss of control accident
June 27, 2008	Juba Air Cargo	AN-12	Malakai, Sudan	En route	7	
July 10, 2008	Aerocord	Beech 99	Puerto Montt, Chile	Takeoff	9	
July 14, 2008	Maldivian Air Taxi	DHC-6	Maldives	Landing	0	
July 16, 2008	North-Wright Airways	DHC-6	Hook Lake, Canada	Approach	0	Loss of control accident
Aug. 13, 2008	Fly540	F-27	Mogadishu, Somalia	Approach	3	Controlled flight into terrain accident
Sept. 1, 2008	AirServ International	Beech 1900	Bukavu, Democratic Republic of Congo	Approach	17	Controlled flight into terrain accident
Sept. 1, 2008	Air Tahoma	CV-580	Columbus, Ohio, U.S.	Approach	3	
Sept. 13, 2008	MAS Wings	DHC-6	Ba Kelalan, Malaysia	Approach	0	
Oct. 8, 2008	Yeti Airlines	DHC-6	Lukla, Nepal	Approach	18	Controlled flight into terrain accident
Nov. 6, 2008	Xpressair	DO-328	Fak Fak, Indonesia	Approach	0	
Nov. 13, 2008	British Gulf International Airways	AN-12	Falluja, Iraq	Climb	7	

● Loss of control accident ● Controlled flight into terrain accident ● Runway excursion

Source: Ascend

Table 3

You can institute a safety management system (SMS) without a positive safety culture, but don't expect it to be successful. Your SMS may influence your safety culture. Your safety culture will influence your SMS.

A positive safety culture must be fully supported by the top of the organization. If it is not supported there, it will not last. Changing the safety culture in an organization is an evolutionary process, not a revolutionary process. In other words, the change takes a while — any existing corporate culture, regardless whether it is positive or negative, has a lot of momentum to overcome. No matter how many statements the CEO has signed or how many of the right words he uses, you cannot fake a positive safety culture. If the organization from top to bottom does not practice the words they publish, the safety culture will be bad.

Today, several aviation organizations, particularly in the military, are measuring their safety culture, or their safety climate. Climate is an important indicator of the underlying safety culture and refers to the perception of the members of the organization that their leaders are committed to safety.

Many organizations do not only measure safety culture or climate, but can compare one organization's safety culture to similar organizations. Even better, they can provide recommendations on how to improve weak areas identified in a safety culture.

The U.S. Navy's cultural assessment program showed that in the 2002–2004 period, 93 percent of the Navy's major accidents happened in organizations without a culture assessment workshop. That is one reason why these assessment workshops are now mandatory for all Naval aviation organizations.

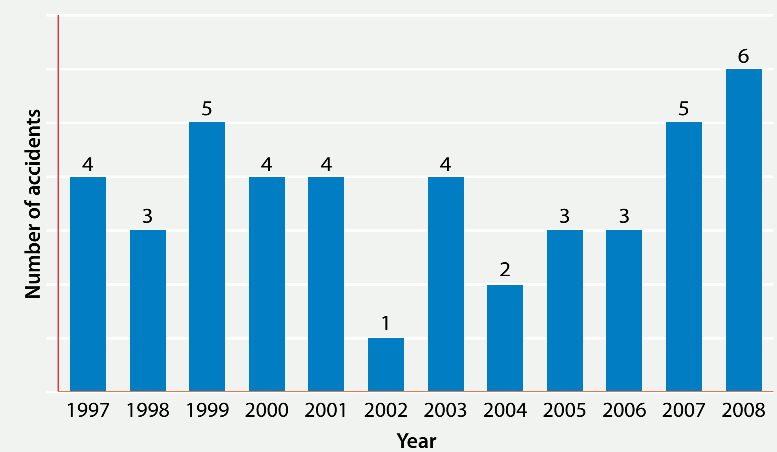
All this information on safety culture and the adoption of a positive safety culture will not reduce anyone's risk to zero. But it will reduce risk.

The Foundation's goal is "to make aviation safer by reducing the risk of an accident." We have achieved great successes advancing toward this goal, but as can be seen from last year's safety record, there are still challenges, such as learning from lessons of the past and ensuring a positive safety culture.

In an industry where risk will never be zero, we face a constant challenge of meeting the public's expectation of perfection as the minimum acceptable standard. However, the aviation industry continues to successfully address that challenge and is constantly working to make aviation safer by reducing the risk of an accident.

James M. Burin is FSF director of technical programs.

Loss of Control Major Accidents, Commercial Jets, 1997–2008



Source: Ascend, Boeing

Figure 2

Accident Classification

Two years ago, Flight Safety Foundation changed from using "hull loss" as the primary accident criterion to a new standard, "major accident." A major accident is defined as an accident in which any of three conditions is met. The first condition is that the aircraft is destroyed or sustains major damage. Major damage is defined by the Ascend Damage Index (ADI), a measure developed by Paul Hayes of Ascend. The ADI is the ratio of the cost of repairs to the projected value of the aircraft had it been brand new at the time of the accident. If the ADI is over 50 percent, the damage is considered major. The second condition defining a major accident is that there are multiple fatalities. The third condition is that there is one fatality and the aircraft is substantially damaged. The major accident classification criteria ensure that an accident is not determined by an aircraft's age or by its insurance coverage, and it gives a more accurate reflection of the high-risk areas that need to be addressed.

— JB

James C. May is president and chief executive officer, Air Transport Association of America.

Reinvest in America's MRO

BY JAMES C. MAY

President Barack Obama is committed to creating three million new jobs over the next two years through the promised American Recovery and Reinvestment Plan. The new president proposes to spend at least US$775 billion to double production of renewable energy, renovate aging infrastructure, modernize healthcare technology and do other things to stimulate high skill–based employment and create substantial economic and social benefits for the American people, including investment in critically important technologies.

While the airline industry is focusing its efforts on securing stimulus funding for new air traffic management technologies, as well as related energy and environmental improvement investments and jobs, more can be done. I hope that Obama's plan includes grants and tax incentives aimed at creating 100,000 new jobs in aircraft maintenance, repair and overhaul (MRO) with these five outstanding goals:

1. Retrain and certificate skilled auto workers to perform MRO on aircraft and all of their high-tech components;
2. Redevelop idled military air bases and refurbish hangars to handle civil aircraft MRO;
3. Upgrade the equipment and technology of the 4,000 certificated aircraft repair facilities in the United States;
4. Create a real partnership between U.S. airlines, contract MRO facilities and labor unions to generate high-paying U.S. jobs in a way that stimulates technological innovation and helps U.S. airlines become more competitive with their global counterparts; and,
5. Create regional centers of excellence for maintenance and alteration of major aircraft types, such as widebody airplanes, to enhance the U.S. reputation for excellence in the MRO field. That will cause U.S. and non-U.S. carriers alike to locate and increase MRO work in this country on the basis of cost and quality.

U.S. airlines employ about 72 people per airplane, which includes six per airplane in maintenance jobs. With an overall fleet of more than 7,800 airplanes, U.S. airlines employ approximately 50,000 people in their maintenance departments. However, that does not include the far larger number of people taking care of airplanes and engines through service contracts.

U.S. aircraft repair stations currently employ more than 212,000 people. These stations perform work not only for U.S. airlines but for many non-U.S. airlines as well.

The type of MRO provided ranges from minor servicing to major overhaul of components, engines and airframes. It should be noted that all third-party mechanics are required to meet the same professional standards as those employed by the airlines. And all maintenance work is subject to FAA audits and airline quality assurance programs, regardless of whether that work is performed by the carrier or a contract maintenance vendor.

While some critics have charged that outsourcing airline MRO poses a threat to safety, independent government figures do not support that conclusion. To the contrary, data compiled by the NTSB clearly show that as U.S. airlines increased contracted maintenance work to vendors around the world, accidents with maintenance as a probable cause declined from 0.05 per 100,000 departures to absolute zero in recent years (Figure 1).

In the post-9/11 environment, as airlines downsized to meet a reduced demand for air travel, it became more difficult for them to efficiently use their exhaustive maintenance infrastructure. That is the primary cause for increased contracting, mostly to U.S. vendors but also including some internationally. However, as the chart demonstrates, maintenance-related safety performance has not declined. It is the best that it has ever been.

We need to accept that air transport is a global business and must be conducted globally. Even the largest engines are readily transportable, enabling access to repair centers around the world. Safety is not an issue. Rather than trying to erect barriers, we — the U.S. aviation industry, U.S. policymakers and representatives of labor — should be doing all that we can to enhance the competitiveness of U.S.-based MRO operations to gain the lion's share of a $42 billion global business.

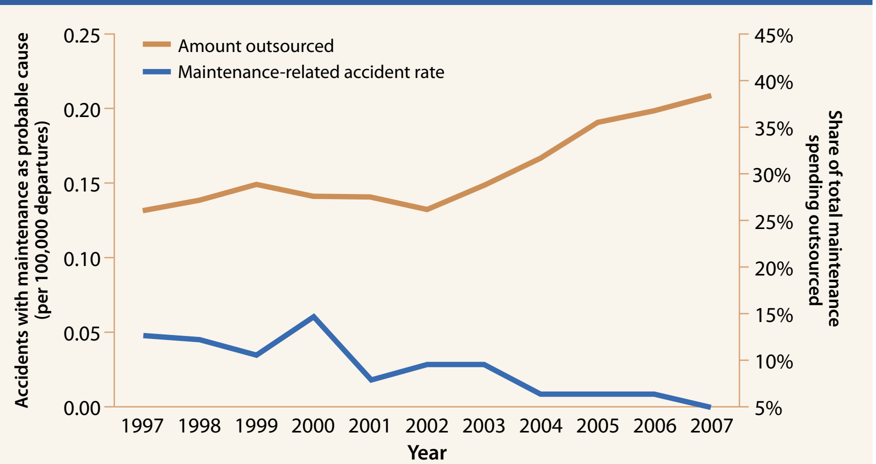
The largest "airline" MRO providers in the United States earn annual revenues of several hundred million dollars by servicing other carriers. Compare that to Lufthansa Technik, the maintenance arm of the leading German carrier, with annual revenues of $3 billion from contracted maintenance for customers beyond Lufthansa and a workforce of 19,000.

The value of supporting this important industry has not gone unnoticed. In 2008, with the help of several nations that recognized the advantage of establishing world-class MRO capabilities within their borders, Lufthansa Technik expanded its operations. As similar international growth moves rapidly ahead, we must not be left behind.

While several world-class facilities exist in the U.S. today, we do not have the capacity to support the domestic fleets. On a national level, we should strive to further develop capabilities and turn U.S. MRO operations — whether airline or independent — into the world's best. We are the country, after all, that is known for its "can do" spirit.

As well as being great inventors, Orville and Wilbur Wright exemplified the U.S. tradition of producing superb mechanics. From a bicycle shop in Dayton, Ohio, they created the aviation industry. There is no reason why those with well-developed mechanical and technical skills should not be able to make a similar move from automobiles to high-paying jobs in the maintenance, repair and overhaul of aircraft.

Maintenance Safety Improves With Increased Outsourcing



Source: U.S. Bureau of Transportation Statistics and U.S. National Transportation Safety Board

Figure 1

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BY LINDA WERFELMAN

Error Management

Only in recent years have aviation maintenance errors been recognized as a symptom of wider problems in the workplace.

Maintenance error presents a "significant and continuing threat" to aviation safety, and effective management of the threat requires the proactive identification of "error-producing conditions" and an acknowledgment that maintenance error will never be completely eliminated, according to an Australian Transport Safety Bureau (ATSB) report.[1]

The report on human factors in aviation maintenance, by Alan Hobbs, said that until recently, maintenance technicians have rarely received human factors training, and maintenance personnel have been largely overlooked by human factors researchers, who focused instead on pilots, air traffic controllers and cabin crew.

The report described the aviation maintenance environment as more hazardous than most other work environments, in part because of time pressure but also because duties often are performed in difficult situations — at heights, in confined spaces and in extreme cold or heat. In addition, although some aspects of the work are physically strenuous, clerical skills and attention to detail are required, along with good communication — even in very noisy areas.

"Maintenance personnel also face unique sources of stress," the report said. "Air traffic controllers and pilots can leave work at the end of the day knowing that the day's work is complete. In most cases, any errors they made during their shift will have either had an immediate impact or no impact at all. In contrast, when maintenance personnel leave work at the end of their shift, they know that the work they performed will be relied

© Chris Sorensen Photography

on by crew and passengers for months or years. … The emotional burden on maintenance personnel whose work has been involved in accidents is largely unrecognized outside the maintenance fraternity. On more than one occasion, maintenance personnel have taken their own lives following aircraft accidents caused by maintenance error."

Tracking Human Error

The first step in understanding how maintenance errors occur is understanding the organizational context in which they occur, the report said. An individual's actions, which may trigger an accident or incident, are influenced by local conditions, such as communication and working conditions; risk controls, such as procedures and precautions designed to manage hazards; and organizational factors, such as management decisions and resource allocation (see "Major Maintenance-Related Crashes," p. 28).

"In many cases," the report said, "maintenance errors are symptoms of underlying problems within the organization."

Descriptions of errors often are *physical* descriptions — which describe the observable actions of the person who made the error and assign them to one of three categories: acts of commission in which an action is performed that should not have been performed, such as cross-connecting cables; acts of omission in which an action that should have been performed is left undone, such as failing to secure an oil cap; and acts of timing and precision in which actions are performed "at the wrong time, in the wrong order or without the necessary level of precision," such as using the wrong torque setting on a wrench to secure a fastener, the report said.

Another way of describing an error is with a *psychological* description — which evaluates the likely intentions of the person who made the error. "For example," the report said, "rather than just concluding that an engineer did not secure a plumbing connection, we would try to understand their mind set at the time of the error. … We would want to know: Did they forget? Did they intend to leave it loose? Did they assume that a colleague was going to complete the task? Obviously we can never know for certain what a person was thinking, but we can usually make reasonable judgments."

One advantage of using psychological error descriptions is that they "enable us to place the error in its organizational context and then develop countermeasures tailored to the root causes of the problem," the report said.

"For example, if we conclude that someone did not perform a necessary action because they forgot, we might consider the prompts to memory available to them, such as documentation. We might also consider what could be done in [the] future to catch similar memory lapses.

"If, on the other hand, we conclude that a person did not perform a necessary action because they thought the procedure did not require it, our investigation might lead us to organizational issues such as training or procedure design."

The report identified six types of psychological errors that are relevant to maintenance:

- Errors of perception, in which a person fails to detect an item he or she should have noticed, such as a worn tire or a visible crack in a metal part;
- Memory lapses, in which a person forgets to perform an intended action, such as forgetting to reconnect a disconnected system after a maintenance task is completed;

Continued on page 30

Major Maintenance-Related Crashes

Aloha Airlines 737, April 1988

The Australian Transport Safety Board (ATSB) cited several accidents and incidents associated with human aspects of aviation maintenance, including the April 1988 explosive decompression of an Aloha Airlines Boeing 737-200 — an accident that revealed the human factors of inspection and maintenance as a major safety issue.[1]

The decompression, during a flight from Hilo, Hawaii, U.S., to Honolulu, ripped an 18-ft (5-m) section of cabin skin away from the airplane. One cabin crewmember was killed. The flight crew diverted the airplane to Maui for an emergency landing.

The accident investigation found that the accident was a result of the airline's failure to detect the disbonding and fatigue damage that ultimately led to the separation of the section of fuselage.

'Dormant' Errors

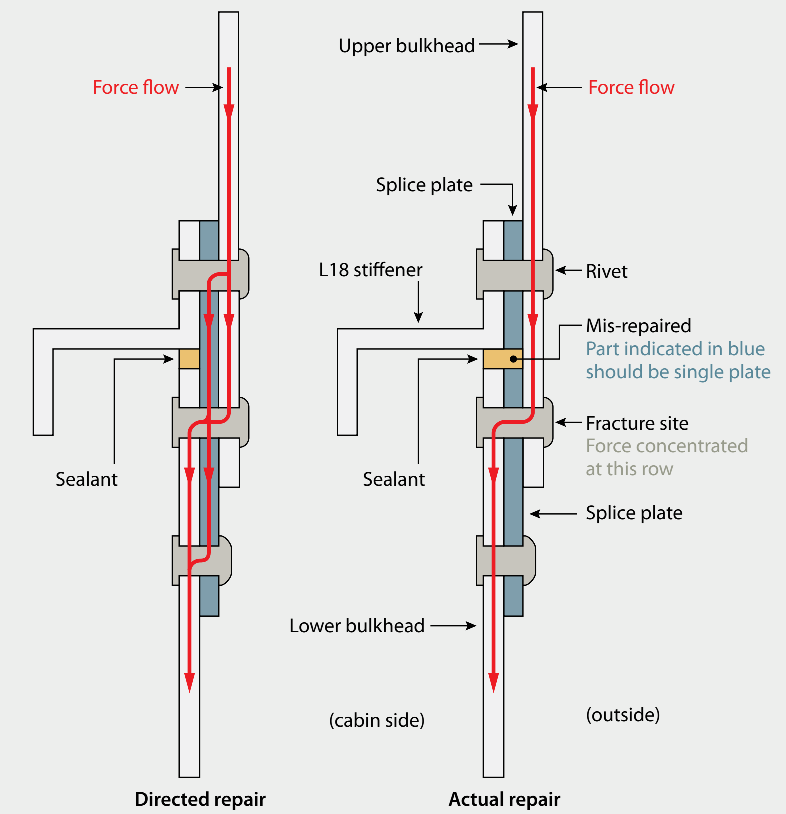
Three years earlier, in August 1985, a Japan Airlines 747-100 crashed, killing 520 people — the greatest number of fatalities in any single-aircraft accident.

The airplane was in cruise flight at 24,000 ft during a domestic flight from Tokyo to Osaka when a rear pressure bulkhead failed, causing a sudden decompression that resulted in the separation of most of the airplane's vertical stabilizer and rudder and the loss of pressure from all four hydraulic systems.

The flight crew tried to steer the 747 using engine power, but they were unable to maintain control. About 30 minutes after the decompression, the airplane struck a mountain northwest of Tokyo.

Investigators attributed the failure of the bulkhead to a fatigue fracture in an area that had been repaired following a tail scrape years earlier.

"The repair had included replacing the lower half of the bulkhead," the ATSB report said. "The new lower half should have been spliced to the upper half using a doubler plate extending under three lines of rivets. However, part of the splice was made using two plates instead of a single plate, as



Note: Faulty repair work on a Japan Airlines 747-100 was cited in an August 1985 crash that killed 520 people.

Source: Australian Transport Safety Board, citing Kobayashi, H.; Terada, H. *Crash of Japan Airlines B-747 at Mt. Osutaka* (2006). In Japan Science and Technology Agency Failure Knowledge Database.

intended. … As a result, the join relied on only a single row of rivets."

After that repair, the airplane was flown more than 12,000 flights and underwent six C checks — major maintenance checks that included visual inspections of the airframe, including the rear pressure bulkhead — before the accident, which the ATSB report said "highlighted the potential for maintenance errors to remain dormant for long periods before having their effect."

Japan Airlines 747, August 1985

Windshield Failure

In June 1990, the windshield of a British Airways BAC-111 was blown out during climb to cruising altitude after departure from Birmingham, England, for a flight to Málaga, Spain, partially ejecting the captain through the broken window. Flight attendants held him in place while the first officer flew the airplane to Southampton Airport for an emergency landing.

The accident investigation found that, during maintenance the previous night, a shift manager had used smaller-than-specified bolts to hold the windshield in place.

"The manager's errors did not occur in isolation, however," the ATSB report said. "The mobile stand set up at the aircraft did not give easy access to the windscreen, and the shift manager had to stretch to install the bolts, giving him a poor view of his work. Partly as a result of this, he did not notice the excessive amount of countersink left unfilled by the small bolt heads."

The ATSB report said that the accident highlighted issues involving parts storage, night shift work, staffing levels and the involvement of supervisors in hands-on maintenance.

Rigging Error

In January 2003, an Air Midwest Beech 1900D crashed after takeoff from Charlotte, North Carolina, U.S., killing all 21 people in the airplane.

The accident investigation found that the pilots had been unable to control the airplane's pitch attitude, partly because its center of gravity was outside limits and partly because the elevator control system had been incorrectly rigged during maintenance two days before the crash.

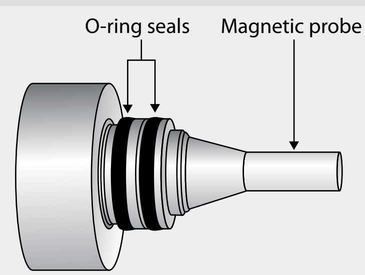
The maintenance work was performed by a technician who had not done the task before and who, in tightening the cables, "inadvertently restricted the amount of nose-down elevator travel," the ATSB report said, adding that the accident highlighted "the difficulties of capturing maintenance errors once they have been made."

Missing O-Rings

In May 1983, an incident involving an Eastern Airlines Lockheed L-1011 illustrated "the potential for preventative maintenance to introduce risk, and how a single error could be carried across multiple systems," the ATSB said.

The L-1011 was descending to Nassau, Bahamas, after a flight from Miami with 172 people aboard, when the "LOW OIL PRESSURE" light for the center engine illuminated. The captain shut down the engine and decided to return to Miami; en route, at 20,000 ft, the "LOW OIL PRESSURE" lights for the two wing-mounted engines illuminated, and both engines flamed out. The passengers were told to prepare for a ditching, but at 4,000 ft, the crew restarted the center engine; minutes later, they landed the airplane at Miami International Airport. No one was injured.

Investigators found that magnetic chip detectors (MCDs) had been installed without O-rings on all three engines and that, as a result, oil leaked from the engines during flight. The maintenance personnel involved in the task assumed that O-rings were — as



Note: The installation of magnetic chip detectors without O-rings was cited in a May 1983 incident involving an Eastern Airlines Lockheed L-1011.

Source: Australian Transport Safety Board, citing Marx, D.; Graeber, R.C. "Human Error in Aircraft Maintenance." In N. Johnson, N. McDonald and R. Fuller (editors). *Aviation Psychology in Practice* (1994): 87–104. Aldershot, U.K.: Ashgate, 1994.

usual —attached to the replacement MCDs, the ATSB report said, noting that another complicating factor was the fact that the replacement MCDs were installed by feel, "with no direct view of the task."

The MCD replacement was performed in accordance with the airline's practice of removing and inspecting MCDs "at 22-hour intervals, whenever the aircraft overnighted at an Eastern Airlines maintenance station," the ATSB report said. The inspections were designed to check for the presence of metal particles — an early warning of engine failure.

Estimates were that, in the 18 months that the practice had been in place, maintenance technicians had performed the task an average of 100 times each. The airline had experienced 12 incidents of in-flight engine shutdowns and unscheduled landings because of problems with O-rings and MCD installation. The ATSB quoted the U.S. National Transportation Safety Board accident report, which said, "In every incident … management investigated the circumstances and concluded that the problem was with the mechanics and not with the maintenance procedure."

The ATSB added, "Rather than addressing the wider system problems such as poor procedures and undocumented norms, the incidents resulted in individual disciplinary action and training."

— LW

Note

1. Hobbs, Alan. *An Overview of Human Factors in Aviation Maintenance.* ATSB Transport Safety Report, AR-2008-055. December 2008.

- Slips, in which a familiar skill-based action is absent-mindedly performed at an unintended time or place, such as automatically signing off a task while not intending to do so;
- Technical misunderstandings, in which a maintenance technician does not possess the knowledge required to perform a given task;
- Wrong assumptions, in which a person misidentifies a familiar situation, such as incorrectly assuming that a colleague will perform a specific step in an assigned task — for example, assuming that the power supply will be disconnected by a colleague who always does so; and,
- Procedure violations, in which someone strays from the specified process for accomplishing a task, either in a way that is *routine,* such as driving a few kilometers faster than the speed limit, or *exceptional*, in response to an unusual situation.

Past surveys of maintenance personnel in Australia, Europe and the United States have indicated that procedure violations are widespread, and that they often are committed in an effort to complete a task on time, the report said.

"The issue of maintenance violations is one of the most difficult human factors issues currently facing the aviation industry," the report said. "Yet many aviation professionals outside the maintenance field are either unaware of the issue or else take a simple moralistic approach when they hear of the extent to which maintenance workers routinely deviate from procedures to accomplish tasks. Maintenance personnel are often confronted with a double standard of task performance: On the one hand, they are expected to comply with a vast array of requirements and procedures while also being expected to complete tasks quickly and efficiently."

Local Conditions

Individual actions — and individual errors — typically reflect local conditions in the workplace when the actions are taken.

One of the most common conditions is time pressure, which sometimes leads maintenance technicians to use a procedural shortcut to complete a job more quickly and enable an on-time aircraft departure. As an example, the report cited the following event, which was reported to the U.S. National Aeronautics and Space Administration Aviation Safety Reporting System:

I was notified by my shop steward that the hydraulic shutoff valve I removed from a Fokker 100 was the same serial number of the new parts tag. … I removed the valve from the aircraft during which I had gotten [hydraulic fluid] in my eyes and could not see for about 30 minutes. I tried to keep working because time was short and I needed to complete the job [as soon as possible]. I apparently installed the old valve back on the aircraft. I completed a flap test with no faults.

Other local conditions include "unworkable or awkward" procedures described in manuals — a problem often cited by maintenance personnel as leading to a procedural violation; misunderstandings and ineffective communication with co-workers; group norms, or unspoken informal rules about how work is done in a specific workplace; fatigue, especially fatigue associated with long work shifts and/or working at night; insufficient knowledge or training for a specific task; and a lack of specialized tools for the job, the report said.

Risk Controls

Risk controls are the defenses established in the workplace to manage safety hazards. In aviation maintenance, most controls are one of two types: preventive risk controls, which are designed to reduce the chances of human error — for example, streamers attached to rigging pins to help maintenance personnel notice the pins and remember to remove them — and recovery risk controls, designed to identify a developing dangerous situation and prevent it from continuing — for example, functional checks.

Other actions, such as read-backs of verbal instructions, also can help identify errors. However, the report said, "checks, inspections and read-backs rely on human performance and are themselves subject to human fallibility. In a survey of airline maintenance personnel, over 30 percent of respondents reported that they had skipped a required functional check (such as an engine run) in the preceding 12 months."

Risk controls differ in their effectiveness, the report said, noting that engineered solutions, such as reverse threaded connections that prevent two parts from being connected, usually are more reliable than self-checks of work.

Organizational Influences

The report said that investigations of airline accidents and incidents involving maintenance actions often have identified organizational factors in those events, including training and qualifications systems, allocation of resources and the culture within the organization.

"For example, a maintenance violation, such as using an incorrect tool, may occur because the correct tool was not available, which in turn may reflect equipment acquisition policies or financial constraints," the report said. "One of the most common reasons given for maintenance violations is time pressure, and this in turn may be symptomatic of organizational conditions such as planning, staffing levels or work scheduling."

New Emphasis on SMS

The first human factors training courses for maintenance personnel were not offered until the 1990s, about 20 years after airlines begin providing similar instruction for flight crewmembers, the report said. This early training in maintenance resource management emphasized communication skills and assertiveness, stress management and conflict resolution.

More recent human factors training has been developed in the aftermath of new requirements by the International Civil Aviation Organization and national civil aviation authorities for maintenance personnel to understand human factors principles. In some cases, this training has been incorporated into development of an organization's safety management system (SMS) — a coordinated approach to managing safety that includes an emphasis on error management and development of a just safety culture.

SMS typically includes a nonpunitive confidential reporting system to encourage disclosure of events that may present threats to safety, and the report said that the industry is making progress in developing such systems.

"If a maintenance engineer has a difficulty with a maintenance procedure at 3 a.m. in a remote hangar, the problem may remain unknown to the organization unless the engineer chooses to disclose the issue," the report said. "Once a maintenance error has been made, years may elapse before it becomes apparent, by which time it may be difficult to establish how it occurred."

The report said that the "culture of maintenance around the world" has discouraged the reporting of problems.

"This is because the response to errors has frequently been punitive," the report said. "In some companies, common errors such as leaving oil filler caps unsecured will result in several days without pay or even instant dismissal. It is hardly surprising that many minor maintenance incidents are never officially reported."

The report cited a 1998 survey of Australian maintenance personnel in which more than 60 percent said they had corrected an error made by a colleague but never documented their action because they hoped to avoid any disciplinary action against the colleague.

The organizational response to maintenance error should involve efforts to identify and counteract error-producing conditions, as well as an acknowledgement that maintenance error can be reduced but not eliminated.

"Airlines can learn to manage the inevitable threat of maintenance error in the same way they deal with natural hazards such as weather," the report said. "Organizational resilience in the face of human error can be maximized by ensuring that appropriate risk controls are in place to identify and correct errors and minimize the consequence of those errors that remain undetected despite the best efforts of the organization."

Note

1. Hobbs, Alan. *An Overview of Human Factors in Aviation Maintenance.* ATSB Transport Safety Report, AR-2008-055. December 2008.

Further Reading From FSF Publications

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Johnson, William B.; Hackworth, Carla. "Human Factors in Maintenance." *AeroSafety World* Volume 3 (March 2008): 34–40.

McKenna, James T. "Maintenance Resource Management Programs Provide Tools for Reducing Human Error." *Flight Safety Digest* Volume 21 (October 2002).

CASS

ORLANDO, FLORIDA

April 21–23, 2009

What does automatic dependent surveillance–broadcast (ADS-B) mean for corporate operators? This year's CASS will include a whole panel of speakers to discuss that question. And safety specialists will confront a wide range of important issues, as shown below.

To register, contact Namratha Apparao, +1 703.739.6700, ext. 101, e-mail apparao@flightsafety.org. To sponsor an event or exhibit at the seminar, get in touch with Ann Hill, ext. 105, hill@flightsafety.org.

Preliminary Agenda

Monday, April 20

0730 Day One–Emergency Response Planning Workshop

Tuesday, April 21

0730 Day Two–Emergency Response Planning Workshop

0900–1200 FSF Corporate Advisory Committee (CAC) Meeting

1200–1700 **Registration**

1200–1700 Exhibit Hall Open With Refreshments

1700–1800 Speakers' Meeting

1830–2000 **Opening Reception — Hilton Walt Disney World**

Wednesday, April 22

The exhibit hall will be open during seminar hours.

0730–1700 **Registration**

0730–0830 **Continental Breakfast in Exhibit Hall**

0830–0925 Seminar Opening — Patricia Andrews, chairman, FSF Corporate Advisory Committee (CAC)

Welcome — William R. Voss, president and CEO, Flight Safety Foundation

Welcome — Ed Bolen, president and CEO, National Business Aviation Association

0925–0930 *Moderators*: Lisa Sasse, vice president, EVASWorldwide/Aircraft Services Group; Sydney A. Baker, former director of aviation, Eastman Kodak Co.; and Edward R. Williams, CEO, The Metropolitan Aviation Group

0930–1000 "The Increasing Threat of Politicizing and Criminalizing Aviation Accidents" — David Rimmer, executive vice president, ExcelAire

1000–1030 "The Criminalization of Aviation Accidents" — Kenneth P. Quinn, Pillsbury Winthrop Shaw Pittman

1030–1100 **Refreshments in Exhibit Hall**

1100–1130 "Macro CRM on a Micro Level: Implementing Effective CRM in Small Corporate Flight Departments" — Capt. Gary Cooke, safety officer, CVS Caremark

1130–1200 "Performance-Based Navigation" — Timothy Taylor, PBN/RNP program manager, Jeppesen

1200–1230 Questions and Answers

1230–1400 **Lunch**

1400–1430 "Management's Role in Creating a Safety Culture" — Richard Bucknell, CEO, Southpac Aerospace

1430–1500 "Safety Leadership: How Management Manages the Safety Climate to Shape Safety Culture" — Kenneth P. Neubauer, technical director, aerospace safety, Futron Corp.

1500–1530 "Unmanned Aircraft Systems: How Can the United States Integrate Them Safely Into the National Airspace System?" — Ardyth M. Williams, air traffic manager, unmanned aircraft systems, U.S. Federal Aviation Administration

1530–1545 Questions and Answers

1545–1615 **Refreshments in Exhibit Hall**

1615–1700 "Update on Current Corporate Aviation Accidents" — Hon. Debbie Hersman, member, U.S. National Transportation Safety Board

Thursday, April 23

The exhibit hall will be open during seminar hours.

0730–1700 **Registration**

0730–0830 **Continental Breakfast in Exhibit Hall**

0830–0900 "Fatigue and Sleep Disorders" — Dr. Carol E. Ash, medical director, Sleep for Life, Somerset Medical Center

0900–0930 "The Aviation Personnel Shortage" — Earl Weener, Ph.D., fellow, Flight Safety Foundation

0930–0945 Question and Answers

0945–1015 **Refreshments in Exhibit Hall**

1015–1200 Panel on Automatic Dependent Surveillance–Broadcast (ADS-B)

Moderator:
Steve Brown, ADS-B co-chair, FAA Aviation Regulatory Advisory Committee and senior vice president, operations, NBAA

Panelists:
David Bjellos, aviation manager, Florida Crystals Corp.; Rick Ridenour Sr., technical staff engineer/pilot, Aviation Communications & Surveillance Systems; and U.S. Federal Aviation Administration representative

1200–1330 **Lunch**

1330–1400 "The Right Stuff? Assessing the Aging Aviator: Safety, Health, Fairness and Dignity" — Quay Snyder, M.D., M.S.P.H., president and CEO, Virtual Flight Surgeons

1400–1430 "SMS Audit Results Analysis" — Steve Witowski, aviation safety program manager, Aviation Research Group/U.S.

1430–1500 **Refreshments in Exhibit Hall**

1500–1530 "Managing Perceptions and Expectations in Incident Investigations" — D. Richard Miekle, vice president, safety, NetJets

1530–1600 Questions and Answers

1600 Seminar Closing — Sydney A. Baker, director of aviation, Eastman Kodak Co.

Attitude Adjustment

BY WAYNE ROSENKRANS

Updated guidance and research findings boost confidence that airplane upset recovery training is on the right track.

Advances in standardization and new evidence of effectiveness make airplane upset recovery training a more robust element of airline strategies for managing the risk of loss of control accidents than 10 years ago (see "Steady State," p. 18). Although ongoing research and development efforts expect to improve existing aircraft-based solutions, many specialists still see technology as complementary to pilot training — not an alternative. Urgency about addressing loss of control risk (Table 1) was reflected during 2008 in more than 40 scientific papers on relevant issues presented at conferences of the American Institute of Aeronautics and Astronautics (AIAA) alone.[1]

Technology promises improvements in, and wider use of, flight envelope protection provided by the software in fly-by-wire airplanes; an aural "overbank" alert when a transport category airplane reaches an angle of bank exceeding normal operating parameters; directed guidance, an immediate aural message to pilots about required control inputs; micro-tactile alerts about incipient unusual attitudes from electronic devices in a seatback or clothing; and perhaps a pilot-activated automatic recovery switch that would transfer airplane control to a future autopilot designed for this purpose, specialists say.

"Enhanced training and procedures are a countermeasure relatively easy to implement, but might be only partially effective," says William Bramble, senior human performance investigator, U.S. National Transportation Safety Board (NTSB), and a presenter at Flight Safety Foundation's International Air Safety Seminar (IASS) in October 2008 in Honolulu. "Recent accidents suggest that [automation] might improve safety for civil transports. Solutions such as modified attitude displays and directed guidance … [also] might only be partially effective."

Various NTSB safety recommendations in recent years have urged the U.S. Federal Aviation Administration (FAA) to require upset recovery training for air transport pilots. Among risk scenarios of concern have been stalls caused by airframe icing, stalls without

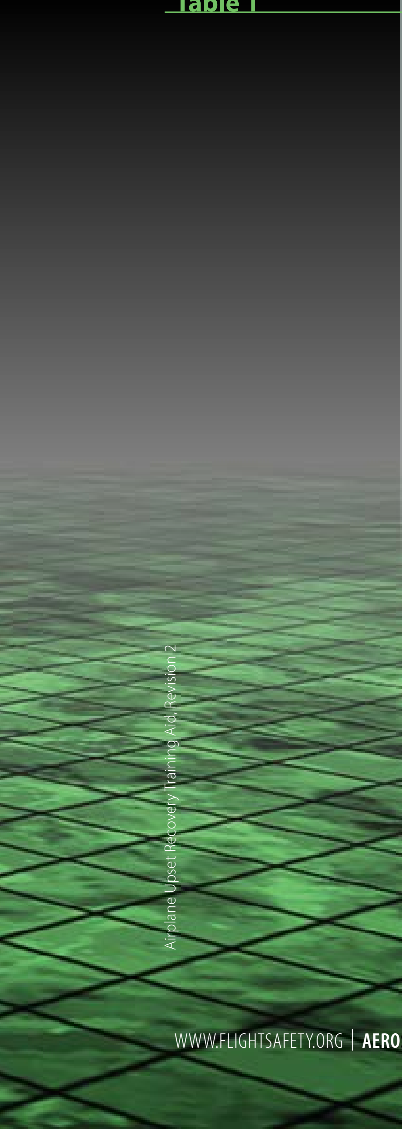
Major Causes of Airplane Upset and Loss of Control Accidents, Worldwide Air Transport, 1993–2007

Causal Category	Accidents/Aircraft Included	Accidents in Category	Fatalities
Aerodynamic stall	9 events involving contaminated airfoils, 6 events involving autopilot-induced stalls (only common factor was no flight envelope protection)	27 (36%)	848 (26%)
Flight control system	7 events involving flight control malfunctions or failures, 6 events involving autopilot malfunctions or failures (excluding autopilot-induced stalls), 3 events involving flight control software issues	16 (21%)	604 (19%)
Spatial disorientation	5 events involving spiral dives (only common factor was no flight envelope protection), 3 events involving upset/misjudged flight path	8 (11%)	630 (19%)
Contaminated airfoil (ice)	9 events involving contaminated airfoils were listed instead among the 27 events in the "Aerodynamic stall" causal category	8 (11%)	200 (6%)
Atmospheric disturbance	3 events involved wake encounters	6 (8%)	477 (15%)
Other causes combined	Not specified	6 (8%)	122 (4%)
Undetermined causes	Not specified	4 (5%)	380 (12%)
	Total accidents	**75**	**3,261**

Note: Total of percentages may not equal 100 because of rounding error.

Source: Lambregts, A.A.; Nesemeier, G.; Wilborn, J.E.; Newman, R.L. "Airplane Upsets: Old Problem, New Issues." American Institute of Aeronautics and Astronautics Modeling and Simulation Technologies Conference and Exhibit, Aug. 18-21, 2008, Honolulu. AIAA 2008-6867.

Table 1



Airplane Upset Recovery Training Aid, Revision 2

icing, wake encounters, spatial disorientation leading to a spiral dive or misjudged flight path, and mechanical failures. Although this training has yet to be required, the FAA has collaborated with airlines, manufacturers and academic institutions on a common reference aid for upset recovery training, simulator fidelity requirements and proposed training standards.

High Altitude Supplement

Among valuable resources for airlines contemplating or updating upset recovery training is the November 2008 release of Revision 2 of the *Airplane Upset Recovery Training Aid* — including a new "High Altitude Operations" supplement (*ASW,* 1/09, p. 10). An international industry team led by Airbus, Boeing Commercial Airplanes and Flight Safety Foundation began work on the revision in 2007. The supplement focuses on known safety issues in the high altitude environment — above Flight Level 250 (approximately 25,000 ft) — and particularly on knowledge gaps identified among pilots who routinely operate there. Revision 2 initially was distributed on paper and compact disc in a binder, but the component elements are more readily available, either together or separately, as free electronic documents that can be downloaded from <www.flightsafety.org/upset_recovery.html>.

In a transmittal letter to the FAA, the team's co-chairmen said, "This [supplement] was developed in response to an FAA request for us to convene an industry and government working group to develop guidance to flight crews as it pertains to issues associated with operations, unintentional slowdowns and recoveries in the high altitude environment. … No reference material published is of value unless it is used. To that end, we implore the FAA to produce language to support implementation of this material that will motivate operators to use it."

Unlike the full training aid, which addresses airplanes with 100 or more seats, the information in the supplement also is directly applicable to pilots of nearly all jet airplanes that routinely operate at high altitudes. Aviation professionals familiar with Revision 1 of the training aid will find a limited number of changes called out for review in Revision 2 — many for consistency with the supplement content.

The second update since 1998 has been designed so that adoption, integration or adaptation by airlines can be simple and straightforward. "Loss of control accidents can have widely varying causes and solutions, so our goal is to get to all the pilots — wherever they might be — to give them the knowledge, the understanding and the training necessary to address this killer in aviation," David Carbaugh, chief pilot for flight operations safety at Boeing Commercial Airplanes and a team co-chairman, told IASS attendees. "What is lacking today is a consistency of application throughout the industry of this training. … Only when such training becomes mandatory will air carriers be getting knowledgeable and fully trained pilots who can handle these situations consistently."[2]

One aim is to help airline pilots avoid repeating the errors of others, such as selecting maximum cruise thrust rather than maximum continuous thrust in response to a gradual, environmentally induced slowdown at high altitude, or selecting inappropriate automation modes that can lead to excessive banking and a stall during routine high altitude operations, such as navigating around en route weather.

The supplement emphasizes practical ways to apply aerodynamic principles, such as avoiding high altitude flight in the slow flight speed range, any speed less than L/D Max;[3] recognizing gradual airspeed decay and its effects; expecting slow cruise speeds to shorten time available to respond to an inadvertent slowdown; avoiding inappropriate vertical speed modes during high altitude climbs; and responding correctly to a thrust-limited condition.[4] Also covered are the risks of operating at maximum altitude, such as reduced bank angle capability and insufficient thrust to maintain altitude (Figure 1); the advantages of operating at optimum altitude; the importance of recognizing airplane buffet as the first indicator of a high altitude stall; the differences between responding to an impending stall versus a full aerodynamic stall; the criticality of exchanging altitude for airspeed during upset recovery; and the threats in inadvertent excursions into extremely high speeds.

A longstanding issue is that the aerodynamic envelopes of simulators — specifically the angle of attack range and sideslip range — simply are not extensive enough.[5] One NTSB scientist has noted that fidelity of simulators for upset recovery training becomes a significant practical issue only in the post-stall flight regime, whereas many loss of control accidents have occurred after upsets within the nominal aerodynamic data envelope (Figure 2).[6]

A forceful nose-down pitch input can be essential to some upset recoveries.

Airplane Upset Recovery Training Aid, Revision 2

Evidence of Effectiveness

When Alteon Training, a Boeing company, recently planned to introduce upset recovery training into all of its initial, transition and recurrent simulator training courses, the course developers could find no scientific study showing that such training would achieve what was intended, according to William Roberson, a senior safety pilot for Boeing Commercial Airplanes and an IASS presenter.

Another research goal was to identify significant negative training in light of findings about a pilot's rudder inputs in the NTSB investigation of the November 2001 in-flight separation of the vertical stabilizer of an Airbus A300, operating as American Airlines Flight 587, in Belle Harbor, New York, U.S.[7] "That accident did, in fact, have a chilling effect on upset recovery training throughout the world," Roberson said.

Alteon hypothesized that Boeing 737 pilots who completed academic work and simulator exercises derived from the training aid would be more successful in coping with upset events than they were before they participated in the study. Thirty-three 737-qualified Boeing pilots received academic training with videos and a simulator session, in which they trained to proficiency — until common errors were eliminated — on each recovery technique.

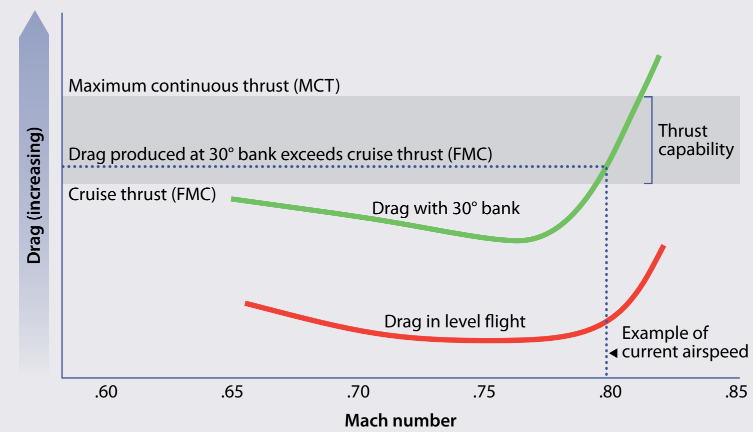
Each pilot was told to "just fly the airplane — do what you would do if you had this event," which meant to keep the airplane inside the aerodynamic envelope, not induce a stick shaker warning of approach to stall, and not stall. "We re-evaluated each pilot to see if performance had improved one to six months after this training, using the exact same initial test and scoring method," he said. Performance on each test element and overall was quantified by subtracting points — for example, for failure to disconnect the autothrottle, a stall, excessive speed or excessive altitude loss — from a perfect score of 10.

Upset events in the simulator comprised one scenario of a 737 that was 40 degrees nose high with zero degrees of bank and twice the amount of aft trim required for normal flight; one scenario with the airplane 25 degrees nose low with 60 degrees of bank and trim neutral; and one scenario with the airplane 25 degrees nose low, with 120 degrees of bank and trim neutral.

"Pilots who scored zero, one or two points on the first nose-high [scenario] predominantly used the roll recovery technique versus the push recovery technique; those who scored eight, nine or 10 points on that [scenario] predominantly used the push recovery technique," Roberson said.

Taking these pilot decisions and other factors — such as adequate control of airspeed and altitude loss — into consideration, the study concluded that for the nose-high scenarios, training made a positive difference, three points on average. For the nose-low and medium-bank angle scenario, training made a positive difference, two points on average. "Improvement occurred because of better recovery technique [after training], such as rolling to level more quickly and pulling more positively once they got the wings level," Roberson said. "For the nose-low and high-bank-angle scenario, considered the most difficult recovery, training made a small — 0.4 point — positive difference. Qualitatively, this was important because this result was not expected given the relative difficulty."

Typical Commercial Jet Operating at Maximum Altitude

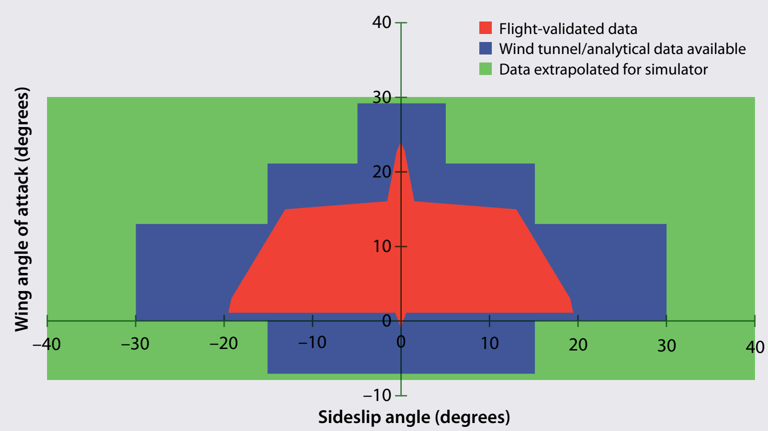


Note: Maximum continuous thrust would be required to maintain altitude under some conditions.

Source: Airplane Upset Recovery Training Aid, Revision 2

Figure 1

Data Sources for Boeing 737 Full Flight Simulator



Note: U.S. Federal Aviation Regulations Part 60 since 2007 has restricted training exercises in which pilots would have to "go beyond the flight-test validated flight envelope," which real-world upset recoveries may require.

Source: Airplane Upset Recovery Training Aid, Revision 2

Figure 2

U.S. National Aeronautics and Space Administration

The NASA Vertical Motion Simulator, shown here in a multiple-exposure photo, exceeds capabilities of conventional full flight simulators.

The researchers said they were encouraged by the results. "Each of the maneuvers showed higher scores after training for the majority of the pilots, but not all the pilots," Roberson said. "Twenty-nine out of 33 pilots did better on the second test, four did worse … and those whose overall scores deteriorated went from 25.8 to 23.0 points [out of a possible 30 points]. These pilots demonstrated the largest increase in average score for the nose-high and zero-bank-angle scenario, requiring the most difficult and challenging maneuver. … We did not expect to see that. There also was a much higher level of consistency of performance among all the pilots after the training."

A second report presented at IASS had been eagerly anticipated by the upset recovery research community.[8] FedEx Express and Calspan Flight Research Group developed the "advanced maneuver–upset recovery training program" using full flight simulators with motion and an in-flight simulator — a Learjet 25 — then evaluated the program's effectiveness in a simulator and in flights in the airplane, said copresenters Brian Ward, managing director of training, Federal Express, and Bob Moreau, experimental test pilot, Federal Express Flight Test.

"Over the past six years, FedEx has experienced six upset events that could have led to loss of control," Ward said. "[One goal,] for the first time in the industry, was to 'connect the dots' by evaluating transfer of training from the full flight simulator to the real world of the airborne environment."

Ten FedEx pilots from the A300 fleet and 10 FedEx pilots from the MD-11 fleet participated. Performance evaluations were conducted before each of three portions of training: aerodynamics, full flight simulator training and airborne training. Training events comprised unusual attitude recoveries, in which the evaluator maneuvered the simulator or airplane to a nose-high unusual attitude and a nose-low unusual attitude; and preprogrammed upset recovery events in the roll axis and the yaw axis of the simulator and airplane.

The A300 pilot group and MD-11 pilot group were divided into two subgroups, a full-program group that received academic training, then advanced maneuver upset recovery training in a simulator, and a control group that received the academics but with equal time in a simulator focused on scenarios unrelated to upset recovery.

The study found that training in the full flight simulator — despite the deficiency in motion cuing and g (load) cuing — produced the largest cumulative training effect, especially in teaching aircraft-specific techniques; airborne training produced a relatively small training effect; and prior experiences exerted a relatively large training effect on performance even compared with the academic work.

For the study, the full flight simulator was equipped with a g-meter display as a reference for the pilots during recovery maneuvers. The meter showed, for example, some pilots exceeding g limits — with up to 8 g displayed on video recordings — while incorrectly performing a rolling pullout maneuver that would have subjected a real airplane to the maximum aerodynamic loads.

The upset recovery training in general revealed pilots' inadequate knowledge about the relevant aerodynamic principles and how to apply them. Therefore, the academic portion of the program alone produced a large increase in training effect. "What stood out was a lack of [understanding of] fundamental aerodynamic concepts, as well as alternate control strategy concepts, among the pilots — concepts required for upset recoveries," Moreau said.

Little of the improvement in pilot test scores on upset recoveries could be attributed to the full flight simulator; instead, the lack of adequate motion cuing worked against pilots in identifying what type of event, such as a yaw event or roll event, was occurring. "This often led to the incorrect technique being applied, and that aggravated the situation," Moreau said. "In comparison, the in-flight simulator provided critical motion cues, and the pilots were better able to correctly identify the event and respond with the correct control technique."

In the tests of unusual attitude recoveries in the simulator, the group with full training showed "markedly better" results than the control group. This difference disappeared when each group flew the Learjet, and this was attributed to pilots having had equivalent motion-cue experiences from earlier unusual attitude training in airplanes.

For airlines to make effective use of full flight simulators, their programs must emphasize pilot understanding of simulator limitations compared with control inputs that may be required for upset recovery in the airplane, the researchers concluded. "Motion cues also should be de-emphasized due to the limitations of the motion cues that we have in simulators today," Ward said. "A g-meter readout is essential for effective training."

Conducting upset recovery training in a full flight simulator with motion off — as some airlines already do — is still advocated by some specialists to sidestep misgivings about insufficient fidelity and unrealistic spatial disorientation practice. "When you enter an upset or have an illusion, your inner ear already is telling you the wrong thing, so our simulator training [with motion on] is about making the picture look right," Boeing's Roberson said. "You cross-check your displays to make sure you don't have a display that is lying to you. The fact that the simulator will give you the wrong vestibular cue, although problematic, is another opportunity for the pilots to override what their vestibular senses are telling them, and to do the correct recovery no matter how they feel."

Airlines cannot afford to wait for perfect hardware, however, or access for thousands of line pilots to the advanced motion and sustainable g-load fidelity of one-of-a-kind simulators such as the Vertical Motion Simulator at the U.S. National Aeronautics and Space Administration Ames Research Center; the generic large transport/757 configuration of the GyroLab-2000 simulator, which is used for upset recovery training at the U.S. National Aerospace Training and Research (NASTAR) Center; or the Desdemona research and demonstration simulator developed by TNO Defence, Safety and Security and AMST Systemtechnik in the Netherlands.

Glenn King, chief operating officer of the NASTAR Center, expects his facility to be part of the solution to loss of control. "Granted, not all airliner upset situations place the aircraft in an inverted attitude, but some upsets have, and it is for these extreme situations that only a full, multi-axis simulator with sustained g [loads] will have a positive transfer of training," King said. "Our advantage is the ability to provide sustained motion cues and g forces during an upset or loss of control in flight. We have the ability to physically place pilots in an inverted flat spin, hanging in the harness, while sustaining up to 2.5 g. When a pilot is hanging in the straps, suffering from facial suffusion and disorientation, legs dangling off the rudder pedals, etc., all this affects the response time and ability to quickly effect a safe and proper recovery. Being able to feel and know the 'energy state' of the aircraft determines the pilot's course of action. The ability to provide sustained g cues to pilots is critical in their upset recovery training/loss of control decision-making process."

Boeing's Roberson expects the updated training aid to enable airlines to sufficiently prepare pilots for the recent types of scenarios. "In most of the loss of control accidents and incidents that we have seen in the last five years, simply leveling the wings and putting the thrust where it needed to be would have solved the [problem]," he said. "They were not really complicated events — at least at the outset."

Notes

1. Bürki-Cohen, Judith; Sparko, Andrea L. "Airplane Upset Prevention Research Needs." In proceedings of the AIAA Modeling and Simulation Technologies Conference and Exhibit, Honolulu, Aug. 18–21, 2008. AIAA 2008-6871.
2. Carbaugh, David. "Simulator Upset Recovery Training and Issues." AIAA 2008-6866.
3. The training aid notes that on a graph plotting lift (L) and drag (D) values against airplane speed values, the lowest point on the total drag curve is called L/D Max (or V_{MD}, minimum drag speed).
4. The training aid notes that some environmental conditions, such as a temperature increase or a mountain wave, may cause a jet to enter a thrust-limited condition in which the desired altitude cannot be maintained and/or airspeed may decay, requiring a descent.
5. Crider, Dennis A. "The Need for Upset Recovery Training." AIAA 2008-6864.
6. Crider.
7. Ibid.
8. Bürki-Cohen; Sparko.

With several aviation safety action programs out of commission, the industry is looking for ways to bolster voluntary safety-reporting endeavors.

REBUILDING

Aviation safety action programs (ASAPs) and other voluntary, confidential safety-reporting efforts have been praised since their inception as vital to the ongoing drive to improve aviation safety. Nevertheless, labor disputes at several airlines in the United States have put four pilot ASAPs temporarily out of business — in one case for more than two years before its reinstatement in January.

Pilot participation in ASAPs at three airlines — American Airlines, Comair and US Airways — lapsed in late 2008 as the programs came up for their required biennial renewal. At Delta Air Lines, where pilot participation ended in 2006, officials announced an agreement on Jan. 28 to reinstate a revised ASAP, which resembles an existing program at Northwest Airlines. Delta and Northwest merged in October 2008.

In each case, the lapse came amid disagreements between the airline and its pilots union over the fairness of the airline's treatment of employees who filed ASAP reports. The airlines and the unions said they support ASAP; their differences involved the issue of if and when an airline should penalize a pilot who has admitted in an ASAP report that he or she made a mistake.

Officials of the airlines where pilot ASAPs still are out of commission and their pilot unions report varying degrees of success in talks to restore the programs, which all parties insist they want to see back in operation.

The programs have faltered because of the relatively fragile structure of ASAP, developed in the 1990s as an experimental program with a key provision that required renewal every two years, and allowed an individual airline's program to expire unless the airline, union representatives and the U.S. Federal Aviation Administration (FAA) unanimously agreed to terms for its continuation.

"ASAP is still set up like a pilot program that can be turned off if anything goes wrong," said William R. Voss, president and CEO of Flight Safety Foundation. "But ASAP has become part of the backbone of safety management in the

BY LINDA WERFELMAN

ASAP

United States, and it's time for us to treat it as though it's here to stay."

The first ASAP was established at American Airlines in 1994 as the Safety Action Partnership, one of several demonstration programs implemented even before the FAA issued an advisory circular (AC) in 1997 that described ASAP characteristics and objectives and provided guidance on how they should be developed.

The current version of AC 120-66B, revised in 2002, says, "The objective of the ASAP is to encourage air carrier and repair station employees to voluntarily report safety information that may be critical to identifying potential precursors to accidents. … Identifying these precursors is essential to further reducing the already low accident rate."[1]

ASAPs typically are developed as a partnership between the operator, the FAA and the employees' labor organization. In most ASAPs, the partners establish an event review committee (ERC), which reviews reports on situations that employees believe may present safety risks, and develops plans to correct any problems.

"The ASAP provides for the collection, analysis and retention of the safety data," the AC said. "ASAP safety data, much of which would otherwise be unobtainable, is used to develop corrective actions for identified safety concerns, and to educate the appropriate parties to prevent a reoccurrence of the same type of safety event."

Under an ASAP, education and corrective action are intended to take the place of FAA penalties or company disciplinary measures. In fact, the AC specifies that operators should not use information obtained through an ASAP "to initiate or support disciplinary action outside of ASAP, with the exception of those events excluded from ASAP due to the appearance of possible criminal activity, substance abuse, controlled substances, alcohol or intentional falsification."

Over the past 14 years, ASAPs have become increasingly common, and at the end of 2008, the FAA said that nearly 170 were in place at more than 70 operators across the United States. Many of these operators have programs not only for pilots but also for maintenance personnel, dispatchers, flight attendants or other groups. Among the newest ASAPs is an American Airlines program that began operating in January for more than 18,000 flight attendants — a program the airline says is the largest in the world.

Both the FAA and the U.S. National Transportation Safety Board (NTSB) have urged wider use of ASAP, and both have called for a resolution of the differences that led to suspension of the four airline programs for pilots.

ASAP and other similar programs "are crucial to ensuring aviation safety and identifying problems before they lead to accidents," the NTSB said. Acting NTSB Chairman Mark V. Rosenker said that the safety board "urges all parties to do what is needed to reinstate proactive safety programs and keep existing programs viable and fully functioning."

Robert A. Sturgell, acting FAA administrator until he stepped down in January, characterized ASAP and other voluntary reporting programs as "crucial to safety," adding, "It's in everyone's best interest to separate safety from labor issues."

FAA Associate Administrator for Aviation Safety Peggy Gilligan urged representatives of the other airlines operating without ASAPs for their pilots to follow Delta's lead in resolving their differences.

"ASAP gives us invaluable insight into the day-to-day activities of people in our aviation system," Gilligan said.

And Voss praised Delta and its labor union representatives for "being persistent and putting safety above all other considerations."

Unanimous Support

In addition, a recent examination of the FAA's handling of safety issues by an independent review team (IRT) appointed by U.S. Transportation Secretary Mary E. Peters found that ASAP and two other major voluntary safety-reporting programs are vital to the future of aviation safety (*ASW*, 11/08, p. 10). The other two programs are flight operational quality assurance (FOQA), which involves the collection and analysis of data recorded during flight to improve the safety of flight operations, air traffic control procedures, aviation maintenance, and airport and aircraft design; and the voluntary disclosure reporting program (VDRP) — which encourages airlines, repair stations and other regulated entities to submit reports of regulatory noncompliance to the FAA for analysis and subsequent monitoring of corrective actions.

In their final report, the members of the IRT said that they had discussed the voluntary reporting programs with virtually everyone they interviewed during their research and found that the programs had the unanimous support of industry representatives and regulators.[2]

"They all understand that the majority of the information on which such enhancements now depend would not surface at all if not voluntarily disclosed," the report said. "The IRT emphatically reaffirms the value of these programs."

"ASAP has become part of the backbone of safety management in the United States."

'Quite Healthy'

Despite the interruption of ASAPs at four major air carriers, Voss said that "a number of programs today are quite healthy. They've been working well for a long time."

He believes, however, that the overall health of the programs would improve if the biennial renewal requirement were eliminated.

"With the renewal requirement, it's too easy for these programs to be derailed," Voss said. "We set up ASAP as an experiment, but that was 14 years ago. We're still treating it like a pilot program, and it is far too fragile for that."

In addition — with ASAPs at risk because of differing opinions about whether a "just culture"[3] provides absolute protection for employees who file ASAP reports or whether, in some cases, penalties may be justified — a solution also may require new guidance material to specify which types of reports should be covered by ASAP protections and which should not. Resolution of the issue ultimately may require regulatory action or legislation, Voss said.

The suggestions have generated a mixed response.

Rory Kay, Air Line Pilots Association, International (ALPA) safety chairman, endorsed the concept of legislation "to provide stronger protections, to ensure that the data collected is only used for intended safety purposes."

However, Kay was skeptical about any move to eliminate biennial renewals.

"Remember, these are voluntary programs," he said. Some sort of renewal time period or process is needed because individuals — individual personalities, beliefs, etc. — can change. These are programs built on trust, and with new people, new trust needs to be developed, re-established."

Billy Nolen, manager of flight/operations safety at American Airlines, said the FAA should consider action to make ASAP permanent and that removal of the renewal requirements would the ease operation of the program. He noted that FOQA operates without such restrictions.

"If there had been no FAA requirement to renew every two years, problems probably would not have come up," Nolen said.

Legal Proceedings

Another threat to ASAP, FOQA, VDRP and other voluntary data-gathering programs is the prospect that lawyers and judges will seek access to ASAP data for use in criminal or civil trials, Voss said. The solution may involve legislation to extend to ASAP the same statutory protections that now prohibit courtroom use of cockpit voice recorder transcripts, Kenneth P. Quinn, the Foundation's general counsel, said.

"Since prosecutors and courts are not protecting the confidentiality of voluntarily supplied safety information, legislatures need to step in to prevent critical sources of safety data from drying up," Quinn said.[4]

The Foundation and others have estimated that about 98 percent of the safety information obtained from voluntary disclosure programs would no longer be available if participants were subject to prosecution and penalties.

The Foundation's first call for legal protection of ASAP data came late in 2008, after court rulings in a case involving the Aug. 27, 2006, crash of a Comair Bombardier CRJ100ER during an attempted takeoff from the wrong runway at Blue Grass Airport in Lexington, Kentucky, U.S.[5] A federal district court judge upheld a lower court's order calling for the release of Comair ASAP reports, ruling that Congress had the authority to pass legislation protecting the confidentiality of ASAP information but had never done so.

Continuing Discussions

Participants in preliminary discussions have concluded that further conversations among the practitioners of ASAP would help, Voss said.

"There's a need to get together the people who work with ASAP so they can document what's working, the best practices," he said. "They need to decide first what everyone can agree on and what still needs to be talked out. People shouldn't have to reinvent their ASAP every time there's a personnel change.

"We need to close this up like a zipper and continue to narrow down the differences so we don't have as much room for disagreement."

"With the renewal requirement, it's too easy for these programs to be derailed."

Notes

1. FAA. Advisory Circular 120-66B, *Aviation Safety Action Program (ASAP)*. Nov. 15, 2002.
2. Independent Review Team. *Managing Risks in Civil Aviation: A Review of the FAA's Approach to Safety*. Sept. 2, 2008.
3. A "just culture" in which everyone is treated fairly is considered a primary element of safety culture. Safety specialists agree that in a just culture, people usually are not punished for unintentional errors. The International Civil Aviation Organization, in its Safety Management Manual, says a just culture is one that recognizes that, although punishment "serves little purpose from a safety perspective," punitive action may be necessary in some circumstances, and there is a need to define the line between acceptable and unacceptable actions.
4. Flight Safety Foundation. *FSF Calls for Stronger Protection of Volunteered Aviation Safety Information*. Oct. 30, 2008.
5. Forty-nine of the 50 people in the CRJ were killed, and the only survivor, the first officer, was seriously injured in the crash, which destroyed the airplane. The NTSB said that the probable causes were "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."

Further Reading From FSF Publications

Stimpson, Edward W.; McCabe, William O. "Managing Risks in Civil Aviation." *AeroSafety World* Volume 3 (November 2008): 10–14.

Rosenkrans, Wayne. "Preventive Fusion." *AeroSafety World* Volume 3 (May 2008): 25–29.

Rosenkrans, Wayne. "Speaking Up." *AeroSafety World* Volume 3 (February 2008): 34–39.

BY WAYNE ROSENKRANS

Moment of Truth

Rigid adherence to procedures for takeoff weight, center of gravity and stabilizer trim setting reduces the likelihood of uncommanded or delayed rotation.

When the U.S. National Transportation Safety Board (NTSB) in July 2008 issued three safety recommendations about mistrim takeoff, one was remarkable for its scope. It urged the U.S. Federal Aviation Administration (FAA) to encourage all operators of the Bombardier Challenger series to provide pilot training to "emphasize the importance of proper stabilizer trim setting," including type-specific mistrim-takeoff characteristics identified in the accident investigation.[1] The status of the recommendations (*ASW*, 9/08, p. 10) — based on findings of a Challenger 600 departure overrun accident at Teterboro (New Jersey, U.S.) Airport in February 2005 (*ASW*, 3/07, p. 30) — was "open — awaiting response," as of late January.

In the accident, the captain rejected the takeoff when the airplane did not rotate immediately at rotation speed (V_R) and the airplane overran the runway. The probable cause was "the flight crew's attempt to take off with the center of gravity (CG) well forward of the forward takeoff limit, which prevented the airplane from rotating at the expected rotation speed."[2]

Some aspects of the Teterboro accident were unique, others were not. The recommendations open an opportunity for all operators, not just those using the Challengers as specified by the NTSB, to reassess their training. "Pilots are less likely to attempt a takeoff with a mistrimmed stabilizer if they are made aware of the importance of the proper takeoff stabilizer trim setting on these particular airplanes and have directly experienced the delay in rotation associated with mistrim-takeoff conditions in a flight simulator," the NTSB said.

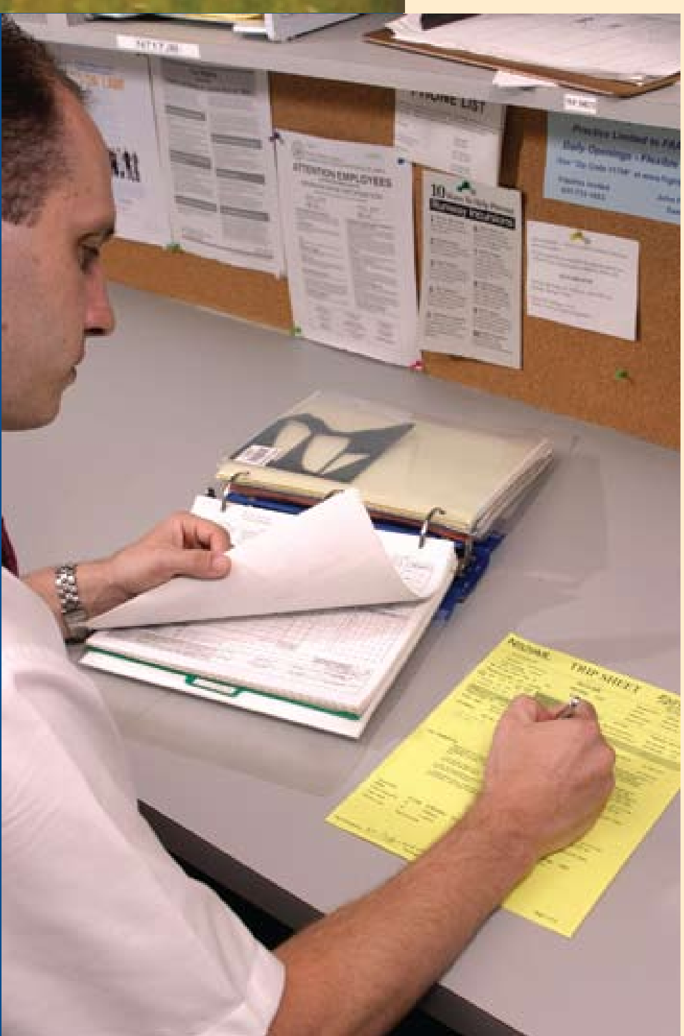
Preventing, recognizing and responding to mistrim takeoffs — as opposed to drills on pitch trim runaways and other equipment failures — ideally would emerge from risk-identification processes within the safety management system of any commercial jet operator. If an operator does not have sufficient events to study, voluntary

Albrecht Bruno/Jetphotos.net

reports from U.S. air carrier pilots since the Teterboro accident could be a starting point for considering factors that have caused uncommanded early rotations, delayed rotations and failures to rotate. The reports also suggest potential subject areas suitable for checking pilot awareness, safety responsibilities of others in the load control system and follow-up to system-level safety threats identified by company pilots.

Industry-developed training aids for this narrowly focused subject may be sparse, but resources such as the *Airplane Upset Recovery Training Aid, Revision 2* <www.flightsafety.org/upset_recovery.html> and detailed guidance from airframe manufacturers on subjects such as tail-strike prevention cover out-of-limit CG and takeoff trim safety issues (see "Attitude Adjustment," p. 34).

Mistrim takeoff, as used by the NTSB, refers to "a takeoff configuration in which the CG is at one limit of its allowable range, but the stabilizer position is set at the green band limit [a range of indications of the horizontal stabilizer position displayed to the flight crew] corresponding to the opposite CG limit." The green band indicates the range in which acceptable handling qualities can be expected during takeoff rotation and climb, and that normal flight operations will remain within the allowable longitudinal range of CG travel.



Guidance on tail strikes from Boeing Commercial Airplanes, for example, describes possible effects of a mistrim takeoff. "A mistrimmed stabilizer occurring during takeoff is not common, but is an experience shared at least once by almost every flight crew," said one article for operators. "It usually results from using erroneous data, the wrong weights or an incorrect CG. Sometimes the information presented to the flight crew is accurate, but it is entered incorrectly either to the flight management system (FMS) or to the stabilizer itself. In any case, the stabilizer is set in the wrong position."[3]

One defense before takeoff — often the last chance to identify the error and correct the condition — is for skeptical pilots to challenge whether the numbers on the final weight manifest or load sheet make sense. Vigilance for any stabilizer trim setting inconsistent with prior experience of what is normal for the same weight range enables crews to catch errors early, Boeing said. An airplane that has been trimmed nose-up substantially more than required may pitch up during takeoff at nearly twice the recommended rate of 2 degrees to 3 degrees per second and may leave the runway without control input from the pilot flying.

Pilots, dispatchers and loading supervisors may understand that flight tests for airplane certification include mistrim takeoffs at the forward and aft CG limits, but this has led some personnel to overestimate the safety margins. The NTSB recently has been concerned about a less-known phenomenon not quantified currently in flight testing: unusual, but characteristic, delays in airplane rotation in response to nose-up control input.

U.S. Federal Aviation Regulations Part 25, for transport airplane certification, specify that during "reasonably expected variations" from takeoff procedures — including over-rotation and out-of-trim conditions — a flight crew must not experience unsafe flight characteristics or a "marked increase"[4] in the scheduled takeoff distances in the airplane flight manual. Revisions have been in process for about six years, however, and changes that would define safely acceptable delays in rotation at V_R have been proposed by the European Aviation Safety Agency in concert with the FAA.

One example of guidance prepared in response to earlier NTSB calls for pilot training on mistrim takeoff was FAA Advisory Circular 120-85, *Air Cargo Operations*, published in June 2005.

U.S. National Transportation Safety Board

This Bombardier Challenger 600 pitch-trim position indicator is similar to one examined in the Teterboro crash.

NTSB safety recommendation A-98-44 had said that the FAA should "require all … Part 121 air carriers to provide flight crews with instruction on mistrim cues that might be available during taxi and initial rotation, and require air carriers using full flight simulators in their training programs to provide flight crews with special purpose operational training that includes an unanticipated pitch mistrim condition encountered on takeoff."

Another indication of the importance of such training is the FAA's January 2009 proposed rule on new training requirements[5] for pilots and other professions, which includes awareness criteria for pilots to "experience the pitch handling qualities of the aircraft with runaway stabilizer or runaway pitch trim, and pitch mistrim during takeoff or landing and during cruise flight" and to "observe the effects of early versus late detection and deactivation or correction." Pilots also would have to practice the procedures for recovery prescribed in the flight crew operating manual. Evaluation of performance would require that pilots in training "confirm that the aircraft trim and wing high-lift devices are configured properly."

The FAA also has focused on auxiliary performance computers (APCs), sometimes called auxiliary performance laptop computers, encompassing in part processes, procedures and computer proficiency underlying the data for setting stabilizer trim for takeoff.[6] Guidance in this information for operators also will "cause operators to review those procedures and related training to ensure their adequacy, if APC is to be used in the operator's approved weight and balance control system."

A forthcoming FAA advisory circular for the on-board aircraft weighing system (OBAWS)[7] on some large transport airplanes — which provides flight crews a continuous display of the aircraft total weight and other safety-critical information whenever the airplane is on the ground — also could enable training developers to cover the recognition of discrepancies that result in out-of-trim takeoff and CG out of limits.

Rotation Surprises

Causal factors in the Teterboro crash already were familiar. The NTSB had investigated the March 2001 rejected takeoff of an Airbus A320.[8] "The flight crew reported that, during the takeoff roll at an airspeed of about 110 kt, the nose of the airplane began to lift off the runway," a safety recommendation letter said. "In a post-accident interview, the captain stated that he continued the takeoff to [computed V_R of 143 kt] but, because he believed the airplane pitch was uncontrollable, he initiated a rejected takeoff. The airplane then became airborne and climbed a few feet. … The flight crew had incorrectly set the trim for the trimmable horizontal stabilizer at minus 1.7 degrees UP (airplane nose up [ANU]). This setting resulted in a pitch-up trim condition. The proper trim setting, 1.7 degrees DN (airplane nose down), would have resulted in a correct trim condition for the way the airplane was loaded."

In the letter about the A320, the NTSB cited similar factors in the April 2000 rejected takeoff of another A320, which simulations showed would have been controllable if the takeoff had continued. In this earlier event, the nose also had begun to lift off below the computed rotation speed. The airplane had been loaded with an aft CG, and the flight crew inadvertently had set the trimmable horizontal stabilizer at minus 2.2 degrees UP rather than the correct setting of 2.0 degrees DN.

Review of U.S. National Aeronautics and Space Administration Aviation Safety Reporting System (ASRS) reports about events in 2005–2008 suggests flight crew training subjects and issues to consider in refining aircraft weight and balance control systems. Most fit the same few categories mentioned in the 1990s by Boeing.

The first officer of a 747 discovered before takeoff that the final weight manifest showed takeoff gross weight 98,700 lb (44,770 kg) less than the correct figure, an error later attributed to a dispatcher's miscalculation. "I was lucky to pick up on the error because the takeoff gross weights were significantly different, and the trim required on the final weight manifest was significantly different from the trim required in the flight management computer [FMC]. The final weight trim was 4.4 units and the FMC said [it should have been] 5.5 units, a difference of 1.1. … It appears there is no safety check between the flight plan, fuel boarded and the final weights. … There is no fleet standard operating procedure or guidance given in the airplane flight manual to help catch this error. If there is, then it is not being effectively taught in training and not being used during line operations. I routinely watch most 747-400 first officers on the line set the trim based on what the final weight paperwork says, and never cross-check the FMC."[9]

A 757 flight crew quickly recognized an incorrect trim setting while accelerating for takeoff. "We had a load of military personnel with their duffel bags," the captain said. "Percent mean aerodynamic chord [MAC] was forecast to be 28.8 with 8,190 lb [3,715 kg] in the front [baggage] pit. … Trim was 3.7 units [ANU] during the takeoff roll, and at [V_R] it took an extraordinary amount of control force to rotate. I had to trim the aircraft in the rotation to help get off the ground. … The final weights calculation indicated [that the actual required takeoff] trim had been 4.2 units with 4,380 lb [1,987 kg] loaded in the front pit, and percent MAC was 25. Basically, the front pit weight fell off 4,000 lb [1,814 kg] from planned, and the trim moved aft from 3.7 to 4.2 units with a full airplane. Unlikely. These were bad numbers — from where, I don't know."[10]

The flight crew of an A320 rejected a takeoff at about 80 kt. "Final weights had the trim set at 38.3 percent MAC," the report said. "Once takeoff power was added, I immediately noticed a strong nose-up tendency. … With the control stick full down to maintain directional control via the nosewheel, I elected to accelerate a bit to see if relative airflow over the horizontal stabilizer would help alleviate this tail-heavy scenario. After about 70 kt, I was hesitant to neutralize the stick because [I felt that] the nosewheel was going to lift off the ground. I knew the CG was aft because the trim setting was unusual although within the limits on paper. … The aft limit for this was 1,672 units and the aircraft was actually loaded to 1,680 units. When [we asked the loading agent] about the out-of-range number, we were told, 'There is slop built into the limits.'"[11]

Takeoff performance of a McDonnell Douglas MD-80 surprised the flight crew, and a load audit was ordered at the destination. "During the takeoff roll at rotation, the aircraft would not rotate — very heavy [control forces] and extra long takeoff roll," the report said. "Fuel and passenger load were spot on [according to the audit results]. Freight was listed at 198 lb [90 kg], I believe. They unloaded 13 crates out of the mid-cargo area. … Assuming 900 lb [408 kg] each, that comes to almost 12,000 lb [5,443 kg] different than reported [to the flight crew], approximately 6,000 lb [2,722 kg] over maximum zero fuel weight. … This was a potentially deadly error. Good airmanship on the part of the first officer prevented disaster. The station manager … should be held accountable."[12]

Other ASRS reports include post-takeoff revision of final weight manifests, sometimes by thousands of pounds; flight crew complaints about load planners' apparent ignorance of the takeoff safety consequences of errors on final weight manifests; flight crew error in departing before receiving the final weight manifest; flight crew input of zero fuel weight data instead of actual takeoff gross weight data; count discrepancies of more than 100 passengers on some flights; errors in identifying which passengers are children; discontinuation of procedures that had required crewmembers to cross-check the actual passenger count; miscommunication of bag counts; failure to account for ballast fuel in load planning; and load-planning computation errors confusing kilograms and pounds.

Notes

1. NTSB. Safety Recommendations A-08-48, -49 and -50. July 17, 2008.
2. NTSB. "Runway Overrun and Collision, Platinum Jet Management, LLC, Bombardier Challenger CL-600-1A11, N370V, Teterboro, New Jersey, February 2, 2005." Aviation Accident Report NTSB/AAR-06/04, 2006.
3. Boeing. "Tail Strike Avoidance." *Aero*. October 1998.
4. In U.S. and European terminology for airworthiness certification, marked increase means any amount greater than 1 percent of the scheduled takeoff distance.
5. FAA. "Qualification, Service, and Use of Crewmembers and Aircraft Dispatchers; Proposed Rule." *Federal Register* Volume 74 (Number 7), p. 1280. January 12, 2009.
6. FAA. "Weight and Balance Control Methods: Auxiliary Performance Computer." Information for Operators, InFO 08031. May 16, 2008.
7. An OBAWS uses strain-sensing transducers in each main wheel and nosewheel axle, a weight and balance computer, and indicators that show the takeoff gross weight, the CG location in percent of MAC and attitude.
8. NTSB. Letter regarding safety recommendations A-02-06 and A-02-07 to FAA Administrator Jane F. Garvey. April 15, 2002.
9. NASA ASRS report no. 754690, September 2007.
10. NASA ASRS report no. 731902, March 2007.
11. NASA ASRS report no. 796177, July 2008.
12. NASA ASRS report no. 694610, April 2006.

U.K. Business Jet Accident Rates Comparatively High

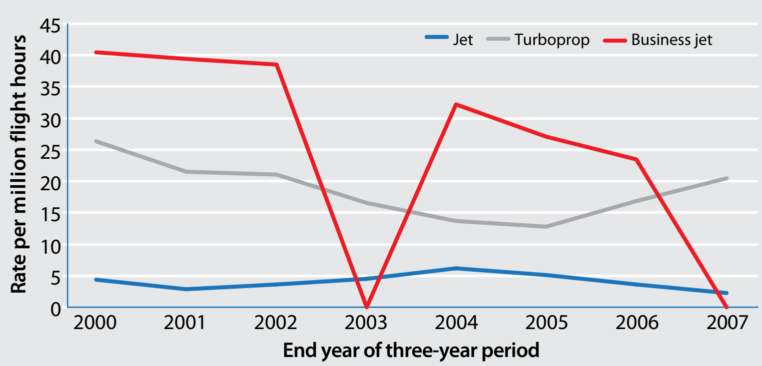
Engine problems were the most frequent factor in serious incidents among large aircraft.

BY RICK DARBY

Rates of reportable accidents were highest for business jets among all U.K. classes of large public transport aircraft in the 1998–2007 period, according to a new review by the U.K Civil Aviation Authority.[1] The reportable accident rate for business jets was more than four times that for jets, a category that excludes business jets.[2] Their fatal accident rate was six times higher than that for turboprops and more than 200 times higher than that for jets.[3]

This reportable accident rate was also more volatile than the rates for jets and turboprops when shown as a three-year moving average (Figure 1).[4] At 16.8 per million flight hours, this rate for business jets remained lower than that for turboprops (Table 1). The fatal accident rate, 8.4 per million flight hours, compared with 1.4 per million flight hours for turboprops and 0.04 per million flight hours for jets.

Reportable Accident Rates, U.K. Large Aircraft, 1998–2007



Source: U.K. Civil Aviation Authority

Figure 1

Reportable and Fatal Accident Rates, U.K. Large Public Transport Airplanes, 1998–2007

Class of Aircraft	Reportable Accident Rate per million flight hours	Fatal Accident Rate per million flight hours
Business jet	16.8	8.4
Jet	3.9	0.04
Piston	0.0	0.0
Turboprop	20.2	1.4
All classes of aircraft	4.8	0.2

Source: U.K. Civil Aviation Authority

Table 1

Incidents, especially serious incidents, are widely considered significant because they may be "accidents waiting to happen."[5] The serious incident rate for business jets was also volatile, but by the last rolling three-year period, ending in 2007, it was lower than the corresponding rate for both jets and turboprops (Figure 2). In the overall 10-year period, business jet serious incidents clocked in at 8.4 per million flight hours — the same as the fatal accident rate — compared with 5.1 for jets and 17.8 for turboprops.

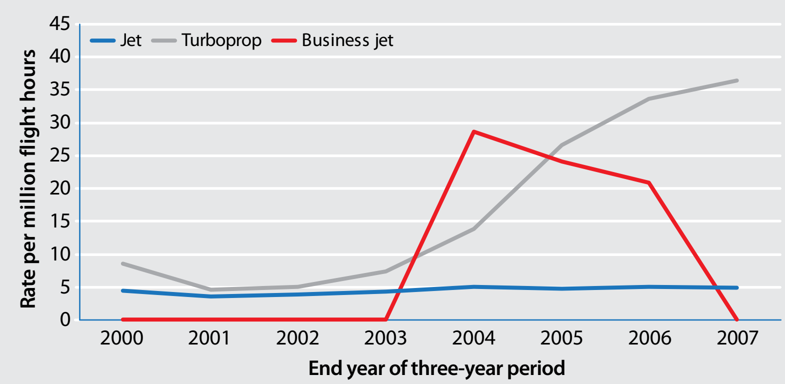
The review also categorizes the serious incidents for the period involving large public transport airplanes (Figure 3). The 10 factors most frequently associated with serious incidents applied to 76 percent of all serious incidents. Heading the list are "engine," "smoke/fumes in cabin or flight deck," "flight control problem," "runway excursion" and "runway incursion."

"Over 42,000 occurrences involving large public transport airplanes were reported between 1998 and 2007," the review says (Figure 4, p. 50). "The figure includes both accidents and serious incidents, which together form less than 1 percent of the total [occurrences]. The three-year moving average occurrence rate has increased 30 percent, from 1,400 per million [flight] hours in the period 1997–2000 to 1,800 per million hours in the period 2005–2007."

Although the overall occurrence rate increased, the rate of what the CAA defines as "high-severity" occurrences decreased (Figure 5, p. 50). "In the 10-year period, 0.8 percent of occurrences involving large public transport airplanes have been considered to be high-severity," the review says. "The three-year moving average high-severity occurrence rate has decreased 70 percent, from 24.7 per million [flight] hours in the period 1997– 2000 to 7.4 per million hours in the period 2005–2007."

For small public transport airplanes, the reportable and fatal accident rates showed an improving trend, although the reportable accident rate was volatile (Figure 6, p. 50).

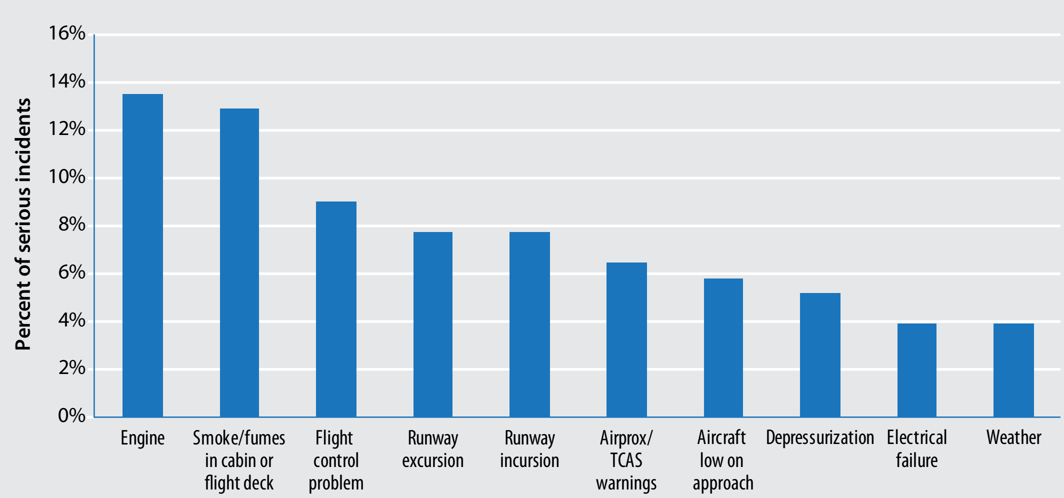
Serious Incident Rates, U.K. Large Aircraft, 1998–2007



Source: U.K. Civil Aviation Authority

Figure 2

Serious Incidents, U.K. Large Public Transport Airplanes, 1998–2007

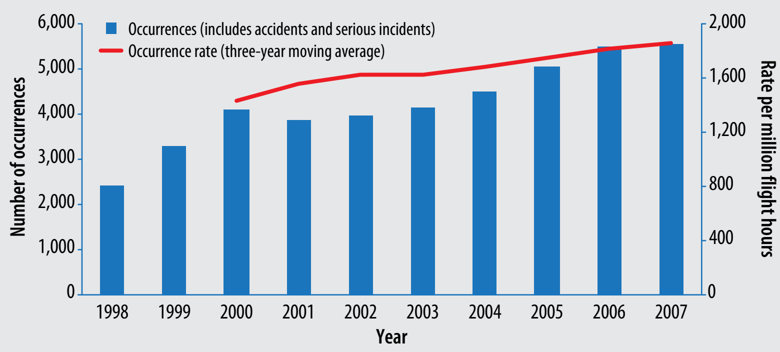


Airprox = loss of required separation TCAS = traffic alert and collision avoidance system

Source: U.K. Civil Aviation Authority

Figure 3

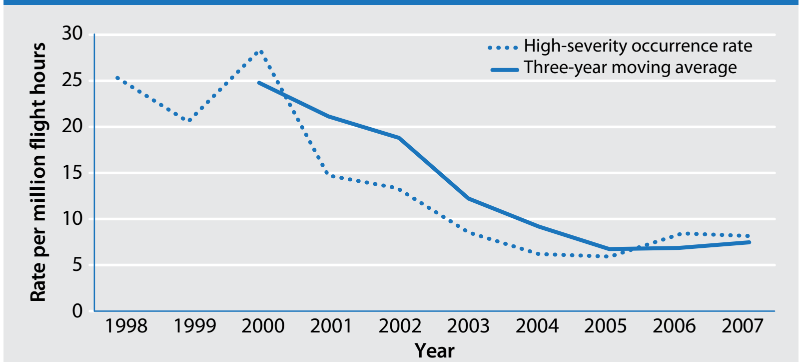
Occurrences, U.K. Large Public Transport Airplanes, 1998–2007



Source: U.K. Civil Aviation Authority

Figure 4

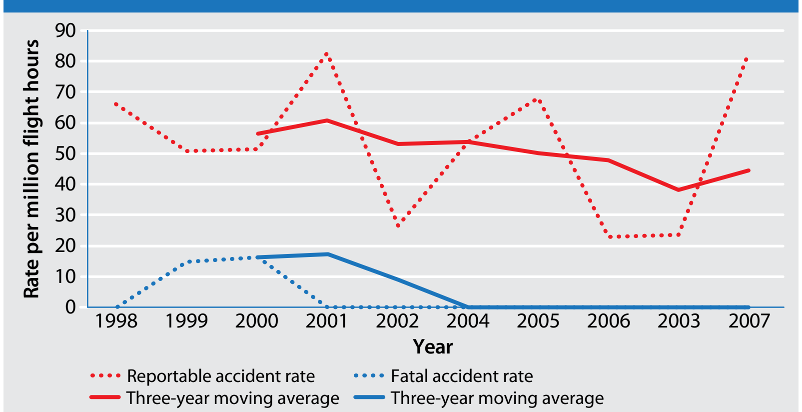
High-Severity Occurrences, U.K. Large Public Transport Airplanes, 1998–2007



Source: U.K. Civil Aviation Authority

Figure 5

Reportable and Fatal Accident Rates, U.K. Small Aircraft, 1998–2007



Source: U.K. Civil Aviation Authority

Figure 6

About 650 occurrences for small public transport airplanes presented a similar picture to their larger counterparts. The three-year moving average occurrence rate increased by 84 percent from 1998–2000 to 2005–2007. The three year moving average high-severity occurrence rate, however, decreased by 31 percent in the same time frame (Figure 7).

Helicopter operations — including all U.K.-registered or -operated helicopters engaged in public transport operations — were categorized as "emergency services," "offshore" and "other," the last being mainly passenger flights. There were 25 reportable accidents in the 1998–2007 period (Figure 8). Among them were four fatal accidents with a total of 22 fatalities. Of the four, two occurred during emergency services and two during offshore operations.

"Overall, the rate of reportable accidents involving public transport helicopters was 19.1 per million [flight] hours, and the fatal accident rate was 3.1 per million hours," the review says.

Public transport helicopters were involved in 11 serious incidents during the study period, all in offshore operations, except in 2004 and 2005. No serious incidents were recorded in 2000, 2001, 2003 and 2006.

During the period, 1.9 percent of occurrences were classified as high-severity. There was no obvious trend (Figure 9).

Summing up the differences between the latest data and those from the previous edition of the safety review, which looked at the 1995–2004 period, the review says concerning large public transport airplanes, "The number of reportable accidents has [been] reduced from 162 to 132 … and the number of fatal accidents has remained the same. A comparison of the three-year moving average reportable accident rates at the end of the two time periods examined shows an overall reduction: In the three-year period ending 2004, the rate was 6.7 reportable accidents per million hours, whereas in the three-year period ending 2007, the rate was 3.1 reportable accidents per million hours."

In the data subset for U.K. public transport helicopters, the number of reported occurrences rose from 2,200 in the previous period to 2,400 in the most recent. The number of reportable accidents decreased, from 31 to 25, while the number of fatal accidents was the same — four — in both study periods.

"The three-year moving average reportable accident rate in 2004 was 17.7 per million [flight] hours, but by 2007 this figure had [been] reduced to 11.8 per million hours," the review says. "Similarly, the three-year moving average fatal accident rate [was] reduced from 2.5 in the period ending 2004 to 2.4 in the period ending 2007."

Numbered Swiss Account

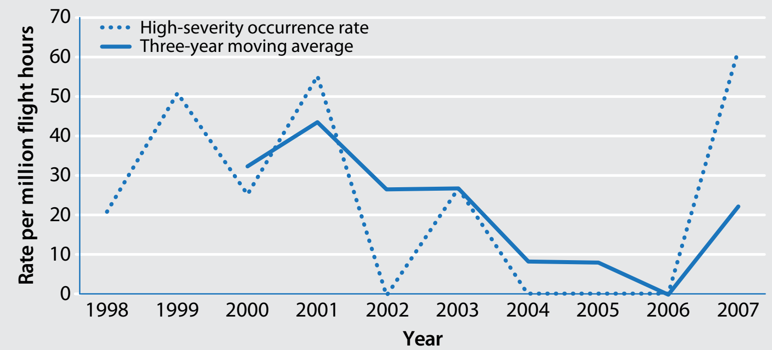
A different report, published by the Swiss Aircraft Accident Investigation Bureau, indicated that the total number of accidents and serious incidents involving Swiss-registered aircraft decreased to 52 in 2007 from 72 in 2006 despite an increase in flight hours (Table 2, p. 52).[6] It was the lowest combined total since 1998.

The 2007 total number of accidents, 43, was the lowest in the period beginning in 1996. Serious incidents were down to nine in 2007 from 14 the previous year.

For large aircraft — greater than 5,700 kg/12,500 lb — the number of accidents and serious incidents among Swiss-registered aircraft in Switzerland was reduced by half, from 12 to six, between 2006 and 2007 (Table 3, p. 52). None of those occurrences involved injuries. The number of accidents involving Swiss-registered helicopters in Switzerland decreased from 11 to seven.

Among accidents and serious incidents involving large airplanes in 2007 — including Swiss-registered airplanes in Switzerland and abroad, and non-Swiss airplanes in Switzerland — four of nine occurred during the landing phase of flight; three during cruise; and two during descent and approach. Among helicopter accidents and serious incidents, four of 10 happened in descent and approach, four in landing, one on the ground, in rolling or in hovering flight; and one during cruise.

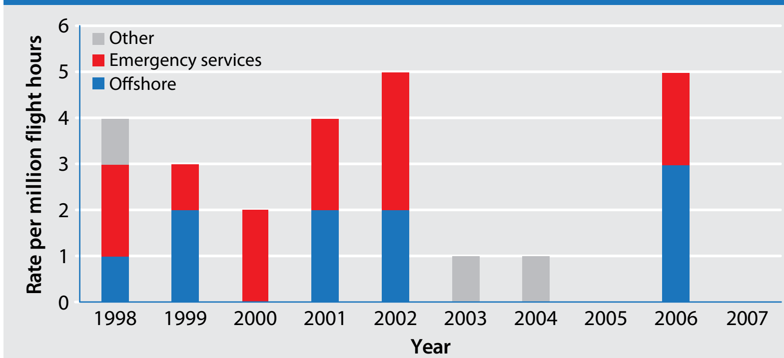
High-Severity Occurrences, Public Transport Airplanes, 1998–2007



Source: U.K. Civil Aviation Authority

Figure 7

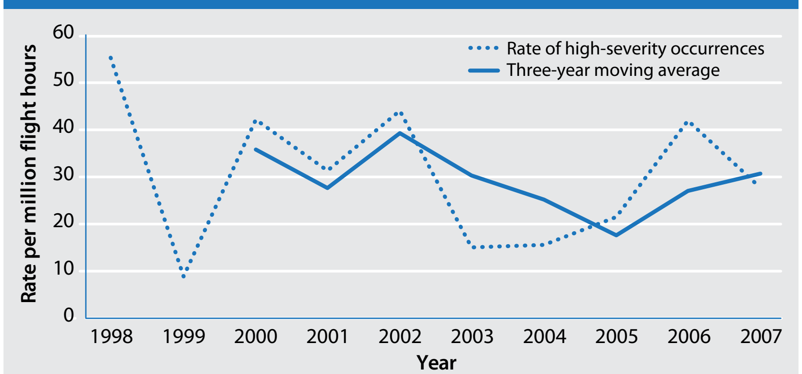
Reportable Accidents, U.K. Public Transport Helicopters, 1998–2007



Source: U.K. Civil Aviation Authority

Figure 8

High-Severity Occurrences, U.K. Public Transport Helicopters, 1998–2007



Source: U.K. Civil Aviation Authority

Figure 9

Notes

1. *Aviation Safety Review — 2008*. Civil Aviation Publication (CAP) 780. Nov. 11, 2008. Covering U.K., European region and worldwide occurrence data, the document is available via the Internet at <www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=3325>. *Public transport operations* include ambulance, cargo, passenger, police support or search and rescue. *Large airplanes* are those exceeding 5,700 kg/12,500 lb maximum takeoff weight; *small airplanes* are those up to that weight. Among large public transport airplanes, U.K. aircraft classes comprise business jet, jet, piston and turboprop.
2. A *reportable accident* meets the definition used by the International Civil Aviation Organization (ICAO). The majority of the data in the review are sourced from the U.K. CAA's Mandatory Occurrence Reporting (MOR) Scheme. U.K. occurrences, the subject of this article, were those involving U.K.-registered or -operated aircraft, or in U.K. airspace. In the 1998–2007 period, that represented about 78,000 occurrences.
3. The report does not specifically say that turboprops exclude business airplanes, but this appears to be the implication.
4. A *moving average* is an average that is recomputed periodically by removing the oldest data and including the latest data. Its effect is to smooth out the data points and make trends more visible.
5. In line with the ICAO definition, a *serious incident* is an incident involving circumstances indicating that an accident nearly occurred.
6. *2007 Statistics Concerning Accidents and Serious Incidents Involving Swiss-Registered Aircraft in Switzerland and Abroad and Foreign-Registered Aircraft in Switzerland.* Available via the Internet at <www.bfu.admin.ch/en/dokumentation_jahresstatistiken.htm>.

Accidents and Serious Incidents, Swiss-Registered Aircraft, 1996–2007

Year	Flight Hours	Total Number of Accidents	Number of Serious Incidents (including Airprox)	Total Number of Accidents and Serious Incidents	Number of Fatalities
1996	833,000	51	2	53	29
1997	750,676	69	0	69	26
1998	739,236	46	2	48	250
1999	778,373	53	16	69	19
2000	828,363	53	27	80	51
2001	758,470	46	18	64	50
2002	844,389	50	16	66	16
2003	873,540	70	24	95	24
2004	749,535	63	18	81	14
2005	768,643	59	16	75	15
2006	715,572	58	14	72	10
2007	766,557	43	9	52	12

Airprox = loss of required separation

Source: Swiss Aircraft Accident Investigation Bureau

Table 2

Accidents and Serious Incidents, Swiss-Registered Aircraft in Switzerland and Abroad, and Non-Swiss Aircraft in Switzerland, 2006–2007

	Swiss-Registered Aircraft in Switzerland						Swiss-Registered Aircraft Abroad						Non-Swiss Aircraft in Switzerland					
	Total		Persons Injured		Persons Not Injured		Total		Persons Injured		Persons Not Injured		Total		Persons Injured		Persons Not Injured	
	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006
Aircraft with MTOW 2,250–5,700 kg	3	0	2	0	1	0	2	0	0	0	2	0	4	1	0	0	4	1
Aircraft with MTOW > 5,700 kg	6	12	0	0	6	12	1	1	0	0	1	1	2	0	0	0	2	0
Helicopter	7	11	2	2	5	9	3	1	1	0	2	1	0	0	0	0	0	0

MTOW = maximum takeoff weight

Source: Swiss Aircraft Accident Investigation Bureau

Table 3

Drive to Succeed

A supplement to the U.K. radiotelephony manual instructs ground vehicle drivers on standardized communication and best practices.

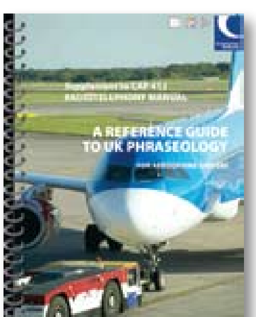
REPORTS

The Phrase That Pays

A Reference Guide to UK Phraseology for Aerodrome Drivers

U.K. Civil Aviation Authority. Supplement to Civil Aviation Publication (CAP) 413, *Radiotelephony Manual*. October 2008. 34 pp. Figures, illustrations. Available via the Internet at <www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=3304> or from The Stationery Office.*

In 2007, 26 percent of reported U.K. runway incursion incidents involved ground vehicles, this guide says. That is not surprising, considering that drivers often work in close proximity to aircraft in areas designed for aircraft movement, not earthbound vehicles. In addition, the guide notes, drivers need to use busy radio frequencies shared with pilots, air traffic controllers and others. "In order to do this, drivers need to understand and use the correct radiotelephony (RTF) phraseology and techniques," the guide says.



The guide is available online in a version that resembles a spiral-bound booklet, with tabs for topical sections and pages that turn when a forward arrow or tab is clicked. Audio files can be activated to provide the sound of correctly formatted voice messages.

Design is clear and clean, with graphic symbols and color coding to identify vehicle driver phraseology, controller or flight information service officer phraseology and air-ground communication service operator phraseology.

The guide begins with basics that may seem obvious to pilots and controllers but could be new to beginning drivers. "Think about what you are going to say before you transmit," the guide says. "Use a normal conversation tone. Do not talk too fast, speak clearly and at a steady pace. Keep the rhythm, speed, volume and pitch normal. … Always read back in full instructions relating to movement on the maneuvering area. Do not replace a readback of instructions with 'roger' or 'copied' or 'wilco.' If you do not understand instructions, ask for clarification and do not guess what it is you are being told to do."

The guide has chapters on "movement instructions," "entering and crossing runways," "towing an aircraft," "adverse weather," "vehicle phraseology" and "additional messages."

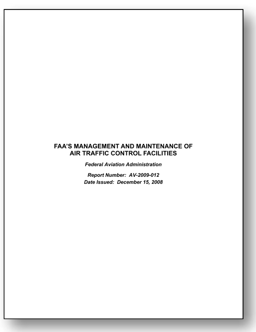
The "additional messages" section alerts drivers that they may need to convey unusual messages that are important for safety, such as, "Ops 1, open ventilation panel starboard side of Blue Skies Boeing triple seven passing on Taxiway Delta" or information about wildlife on or near a runway. It also cautions drivers that "it is easy to get disoriented on an aerodrome, particularly at night or in poor visibility," and that in such a situation, the driver should immediately ask for directions or instructions.

Although the terminology applies to U.K. vehicle drivers, many of the general principles will be useful to drivers at any large airport.

Upgrading ATC Facilities

FAA's Management and Maintenance of Air Traffic Control Facilities

U.S. Federal Aviation Administration (FAA). Report AV-2009-012. Dec. 15, 2008. 32 pp. Figures. Available via the Internet at <www.oig.dot.gov/item.jsp?id=2405>.



"Many of FAA's air traffic control facilities have exceeded their useful lives, and their physical condition continues to deteriorate," says this report by the U.S. Department of Transportation Inspector General's office. The report presents the results of an audit of FAA air traffic control (ATC) facilities, based on visits to terminal control facilities, en route control centers, an FAA service area and FAA headquarters.

The report appears as the FAA is beginning its transition to the Next Generation Air Transportation System (NextGen), planned for completion in 2025. The objectives of the audit, the report says, were to determine if the agency has "(1) developed and implemented a comprehensive strategy to effectively manage the replacement, repair and modernization of its ATC facilities and (2) allocated sufficient funds to carry out those activities."

While acknowledging that recent years have brought improvement, the report says that the FAA lacks adequate controls to ensure that its routine facility maintenance needs are sufficiently funded. "More importantly, FAA's newly developed processes for its capital maintenance needs are only short-term solutions that focus on sustaining the existing ATC infrastructure," the report says. "This is because FAA has not made key decisions on facility consolidations and infrastructure needs related to NextGen."

An average ATC facility is expected to have a useful life of 25 to 30 years, but 59 percent of FAA facilities — 249 of 420 — are more than 30 years old. The average age of en route facilities is 43 years. Fifteen facilities are more than 50 years old.

During site visits, the auditors observed structural problems and maintenance issues at several locations, including "water leaks, mold, tower cab window condensation, deterioration due to poor design and general disrepair. While the deficiencies observed posed no immediate risk to the operations of the National Airspace System, they could affect operations in the long term if they are not addressed."

Inadequate lines of sight were noted at some ATC facilities because the airport had been expanded since the tower was built, so that controllers can no longer see the entire airfield. This was a particular problem at one airport where the control tower dates from 1958 and another where the tower was commissioned in 1960.

"Over the years, facility maintenance has been neglected as FAA took a reactive rather than proactive approach to sustaining its ATC facilities," the report says. "For example, managers at several FAA facilities stated that FAA was only focusing on emergency repairs and fixing problems as they arose."

Formerly, requests for maintenance funding came from the agency's nine regional offices, which would submit a list of priorities to FAA headquarters, and the agency would allocate funds to the regions based on the priority lists. "This decentralized process resulted in several problems," the report says. "First, there was a lack of consistent information flow to headquarters, making it difficult for FAA to accurately gauge its agency-wide requirements. Second, resources were not always utilized efficiently; because the regions used their own prioritization methods, there was no way for headquarters to validate that the work that was most needed nationally was actually the work being completed.

"Finally, the regions were granted flexibility to reprogram funds to projects, which may not have been the projects that were initially submitted to headquarters. As a result, FAA headquarters was not always aware of which projects had been funded and completed and which projects still remained incomplete. This uncertainty made it difficult for FAA headquarters managers to plan for future projects and accurately estimate their needs."

The agency has since developed a process to better manage maintenance needs, the report says. The Air Traffic Organization's Terminal Services unit now uses an agency-wide tool called the Needs Assessment Program. Terminal maintenance projects are entered into a central system, and headquarters is able to prioritize them based on urgency. In addition, to aid in preventive maintenance, Terminal Services has begun conducting life-cycle assessments at terminals and has instituted a Structured Facility Planning Process that helps the unit determine which facilities most need to be replaced.

Over fiscal years 2008 through 2015, the agency plans to replace 29 of its 397 terminal facilities. The auditors recommend that a similar process be followed for en route facilities. The report says that the FAA should "determine what type of facilities (i.e., terminal versus en route or a hybrid of the two) will be needed, how many of these facilities will be needed, and where they should be located to effectively support NextGen."

On the Deck

Offshore Helicopter Landing Areas — Guidance on Standards

U.K. Civil Aviation Authority (CAA). Civil Aviation Publication (CAP) 437. Sixth edition. December 2008. 138 pp. Figures, tables, references, glossary, appendixes. Available via the Internet at <www.caa.co.uk/default.aspx?catid=241&pagetype=90> or from The Stationery Office.*


Safety Regulation Group

CAP 437

Offshore Helicopter Landing Areas - Guidance on Standards

www.caa.co.uk

This supersedes the fifth edition of 2005. The document says that it has been "revised to incorporate further results of valuable experience gained from CAA-funded research projects conducted with the support of the U.K. offshore industry into improved helideck lighting and the conclusion of projects … relating to offshore helideck environmental issues."

Other changes include:

- A detailed specification is provided for lighting the "H" heliport identification marking and the touchdown and positioning marking circle;
- A new reference is provided to the final specification for helideck status light systems;
- As a result of completed helideck environmental projects, a new turbulence criterion is published and the longstanding vertical flow criterion is removed;
- New International Civil Aviation Organization standards and recommended practices relating to offshore helidecks and shipboard heliports, which are to become applicable in November 2009, are included;
- Material is added from the fourth edition of the International Chamber of Shipping Guide to Helicopter/Ship Operations, published in December 2008; and,
- For the first time, guidance is included for the design of winching area arrangements on wind turbine platforms.

WEB SITES

Knowing Your Avionics

Aircraft Electronics Association, <www.aea.net/default.asp>

Aircraft Electronics Association (AEA) is a member-supported organization representing aviation electronics and avionics businesses and educational institutions.

Portions of AEA's Web site are available to nonmembers. Materials may be read online or printed at no charge.

- Avionics News, AEA's publication: Selected articles from 2003 through 2008 in full text are featured in the News Archive section of the Web site.

- Technical Training Exam: A copy of the exam designed to help member companies meet technician-training requirements is accompanied by links to Avionics News full-text articles that provide background research to aid in successfully completing the exam. The 2007 exam with relevant background articles is also available.

- Avionics INTEL Sheets: Each two-page briefing paper gives an overview of an avionics system such as terrain awareness and warning system (TAWS), traffic alert and collision avoidance system (TCAS) and emergency locator transmitter (ELT) with product specifications, descriptions of the technology and references to applicable U.S. Federal Aviation Regulations.

The Human Touch

Royal Aeronautical Society, Human Factors Group, <www.raes-hfg.com>

Its mission statement says, "The Human Factors Group [HFG] of the Royal Aeronautical Society [RAeS] exists to improve standards of safety in aviation by promoting better industry understanding of human factors hazards and techniques for dealing with them."

The standing groups and focus teams address issues related to topics such as air traffic control, crew resource management (CRM), maintenance engineering, ramp safety and human interface design. Proceedings from their conferences, from 1998 through 2007, contain PowerPoint presentations by RAeS members, academia and industry. Conference titles include "Risks in Aviation Maintenance," 2007; "Management of Human Factors Risk in Safety-Critical Industries," 2006; and "Human Factors: Making a Difference," 2008, which focused on human factors in safety management systems.

HFG similarly provides free access to related CRM and human factors papers and reports; regulatory, standards and guidance materials; and journal articles, including some from the U.K. Civil Aviation Authority and the U.S. Federal Aviation Administration.

To access most materials, select and click on the *conferences* icon. Passwords are not required for this portion of the Web site. Documents and individual presentations are full text and may be downloaded or read online at no cost.

Source

* The Stationery Office <www.tso.co.uk>

— Rick Darby and Patricia Setze

Engine Cowling Departs on Landing

Distracted maintenance technicians neglected to secure the latches.

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

Section Strikes Horizontal Stabilizer

Airbus A319-100. Substantial damage. No injuries.

Maintenance had been performed on the A319's right engine the evening before the airplane was scheduled for a flight from New York's La Guardia International Airport to Detroit Metropolitan Wayne County Airport with 68 passengers and five crewmembers the morning of Jan. 9, 2008. "The first officer reported the engine cowlings were flush and he did not see any 'hanging' latches when he looked underneath the engine cowlings during the preflight," said the report by the U.S. National Transportation Safety Board (NTSB).

The captain said that taxi and takeoff appeared normal. However, during initial climb, the lead flight attendant told the flight crew that a passenger had seen a right-engine cowling flapping after takeoff. "A pilot-passenger who was sitting behind this passenger reportedly did not see the cowling move, nor did the flight attendants when they looked out the window," the report said.

As the airplane climbed to cruise altitude, the engine-vibration monitors showed that the vibration measurement for the right engine was about twice as high as for the left engine, but no cautions or warnings were generated. "The captain reported that during cruise flight, the no. 2 [right] engine vibration decreased, and about 20 minutes after they leveled off, the airplane shuddered as if flying through wake turbulence," the report said.

The flight proceeded without incident until after the airplane touched down in Detroit, when the lead flight attendant told the flight crew that "part of the right engine came off." The crew shut down the right engine and taxied the airplane to the gate, and the first officer told the airport ground traffic controller that there might be debris on the runway.

Investigators found that half of the engine-fan cowling had separated when the airplane was on final approach about a mile from the runway; the other half had separated on touchdown. The report said that this part of the cowling was struck by an airplane that landed after the A319, but it provided no details about the incident.

Investigators also found that part of the cowling had struck and substantially damaged the A319's right horizontal stabilizer. "In addition, the fan cowling doors, no. 2 engine pylon, the no. 2 engine reverser and the right wing no. 1 slat were damaged," the report said.

The work on the right engine — to replace the N_1, or low-pressure rotor (fan) speed, sensor — had been performed by two contract maintenance technicians. "They reported that they had shut the fan cowling but did not latch it, as they still needed to perform an engine run and check for leaks [after replacing the sensor]," the report said. "They performed the engine run and were in the cockpit when another mechanic asked for help on another airplane."

Neither maintenance technician returned to the A319 after assisting the other mechanic, and the airplane was returned to service with the engine-fan cowlings unlatched.

Tire Failure Traced to Frozen Brake

Bombardier Global Express. Substantial damage. No injuries.

After a flight of more than nine hours with two passengers from the United States on Jan. 29, 2008, the aircraft was being landed at London Luton Airport when the pilots heard a rumbling noise that they identified as a burst tire. They also observed indications of low pressure in the no. 2 and no. 3 hydraulic systems. "The commander brought the aircraft to a stop on the runway using normal brakes and, as fire vehicles approached, shut down both engines," said the report by the U.K. Air Accidents Investigation Branch (AAIB).

Investigators determined that the inboard wheel on the left main landing gear was locked — not free to rotate — on touchdown, causing the tire to burst. Friction forces then caused the wheel to break free and rotate, and flailing segments of torn tire tread and tire carcass struck the spray guard.

"This destroyed the guard, inflicted significant damage to the wing local auxiliary spar structure and fractured hydraulic pipes, resulting in the nos. 2 and 3 hydraulic systems becoming inoperable," the report said. "It also fractured the flap-drive torque tube, damaged a major wiring loom and caused metallic debris to be forced between and into contact with the two cables driving the left aileron."

The left inboard wheel had become locked because its brake rotor and stator had frozen together. The Global Express had been parked in the open, in heavy rain, for four days at Van Nuys (California) Airport. "During this period, the wheels were chocked with the brakes off," the report said. "Significant rain ceased 11 hours before takeoff, and no rain fell during the last eight hours before departure." Surface temperature during the last eight hours was 12° C (54° F).

The Global Express had been parked in the open, in heavy rain, for four days.

The operations reference manual, a training document, for the Global Express recommends that when ground surfaces are "contaminated or covered with water," the wheel brakes should be applied while taxiing to warm the brakes and the wheels so that the brakes do not freeze.

However, the ramp, taxiways and runways at Van Nuys were dry when the occupants boarded the aircraft. Recorded flight data indicated that there was minimal brake application — and little kinetic heating of the brakes — as the aircraft was taxied to the departure runway, and a rapid climb subsequently was made to Flight Level 410 (approximately 41,000 ft), where the outside air temperature was minus 25° C (minus 13° F).

Investigators found that rainwater on the upper wing surface of a Global Express can pass through a drain hole and flow along the lower wing surface until encountering a flush skin joint, where it tends to drip onto the inboard tire and migrate onto the brake stator and rotor. "The brake manufacturers have confirmed that the materials of the rotors and stators, both being carbon-type structures, are porous and slightly absorbent," the report said. "After extensive water soaking, they require a prolonged period of exposure to dry, warm conditions to ensure that full drying takes place. Alternatively, significant braking action must be deliberately applied during taxiing before departure to ensure brake drying."

The inboard left brake rotor and stator were still wet when the accident aircraft departed from Van Nuys, and they froze together during cruise flight. The tire that burst on landing was of cross-ply, or bias-ply, construction. The report said that when a radial-ply tire bursts, the "detached or flailing debris is likely to be significantly smaller and lighter."

After the accident, Bombardier published an advisory reminding pilots and maintenance personnel that carbon brakes can absorb moisture and freeze if they are not heated properly. "After exposure to moisture, a prolonged period of dry, warm conditions is required to ensure [that] full drying takes place," the advisory said. "Alternatively, brake applications must be deliberately applied during taxi, before departure, to ensure that the moisture is evaporated away."

AAIB recommended that regulatory authorities "raise awareness of the vulnerability of carbon brakes to freezing in flight following exposure to moisture on the ground." The bureau also recommended that Bombardier modify the Global Express to reduce the amount of water that flows onto the brakes when the aircraft is parked in rain.

Broken Wire Silences Warning Horn

British Aerospace Hawker 700A. Substantial damage. No injuries.

No checklist callouts were recorded by the cockpit voice recorder (CVR) as the Hawker — en route with 10 passengers on a business flight from Toluca, Mexico — neared Fort Lauderdale/Hollywood (Florida, U.S.) International Airport the night of Nov. 1, 2006. The flight crew advised air traffic control (ATC) that they had the airport in sight and were cleared to conduct a visual approach. The pilot told investigators that he was distracted during the approach while looking for the runway, the NTSB report said.

The landing gear was not extended when the Hawker touched down and slid about 2,600 ft (792 m) before coming to a stop on the runway with substantial structural damage and fire damage to the bottom of the fuselage. "Following touchdown, the CVR recorded that the pilot asked what happened to the landing gear and the copilot responded, 'We never put it down,'" the report said.

Examination of the landing gear extension system showed that it operated normally and that the primary and secondary annunciators correctly indicated the position of the gear. Investigators found, however, that a wire had separated from a relay, rendering the landing gear warning horn inoperative. "The CVR had captured no sounds that could be associated with the landing gear warning horn, and the pilot reported that he did not hear a warning," the report said.

There is no preflight test procedure for the landing gear warning horn. However, the horn is shared by the cabin altitude warning system. "The cabin altitude warning system is a preflight check item for flight crews," the report said. "Therefore, the anomaly that rendered the gear warning system inoperative would be detectable during a flight crew's preflight check because the cabin altitude warning would fail to function.

"However, a review of available maintenance and discrepancy records revealed no indication that any flight crews had previously detected and reported an inoperative cabin altitude warning system. … Therefore, it could not be determined when the wire fracture occurred."

The records indicated that both fuel gauges and an interstage turbine temperature gauge were inoperative. The report said that these gauges are required by the airplane's minimum equipment list to be functional for flight.

The report also said that neither pilot was properly certificated to fly the Hawker, which was registered in the United States. The pilot's U.S. commercial certificate and the copilot's U.S. private certificate were based on their Mexican certificates. Neither pilot had a U.S. instrument rating, and the captain was not type-rated in the Hawker.

"Although there is insufficient evidence to indicate that any of these flight crew discrepancies were directly related to the cause of the accident, the FAA [U.S. Federal Aviation Administration] determined that the discrepancies represented noncompliance with numerous Federal Aviation Regulations," the report said.

The pilot asked what happened to the landing gear. The copilot responded, 'We never put it down.'

Collision With a Misplaced Airbridge

Boeing 757-300. Substantial damage. No injuries.

The visual docking-guidance system was activated remotely by an airport apron controller as the 757 was being taxied to Stand 32 at Manchester (England) Airport the evening of Dec. 12, 2007. "Due to commitments elsewhere on the airport, a dispatcher allocated to attend the arriving aircraft was unable to reach the stand before the aircraft," said the AAIB report.

The commander used references from the visual docking-guidance system to turn off the taxiway and align the 757 with the centerline of the stand, and he reduced groundspeed below 4 kt as the aircraft neared the indicated stopping position. "Deceleration was more pronounced than he expected, and the aircraft stopped approximately 3 ft [1 m] short of the indicated position," the report said, noting that the left engine cowling had struck an airbridge. "The pilots shut down the engine, and the [283] passengers and [10] crew disembarked without further incident."

The 757 was the first aircraft to be parked at Stand 32 after it was reopened following two days of maintenance on the airbridge. The airbridge had not been retracted so that the wheels on its outer section were within a designated circle painted on the apron. "In the absence of relevant procedures, the airport operator did not check physically that the airbridge … had been returned to its correct parking position," the report said. "The apron controller was unable to check visually, prior to its use, that the stand was clear and that [the airbridge was] properly positioned."

AAIB recommended that the airport prohibit remote activation of a visual docking-guidance system until personnel at the stand confirm that the stand is clear.

Starter Bursts During 'Crash Engagement'

Airbus A330-300. Substantial damage. No injuries.

The flight crew made two unsuccessful attempts to start the A330's right engine while preparing for a flight from Darwin, Australia, on Oct. 24, 2007. The first attempt was an automatic start that lasted 1 minute 10 seconds but resulted in no N_2, or high-pressure compressor, rotation. "The second attempt was a manual start lasting six minutes, at which time smoke and sparks were observed from under the engine cowlings," said the report by the Australian Transport Safety Bureau (ATSB). "Subsequent inspection of the engine revealed an uncontained failure of the starter turbine and secondary damage to the [adjacent] integrated drive generator."

The starter on the General Electric CF6-80E1 engine had accumulated 14,988 flight hours and 2,428 cycles. The manufacturer's examination of the starter revealed that the failure was precipitated by a previous "crash engagement" of the starter clutch. This is a complex phenomenon that can occur when an interruption in the flow of pressurized air driving the starter turbine causes the clutch to disengage and the starter shaft to decelerate. When airflow is restored, the starter turbine accelerates to "free-run speed," and re-engagement of the clutch causes internal components to "crash" against each other. The damage increases during subsequent engine starts and can spread to other starter components, such as the turbine bearings. The starter has cutter pins designed to cut off the turbine blades if the bearings fail and a containment ring that is supposed to prevent the blades from exiting from the starter.

The report said that there have been three starter turbine failures since the CF6-80E1 engine was introduced in 1993. The incident at Darwin was one of two failures that were not contained. "As a result of this incident, the engine manufacturer undertook corrective actions in the form of a starter containment improvement plan, which proposed design improvements to the starter," the report said.

TURBOPROPS

Frost Blamed for Loss of Control

Cessna 208B Caravan. Substantial damage. One serious injury, one minor injury.

Night visual meteorological conditions prevailed and surface temperature was minus 11° F (minus 24° C) when the pilot prepared the Caravan for a cargo flight from Bethel (Alaska, U.S.) Airport on Dec. 18, 2007. The pilot told investigators that he used a broom but no deicing fluid to clean frost off the wing and tail surfaces.

The pilot used 20 degrees of flap for the takeoff and maintained an airspeed of 110 kt for the initial climb at 500 fpm. When he retracted the flaps to 5 degrees, the Caravan began to roll right in what the pilot described as similar to an encounter with a wake vortex. He applied left aileron and extended the flaps to 20 degrees, but the rolling tendency became more severe.

"He then noticed that the airplane was descending toward the ground, so he attempted to put the flaps completely down," the NTSB report said. "His next memory was being outside the airplane after it collided with the ground." The pilot received minor injuries; a passenger, a ground-support employee of the operator, was seriously injured.

Investigators determined that the pilot's description of the rolling tendency was consistent with airframe contamination by ice. "The airplane's information manual contains several pages of limitations and warnings about departing with even small amounts of frost, ice, snow or slush on the airplane, as it adversely affects the airplane's flight characteristics," the report said. "The manufacturer … notes that a heated hangar or approved deicing fluids should be used to remove ice, snow and frost accumulations."

Back to Work Too Soon

De Havilland Dash 8. Substantial damage. No injuries.

The commander, 48, had been hospitalized for 12 days for an illness that was not specified in the AAIB report. After being discharged, he advised his aviation medical examiner (AME) about the hospitalization. "The AME advised the commander that … he could return to work when he felt fit and no medical examination would be required," the report said.

According to the U.K. Civil Aviation Authority (CAA) Aeromedical Section, however, the illness suffered by the commander could result in fatigue that can last for six weeks after the main symptoms of the illness abate.

The commander reported for duty about two weeks after leaving the hospital. Nine days later, on May 28, 2008, he was scheduled to administer line training of a copilot during a scheduled flight with 37 passengers and two cabin crewmembers from Exeter, Devon, England, to Paris.

During final approach to Charles de Gaulle Airport, the Dash 8 was about 120 ft above ground level (AGL) when airspeed decreased below VREF, the target landing speed. The commander told the copilot, "Speed appears to be a bit low." The copilot moved the power levers from flight idle to a position that caused a 1 percent increase in torque, to 8 percent; an appropriate setting was 15 percent torque.

As airspeed continued to decrease, the commander thought that he needed to increase power but did not move the power levers. "He also remembered a sense of 'why am I not reacting to this?' and being puzzled by this," the report said.

The commander thought that he needed to increase power but did not move the power levers.

Airspeed was 11 kt below VREF when the Dash 8 touched down, striking its tail on the runway. The bottom of the rear fuselage was damaged, but the pilots were able to taxi the aircraft to the stand, where the passengers disembarked normally.

"The commander stated that after his return to work, he did not feel unwell but was getting progressively more tired," the report said. "[He] felt he should have been advised to have a longer recuperation period."

After the accident, the CAA Aeromedical Section issued expanded guidelines to AMEs for assessing the fitness of professional pilots to return to work after hospitalization for an illness.

Horizontal Stabilizer Strikes Parachutist

Beech 99. Substantial damage. One fatality.

Two of the 12 parachutists aboard the airplane jumped before the pilot reduced airspeed and illuminated the green jump light during a skydiving flight near Bowling Green, Missouri, U.S., on June 21, 2008. "The first parachutist stated that as soon as he jumped, he realized that the airplane was going faster than normal, and he tucked into a ball, barely missing the horizontal stabilizer," the NTSB report said.

"Parachutists that remained in the airplane recalled that the second parachutist exited the airplane and arched into an 'X' before being struck by the airplane's horizontal stabilizer. He never opened his parachute."

The pilot aborted the flight, performed a controllability check while returning to the departure airport and landed the airplane without further incident.

Leaking Windows Cause Short Circuit

Shorts 360. Minor damage. No injuries.

While departing from Inverness, Scotland, for a cargo flight the night of Aug. 19, 2008, the commander noticed a large amount of water spilling into the area around the flap control lever. The aircraft was climbing through 6,000 ft when the pilots detected the odor of an electrical fire. "They attempted to don their oxygen masks but had some difficulty in using them because they were different from the masks on which they had received their training," said the AAIB report.

Nevertheless, the crew was able to return to Inverness and land the aircraft without further incident. "The operator has confirmed that the cause of the electrical smell was water entering past the window seals and causing an electrical short circuit behind the flap lever," the report said. "The leaking window seals have since been repaired."

The incident aircraft had a different oxygen system and masks than the other two Shorts 360s in the operator's fleet. "The company has now introduced additional training to ensure that all their crews are fully conversant with the differences between the aircraft in their fleet," the report said.

PISTON AIRPLANES

Cylinder Separation Causes Fire

Piper Aztec. Substantial damage. No injuries.

About 25 minutes after departing from Northeast Philadelphia Airport for a positioning flight to Newburgh, New York, U.S., the evening of Sept. 6, 2007, the pilot felt a slight vibration and noticed decreased fuel flow to the right engine. He turned back toward the departure airport.

A few moments later, the pilot noticed smoke trailing from the right engine cowling and shut down the engine. "He then observed a flame emanating from the right side of the engine, so he pitched the nose of the airplane down, increasing the airspeed and extinguishing the fire almost immediately," the report said. He landed the Aztec without further incident.

Examination of the right engine revealed that a cylinder had separated from the case because of fatigue failure of the attachment studs. The report said that appropriate procedures for attaching the cylinder had not been followed when the engine was overhauled 1,055 flight hours before the incident. Relatively thick paint, rather than the thin layer of primer specified by the overhaul manual, was found between the cylinder flange and hold-down plate. "The presence of this paint could have led to an in-service loss of preload [of the cylinder-fastening nuts], even if sufficient torque was applied to the cylinder nuts at the time of installation," the report said.

Training Exercise Turns Deadly

Piper Seminole. Destroyed. Three fatalities.

The Netherlands-based aviation school required student pilots training for a multiengine rating to practice an in-flight engine shutdown and restart with a procedures trainer, and later in an aircraft under the supervision of a flight instructor. The school prescribed a minimum altitude of 3,500 ft for the actual in-flight training.

Nevertheless, during a training flight from Eelde on Aug. 14, 2002, the left engine on one of the school's Seminoles was shut down at 2,000 ft. Soon thereafter, "the still functioning right engine also stopped, probably as a result of an unintentional, incorrect [action] by the crew, most likely the closure of the right engine fuel valve," said the report published recently by the Dutch Safety Board.

"Because not enough attention was paid to the primary task of [flying] the aircraft, speed dropped below stalling speed," the report said. "This led to a loss of control of the aircraft at an altitude at which recovery was no longer possible. Witnesses stated that the aircraft lost altitude, rotating around its vertical axis before hitting the water." The three occupants were killed.

Noting in the report that the training benefits of shutting down an engine in flight likely do not outweigh the risks, the board recommended that schools providing pilot training in light twins require that engine shutdowns/restarts be practiced only with procedures trainers.

Fuel Selector in Wrong Position for Takeoff

Piper Aerostar 601P. Destroyed. One fatality.

Weather conditions at Chautauqua County Airport in Jamestown, New York, U.S., the morning of Jan. 8, 2007, included surface winds from 260 degrees at 6 kt, gusting to 26 kt, 1/2 mi (800 m) visibility in snow and a 600-ft overcast ceiling. Shortly after the Aerostar took off from Runway 25, witnesses heard a "throbbing or surging" sound and then saw the airplane descend "straight down" into marshy terrain, the NTSB report said.

Investigators found the right-engine fuel selector in the "X-FEED" position. The airplane flight manual (AFM) for the 601P says that crossfeed should be used only in level, coordinated flight. The report indicated that the pilot used a homemade checklist for takeoff that did not include the AFM requirement to ensure that the fuel selectors are in the "ON" position for takeoff.

The report said that the probable cause of the accident was "the pilot's incorrect selection of the right engine fuel selector position, which resulted in fuel starvation of the right engine, a loss of the right engine's power and a loss of control during initial climb."

HELICOPTERS

Disorientation Suspected in Control Loss

Aerospatiale AS 355F2. Destroyed. Four fatalities.

The Twin Squirrel was on a flight from Liverpool, England, to a private landing site in Peterborough the night of May 1, 2007, when an area of shallow fog and low clouds was encountered. The pilot descended to 20 ft AGL and reduced airspeed to 60 kt. The AAIB report said that he likely attempted to complete the flight below the clouds, using an illuminated haulage yard and quarry for guidance.

"Either imminent contact with the ground or impending contact with trees ahead forced the pilot to climb, where it is possible that he became disoriented and lost control," the report said. The pilot and three passengers, including the owner of the helicopter, were killed when the helicopter descended in a left turn into a wooded area.

"No evidence was found during the examination of the wreckage of any pre-impact defect or failure which could have caused or contributed to the accident," the report said.

Bystander Struck by Rotor Blade

Robinson R22 Beta. Minor damage. One fatality.

Several visitors were at the helipad at Maryfield Station, Australia, when the pilot took off for a cattle-mustering flight the afternoon of July 24, 2007. "There was no plan for positive control of the people in the vicinity of the departing helicopter," the ATSB report said.

"The pilot reported that during the initial climb after takeoff and when 'nearly at tree height,' the helicopter was struck by a gust of wind that resulted in height loss and activation of the helicopter's 'low rpm' warning horn," the report said.

As the pilot recovered from the upset, a woman who was walking with her back to the helicopter was struck by the tip of a main rotor blade and later died from her injuries. "Following the rotor strike, the pilot turned the helicopter to the right into wind and landed," the report said.

Maintenance Error Leads to Drive Shaft Failure

Bell 206B-3. Substantial damage. No injuries.

The pilot was applying collective control to land at Lakeland, Florida, U.S., on Sept. 5, 2007, when the JetRanger yawed right and landed hard. The fuselage was damaged near a cross-tube attach point, but none of the four occupants was injured.

The NTSB report said that the no. 5 tail rotor drive shaft bearing had failed because of improper maintenance. It noted that the tail rotor blades had been replaced after a "sudden stoppage" of the tail rotor in 1999.

"The tail rotor drive shaft [and bearings] were not replaced at that time, as required by the maintenance manual, and remained installed until 2004, when they were inspected … and approved for return to service by the same facility that had scrapped the tail rotor blades in 1999," the report said.

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Dec. 3, 2008	Planeta Rica, Colombia	Aero Commander 500	destroyed	2 fatal
The airplane crashed in a field after a technical problem occurred during an air ambulance flight from Medellín to Montería.				
Dec. 3, 2008	Río Grande, Puerto Rico	Rockwell Commander 690B	destroyed	3 fatal
The pilot was conducting a visual approach to San Juan in instrument meteorological conditions when the Commander struck a mountain.				
Dec. 6, 2008	Fort Lauderdale, Florida, U.S.	Piper Seminole, Cessna 172	destroyed	4 fatal
Both airplanes were on instructional flights when they collided at 2,000 ft in a designated flight-training area.				
Dec. 7, 2008	Tlaxcala, Mexico	Learjet 23	destroyed	2 fatal
The pilots were conducting a second landing attempt at the unlighted airport when the Learjet descended into a lake on final approach at 1815 local time.				
Dec. 9, 2008	Millington, Tennessee, U.S.	Mitsubishi MU-2B	substantial	1 minor
The pilot turned back to the airport after the right engine lost power on takeoff. The MU-2 touched down about 1,800 ft (549 m) from the departure end of the 8,000-ft (2,438-m) runway and veered off the side.				
Dec. 11, 2008	Gulf of Mexico	Bell 206L-4	destroyed	5 fatal
The JetRanger struck the water shortly after taking off in visual meteorological conditions (VMC) from Sabine Pass, Texas, U.S., for a charter flight to an offshore platform.				
Dec. 14, 2008	Rocksprings, Texas, U.S.	Beech King Air C90B	destroyed	1 fatal
The King Air crashed under unknown circumstances in VMC during a flight from Hondo, Texas, to Phoenix.				
Dec. 15, 2008	Turks and Caicos Islands	Britten-Norman Trislander	destroyed	12 fatal
The Trislander is believed to have crashed at sea near Providenciales Island shortly after the pilot declared an emergency about an hour after departing from Santiago, Dominican Republic, for a charter flight to New York with an en route stop at Mayaguana, Bahamas.				
Dec. 17, 2008	Santa Clarita, California, U.S.	Kaman 1200	substantial	1 fatal, 1 none
The pilot said that after the engine was started, the helicopter was overturned by a gust. Debris from the rotor blades struck and killed a ground crewmember who was moving away from the helicopter after disengaging a portable ground power unit.				
Dec. 18, 2008	Buenos Aires, Argentina	Piper Cheyenne	destroyed	2 fatal
The pilots reported a technical problem shortly after takeoff and were attempting to return to San Fernando Airport when the Cheyenne crashed in a parking lot.				
Dec. 19, 2008	Espiritu Santo, Vanuatu	Britten-Norman Islander	destroyed	1 fatal, 9 serious
The pilot was killed when the Islander struck a mountain shortly after departing from Olpoi for a scheduled flight to Luganville. Thick fog was reported in the area.				
Dec. 20, 2008	Denver	Boeing 737-500	substantial	5 serious, 27 minor, 83 none
Surface winds were from 290 degrees at 24 kt, gusting to 32 kt, when the 737 veered off the left side of Runway 34R and crashed in a ravine during takeoff from Denver International Airport.				
Dec. 21, 2008	Riversdale, South Africa	Bell 206B	destroyed	1 minor
The helicopter crashed while being maneuvered to drop water on a wildfire.				
Dec. 26, 2008	Wellington, New Zealand	ATR 72-500	minor	69 none
The airplane was climbing through 500 ft when a cockpit indication prompted the flight crew to shut down the right engine. The crew turned back to the airport and landed without further incident.				
Dec. 27, 2008	near Honiara, Solomon Islands	Hughes 369	destroyed	1 fatal, 1 serious
The pilot reportedly did not remove the tail-rotor-pedal lock before departing from a fishing vessel. After liftoff, the helicopter spun into the Solomon Sea and sank. The pilot was killed.				
Dec. 30, 2008	Cairo, Egypt	Airbus A300	minor	227 none
The right engine failed during departure. The flight crew turned back to the airport and landed the A300 without further incident.				

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