AeroSafety WORLD

ROUGH ICE
Airfoil risks misjudged

FAMILIAR AIRPORT
Invalid SOPs wreck bizjet

STATE POLICE CRASH
HEMS pilot too low

REST IN PLACE
Cockpit napping debate

2009 ACCIDENT RATE PLATEAU

NEW DECADE'S GLOBAL CHALLENGES

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

DECEMBER 2009 – JANUARY 2010

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UNNECESSARY Slide

I've been in the newspapers a lot again. This time, the discussion revolved around the late December American Airlines Boeing 737-800 runway excursion at Kingston, Jamaica. As usual, I got to try to comprehensively explain a complex set of interacting factors in a 10-word quote, a four-second sound bite. No matter how hard I try, I never get it quite right. Let me see if I can do better with 500 words.

The preliminary report shows that the airplane landed 4,000 ft (1,220 m) down a wet runway with a substantial tailwind. The tendency is to shrug off that approach as a dumb mistake in the cockpit, but that would be a real disservice. First, let's consider the environment during the approach. There were lots of bumps and lots of rain. The flight crew was offered a chance to circle to Runway 30 for a better wind angle, but considering that it was dark and rainy with clouds around 1,000 ft above ground level, it is easy to understand why the crew passed on that option.

Logically they chose to land straight in, with a significant tail wind that was on the margins of acceptability. With about 8,900 ft (2,700 m) of runway that didn't seem to be a big deal. The runway was wet, but there was plenty of it.

Some tough questions should be asked. First of all, why were the crew's choices limited to a tough downwind landing or a risky circling maneuver? There was an area navigation (RNAV) approach to Runway 30. I am not sure that option was really considered by air traffic control (ATC) or the flight crew. An RNAV approach can be a pain in the flight deck and something out of the ordinary for ATC in the control room. Global positioning system (GPS) approaches with vertical guidance can have huge safety benefits, but only if we are prepared to use them. Have we spent years implementing something people don't actually intend to use?

Another interesting part of this accident is the airport. Much has been made of the fact that the runway wasn't grooved. Grooved pavement is common in the United States but it isn't required by International Civil Aviation Organization (ICAO) standards. It is worth noting that the runways were not grooved in the Air France accident in Toronto, or the TAM accident in São Paulo, Brazil. Maybe it is time for ICAO to tighten up compliance with that standard?

Something that worries me even more is the runway end safety area (RESA) in Kingston. It doesn't even come close to meeting ICAO standards. Many airports in the region have the same problem. This has been known and documented for years. It would be nice if somebody asked, why does this requirement seem to be so widely ignored? There also are proven arrestor pavement technologies that could have turned this accident into a non-event. Where were they?

Lots of things had to go wrong on that rainy night to have an outcome this bad. I hope the investigators ask, as a minimum: Why wasn't the RNAV approach considered a viable option? Is it time to admit that grooved pavement actually works? And when will airports start taking the requirements for RESAs seriously?

William R Voss

William R. Voss
President and CEO
Flight Safety Foundation

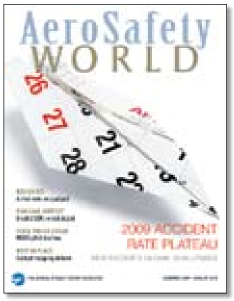
AeroSafetyWORLD

contents

December 2009–**January** 2010
Vol 4 Issue 12

features

departments



About the Cover
Reducing rates of major accidents requires daily commitment in the new decade.
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DEUS EX Machina

For the most part, we know how to be safe. Much of our current safety work involves promoting proven procedures and technologies to prevent the same kind of accident from happening over and over again. As Bill Voss points out in his column this month, the American Airlines 737 accident in Jamaica involved, among other factors, a runway that lacked an adequate runway end safety area. A few weeks later, on Jan. 19, the pilots of a US Airways Express Bombardier CRJ-200 with 31 passengers and a crew of three rejected a takeoff from the hilltop Yeager Airport at Charleston, West Virginia, U.S., and did not plunge off of the side of the mountain because the airport management had installed an engineered material arresting system (EMAS) at the runway's end.

This compare-and-contrast exercise is so obvious I'm almost embarrassed to do so, yet I feel obligated to point out once again the number of technologies that exist and are just waiting for use to either avoid incidents and accidents, or minimize damage and injuries when something bad does happen. The event at Charleston was prevented from becoming a very expensive, very fatal catastrophe by a few hundred feet of EMAS bed that will cost much less than $1 million to fix, an amount that the airline's insurance company is happily paying.

The title of this column is, of course, what it is about, for just as ancient Greek plays often end with a god being lowered to the stage by a mechanism – hence, the god from the machine – to resolve the drama, so, too, does aviation have access to salvation through the use of a variety of technologies. While much of our current work involves the human side of the equation and developing procedures to avoid known pitfalls, sometimes you really can just go out and buy enhanced safety. The most dramatic example of this is the use of terrain awareness and warning systems that can eliminate controlled flight into terrain, the class of accident that used to kill more people than any other.

Along the way, some have been reluctant to buy the latest devices, which, in part, is understandable when the technology is new and rapidly evolving. But some of these safety enhancements have been with us for years, decades even, and yet many still choose not to invest. One such technology that immediately springs to mind is the head-up guidance system (HGS).

Perhaps people have no money right now — who does? — or are waiting for the next generation aircraft, or the integration of HGS with enhanced vision and/or synthetic vision, with regulatory buy-in in the form of reduced minima to improve schedule regularity. Then there is the next generation air traffic control system transition on the horizon, also promising benefits in both safety and operational efficiency, and a flood of associated products leveraging the automatic dependent surveillance-broadcast technology. And even simple-sounding stuff, like the Airbus system that tells pilots where on the runway they are going to land and whether the space is sufficient, is becoming available and appears to offer great value.

There are a lot of products either here or arriving soon that can reduce the risk of an accident, and isn't that what we are all trying to do? Budget planning should reflect that intention.

J.A. Donoghue

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

Automation must not degrade decision making skills

I read “Topsy Turvy” and “Grappling with the Unexpected” (*ASW*, 11/09, p. 20 and p. 26, respectively) with great interest.

As one familiar with flight operations, I suggest possible new avenues to identify why things happen:

Incident/accident investigations start with the affected pilot’s ability to handle the unforeseen situation. Identifying a possible triggering point is next — changes from normal to abnormal conditions. These might vary through hidden gradual build-ups or external influence. They can result in the need for split-second decision making!

Regardless of modern well-equipped aircraft/warning systems, human brain capacity limits must always be taken into consideration. Automation must, for instance, include override systems, to enable the pilot-in-command to take corrective action. Such decision making requires human skill and experience.

On the other hand, flight simulator instruction has become an indispensable means of teaching procedures, but “upside down” aircraft positioning and feeling the actual g forces are impossible in a simulator.

In earlier days, many pilots were recruited from an air force milieu and fighter squadrons, well educated and used to handling aircraft in all axes.

Times have changed, however, and new pilot recruits have to be trained in civil aviation schools. “Unusual position recovery” training might therefore be one correct response; however, I believe this picture can be expanded a bit.

Among new generation pilots a change might be observed: from childhood, they have grown up with advanced computer games. This new kind of background has, perhaps, tended toward “autoflight complacency.”

Observations from active pilots reported back to me, as an advisor to the International Federation of Air Line Pilots’ Associations (IFALPA), hint of a complete new-pilot view that “autoflight” from the point of flap retraction after takeoff until full stop after landing, including autobraking, seems acceptable — worrying!

Flying as a profession ought to keep being a skilled art, since it includes obeying laws of nature. Actual flying by feel, such as visual, minimum circling approaches, etc. is good training.

Initial, progressive pilot education is essential, followed by continuous skill updating and training. An engine failure will not be adjusted by the autoflight mode. Situations outside autoflight control, perhaps slight discrepancies, might pass unobserved by the pilot.

IFALPA AIR (Airworthiness Study Group, now AGE/ADO) has always had a high priority of merging human brain capacity with high-stress piloting work.

“Pilot reaction time” has for decades been standard within FARs Part 25 aircraft certification. Everything has limits and that includes how much instant stress even a well-trained human brain can take, as well as the ability to make the correct “split-second decision.”

Further, AIR’s message to aircraft manufacturers was, “Do not fill up cockpits with all kinds of warnings.” For example, a howling horn, with simultaneous flashing lights for stall warning, which would be more nerve-wracking than useful, was not acceptable.

Acceptable was: “Bell ringing, red light = fire.” Likewise, “aural horn signal, red light = unsafe gear.” “Stick shaker = stall warning,” etc. For lesser priority warnings, various voice messages were OK.

Nowadays, with the introduction of all-remote-controlled aircraft, ever-increasing weight, etc., a new updated understanding of human brain capacity versus technological expansion ought to be considered.

Capt. (retired) Oddvard Johnsen

CALL FOR PAPERS ➤ 41st Annual Seminar of the International Society of Air Safety Investigators. Sapporo, Japan, Sept. 6–9. Bob Matthews, <bob.matthews@faa.gov>.

CALL FOR PRESENTATIONS AND PANELISTS ➤ Shared Vision of Aviation Safety Conference. U.S. Federal Aviation Administration. June 1–3. San Diego. Lucy Erdelac, <lerdelac@utrs.com>, <www.aqp-foqa.com/Conferences/2010/index.html>, +1 215.870.2331.

FEB. 2–7 ➤ Singapore Air Show. Singapore Airshow & Events. Singapore. <angelicalim@singaporeairshow.com.sg>, <www.singaporeairshow.com.sg/>, +65 6542 8660.

FEB. 12 ➤ Managing Human Error in the 21st Century. The Aviation Consulting Group. Myrtle Beach, South Carolina, U.S. <www.tacgworldwide.com>, 800.294.0872; +1 954.803.5807.

FEB. 17–18 ➤ 2nd South Pacific Aviation Safety Management Systems Symposium. Aviation Industry Association of New Zealand. Queenstown, New Zealand. Bob Feasey, <bob.feasey@aia.org.nz>, <www.aia.org.nz/Events/2nd+South+Pacific+Aviation+Safety+Management+Systems+Symposium.html>, +64 04.472.2707.

FEB. 17–19 ➤ Human Factors in Maintenance Workshop (Phases 1 and 2). Grey Owl Aviation Consultants. Houston. Richard Komarniski, <richard@greyowl.com>, <www.greyowl.com>, +1 204.848.7353.

FEB. 20 ➤ Safety Management Systems Maintenance Workshop. Grey Owl Aviation Consultants. Houston. Richard Komarniski, <richard@greyowl.com>, <www.greyowl.com>, +1 204.848.7353.

FEB. 20–23 ➤ Heli-Expo 2010. Helicopter Association International. Houston. <heliexpo@rotor.com>, <www.heliexpo.com>, +1 703.683.4746.

FEB. 24–25 ➤ Human Factors for Aviation Managers and Technicians Workshop (Phase 1). Grey Owl Aviation Consultants. Morristown, New Jersey, U.S. Richard Komarniski, <richard@greyowl.com>, <www.greyowl.com>, +1 204.848.7353.

FEB. 24–25 . ➤ 18th Annual Leadership Conference. National Business Aviation Association. San Diego. <www.nbaa.com/events/leadership/2010>, +1 202.783.9000.

MARCH 1–4 ➤ Next Generation of Aviation Professionals Symposium. International Civil Aviation Organization. Montreal. Nicole Barrette-Sabourin, <ngap@icao.int>, <www.icao.int/ngap>, +1 514.954.6728.

MARCH 2–3 ➤ Air Charter Safety Foundation Symposium. Air Charter Safety Foundation. Chantilly, Virginia, U.S. Alison McHugh, <amchugh@acsf.aero>, < <www.acsf.aero/en/cev/16>, 888.723.3135.

MARCH 3–7 ➤ 2nd International Exhibition and Conference on Civil Aviation: India Aviation 2010. Ministry of Civil Aviation, Government of India, and Federation of Indian Chambers of Commerce and Industry (FICCI). Hyderabad, India. FICCI, <indiaaviation@ficci.com>, +91 11 32910417.

MARCH 4–6 ➤ Annual Repair Symposium. Aeronautical Repair Station Association. Arlington, Virginia, U.S. <arsa@arsa.org>, <www.arsa.org/node/227>, +1 703.739.9543.

MARCH 8–11 ➤ Safety Management Course. ScandiAvia. Stockholm. Morten Kjellesvig, <morten@scandiavia.net>, <www.scandiavia.net>, +47 91 18 41 82.

MARCH 9–11 ➤ Managing Human Error in Complex Systems Workshop. Wiegmann, Shappell & Associates. Alexandria, Virginia, U.S. <www.hfacs.com>, 800 320.0833.

MARCH 9–11 ➤ ATC Global Exhibition and Conference. United Business Media. Amsterdam. <www.atcevents.com/ATC10/Website/HomePage.aspx?refer=1&id=mainLnk1>, +44 (0)20 7921 8545.

MARCH 10–11 ➤ Global ATM Operations Conference. Civil Air Navigation Services Organisation. Amsterdam. Anouk Achterhuis, <events@canso.org>, <www.canso.org/operationsconference>, + 31 (0)23 568 5390.

MARCH 15–16 ➤ First Middle East and GCC LOSA and TEM Conference. World Food Programme Aviation Safety Office. Abu Dhabi, United Arab Emirates. Samir Sajet, <samir.sajet@wfp.org>, +971 6 5574799.

MARCH 15–17 ➤ 22nd Annual European Aviation Safety Seminar. Flight Safety Foundation, European Regions Airline Association and Eurocontrol. Lisbon, Portugal. Ahlam Wahdan, <wahdan@flightsafety.org>, < http://www.flightsafety.org/aviation-safety-seminars/european-aviation-safety-seminar>, +1 703.739.6700, ext. 102.

MARCH 15–17 ➤ Human Factors — General Principles. Baines Simmons. London. Kevin Baines or Bob Simmons, <officemanager@bainessimmons.com>, <www.bainessimmons.com/directory-course.php?product_id=99>, +44 (0)1276 855412.

MARCH 15–19 ➤ Accident and Incident Investigation Course. ScandiAvia. Stockholm. Morten Kjellesvig, <morten@scandiavia.net>, <www.scandiavia.net>, +47 91 18 41 82.

MARCH 16–17 ➤ Safety Management Systems Overview Course and Workshop. ATC Vantage. Tampa, Florida, U.S. <registrations@atcvantage.com>, <www.atcvantage.com/sms-workshop-March.html>, +1 727.410.4759.

MARCH 16–18 ➤ Dangerous Goods Inspector Initial Training. U.K. Civil Aviation Authority International. London Gatwick. Sandra Rigby, <training@caainternational.com>, <www.caainternational.com/site/cms/coursefinder.asp?chapter=134>, +44 (0)1293 573389.

MARCH 17–19 ➤ Spring Conference: Leadership and Advocacy. Association of Air Medical Services. Washington, D.C. Natasha Ross, <nross@aams.org>, <www.aams.org/Content/NavigationMenu/ EducationMeetings/SpringConference/default.htm>, +1 703.836.8732, ext. 107.

MARCH 24–25 ➤ AQD Customer Conference. Superstructure Group AQD Safety and Risk Management. Hong Kong. Liz Swanston, <liz.swanston@superstructuregroup.com>, <www.superstructuregroup.com>, +64 4385 0001.

MARCH 29–APRIL 1 ➤ AMC — Improving Maintenance and Reducing Costs. ARINC. Phoenix. Sam Buckwalter, <sbuckwal@arinc.com>, <www.aviation-ia.com/amc>, +1 410.266.2008.

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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>.

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Safety News

New Support for Anti-Criminalization Pact

The joint resolution opposing the criminalization of aviation accidents, originally published in 2006, has gained new backing from the International Society of Air Safety Investigators (ISASI), which added its signature to the document in January.

"The current trend of criminalizing aviation accidents has a deleterious effect on the appropriate investigation of said occurrences, the finding of contributing factors and probable causation, and the formulation of recommendations to prevent recurrence," said ISASI President Frank Del Gandio.

The resolution originally was developed by Flight Safety Foundation, the Civil Air Navigation Services Organisation, the Royal Aeronautical Society and the Académie Nationale de l'Air et de l'Espace. Subsequently, it also was signed by the European Regions Airline Association, the Professional Aviation Maintenance Association and the International Federation of Air Traffic Controllers Associations.

"We welcome these latest safety professionals joining in our statement of principles, and urge judges, jurors and prosecutors, like those involved in the unfortunate Concorde criminal case soon going to trial in France, to pay close attention," said Flight Safety Foundation President and CEO William R. Voss. "We cannot afford to let the desire by some for vengeance or publicity to come at the expense of safety for all. We need to learn from accidents to prevent them, not criminally punish well-meaning professionals and thereby risk a repeat of a tragedy."

The Concorde trial, scheduled for February, stems from the July 25, 2000, crash of an Air France Concorde during takeoff from Paris Charles de Gaulle Airport. The French Bureau d'Enquêtes et d'Analyses said the probable cause of the crash involved the passage of one of the Concorde's tires over a titanium strip that had fallen off a Continental Airlines McDonnell Douglas DC-10 that had taken off earlier from the same runway. As the tire broke apart, one piece struck one of the Concorde's fuel tanks, the fuel ignited, and the burning airplane struck the ground. All 109 people in the airplane were killed, along with four on the ground. The airplane was destroyed.

French prosecutors plan to try Continental and two of its maintenance employees on involuntary manslaughter charges, as well as former officials of the French airline regulator and the Concorde division at Aerospatiale, which built the airplane.

Wikimedia

Aviation Policy Statement

The Australian government has issued a new national aviation policy statement, outlining more than 130 policy initiatives and pledging that safety and security will remain the no. 1 priority.

The policy calls for modernizing air traffic management with increased use of satellite technology and providing additional funding to the Civil Aviation Safety Authority (CASA) for safety surveillance and oversight. The additional funds allocated for the current fiscal year will be used to hire specialized technical staff in such areas as surveillance of helicopter operations and foreign operators that fly into Australia, and increased oversight of low-cost operations and offshore maintenance, CASA said.

The policy statement also identified seven emerging safety issues, including monitoring the effectiveness of safety management systems, aging aircraft, regulation of dangerous goods, shortages of pilots and maintenance personnel, and the regulation of unmanned aircraft systems.

In implementing the new policies, the government will "ensure Australia's safety regulatory and investigatory agencies remain world-leading and have the skills and capabilities to maintain safety and facilitate the industry's growth; regulation of safety will take account of best international practice … ; [and] Australian safety agencies will explore opportunities to adopt technologies that improve safety and work with industry to implement them."

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Incident Reporting

The General Civil Aviation Authority (GCAA) of the United Arab Emirates has begun an incident reporting program as part of an effort to centralize the reporting of aviation accidents and incidents throughout the federation.

"We recognize the need to constantly improve processes and systems for managing risks effectively," said Ismaeil Mohammed Al Balooshi, GCAA director of aviation safety. "Centralized reporting will ensure effective communication and coordination necessary for higher records of successful incident management."

The GCAA said that introduction of the centralized reporting system is a "milestone achievement in raising air safety standards" in the region, where growth is forecast in the aviation industry.

Advent of ADS-B

Air traffic controllers have begun using automatic dependent surveillance–broadcast (ADS-B) to manage air traffic over the Gulf of Mexico — an area without radar coverage.

U.S. Federal Aviation Administrator Randy Babbitt described the advent of ADS-B as "a significant early step toward NextGen" — the satellite-based transformation of the National Airspace System, including airports, known officially as the Next Generation Air Transportation System. He said ADS-B is "not only more accurate than radar but comes with significant safety and efficiency benefits."

In addition to providing for tracking aircraft by their satellite-based position reports, ADS-B will provide for more efficient routing of aircraft, and provide pilots with more accurate weather information and other benefits.

U.S. Federal Aviation Administration

Black Box Recommendations

The French Bureau d'Enquêtes et d'Analyses (BEA), citing its continuing investigation of the June 1, 2009, accident in which an Air France Airbus A330 plunged into the Atlantic Ocean during a flight from Rio de Janeiro to Paris, is recommending steps to aid in the post-accident recovery of aircraft flight recorders.

The crash killed all 228 people in the A330, which has not been located. Searchers also have been unable to find the airplane's flight data recorder and cockpit voice recorder, both of which were equipped with regulation underwater locator beacons (ULBs), which stopped transmitting a little more than 30 days after activation.

U.S. National Transportation Safety Board

"The investigation … confirms the importance of data from the flight recorders in order to establish the circumstances and causes of an accident and to propose safety measures that are substantiated by the facts," the BEA said in its second interim report on the crash. "It also brings to light the difficulties that can be encountered in [locating], recovering and reading out the recorders after an accident in the sea."

In the accident's aftermath, the BEA formed an international working group to review techniques that might be used to safeguard flight data "and/or to facilitate localization of the wreckage and recovery of the flight recorders."

Citing the working group's findings, the BEA recommended that the European Aviation Safety Agency (EASA) and the International Civil Aviation Organization (ICAO) extend to 90 days the current 30-day transmission requirement for data recorder ULBs installed in airplanes conducting overwater public transport flights.

The BEA's additional recommendations included a call for EASA and ICAO to study requiring airplanes involved in public transport flights to regularly transmit position, altitude and other basic flight parameters. Another recommendation asked that an ICAO panel establish proposals on "conditions for implementing deployable recorders" on public transport flights.

Threats, Errors and Safety

Adverse weather is the most common specific threat to aviation safety reported by Australian pilots engaged in low capacity air transport operations — those involving no more than 38 passenger seats and maximum payloads smaller than 4,200 kg (9,259 lb), according to a report by the Australian Transport Safety Bureau (ATSB).

The report was based on responses from 167 participants in a threat and error management course; of that number, 55 pilots worked in air transport operations and 112 were involved in flight training and other types of aerial work. All 167 pilots were asked to identify "the five most common threats to operations and errors made by pilots in their industry in the preceding 12 months."

In both flight categories, departure/arrival threats were the most common, but the most common specific threat was bad weather, including turbulence, fog, crosswinds and high temperatures, the report said.

"Communication issues" involving air traffic control (ATC) or the pilots of other aircraft also was among the top five threats identified by pilots in both groups. The report said, "Examples included pilot language difficulties, ATC command (e.g., difficult clearance, late changes) and ATC instructions."

Cushioning the Fall

Researchers at the U.S. National Aeronautics and Space Administration (NASA) are looking for ways to reduce the destructive forces of aviation crashes. Recent efforts have focused on determining whether a "deployable energy absorber" — an expandable honeycomb cushion attached to the belly of a helicopter — can ward off damage to a helicopter in a crash.

In a recent experiment, they dropped an MD-500 — donated by the U.S. Army — from a height of 35 ft (11 m) to determine whether the destruction was lessened by the honeycomb cushion beneath the fuselage. Before researchers can reach a conclusion, they must analyze data gathered by instruments that had been installed in the helicopter for the event.

"I'd like to think the research we're doing is going to end up in airframes and will potentially save lives," said Karen Jackson, an aerospace engineer who oversaw the test at the NASA Langley Research Center in Hampton, Virginia, U.S.

The honeycomb cushion, developed by Sotiris Kellas, a Langley engineer, is made of Kevlar and includes a flexible hinge that enables the cushion to be packaged and lie flat until it is needed.

U.S. National Aeronautics and Space Administration

NASA said the drop test "imitated what would be a relatively severe helicopter crash," with a flight path angle of about 33 degrees and combined forward and vertical speeds of about 48 ft (15 m) per second, or 30 mph (48 kph).

The MD-500 survived the crash "relatively intact," NASA said. In a future experiment, the helicopter will be dropped again, without the deployable energy absorber.

© Yeager Airport

Emergency vehicles surround a US Airways Express CRJ200 that stopped in the engineered material arresting system (EMAS) area of a runway at Yeager Airport in Charleston, West Virginia, U.S., following a rejected takeoff. No one in the airplane was injured. The U.S. Federal Aviation Administration said the Jan. 19 incident was the fifth incident in the United States in which EMAS stopped an airplane after a runway overrun.

The Association of Air Medical Services and the International Society of Aeromedical Services (Australasia) have agreed to collaborate on initiatives to enhance **air medical transport** throughout the world. … Earl F. Weener, a Foundation Fellow of Flight Safety Foundation and a former chief engineer with The Boeing Co., has been nominated by President Barack Obama as a member of the **U.S. National Transportation Safety Board**. Weener was the co-leader of the FSF Runway Safety Initiative and the FSF Ground Accident Prevention Program and the initial leader of the FSF Controlled Flight Into Terrain and Approach and Landing Accident Reduction task forces. … **Eurocontrol** says it is moving to enhance civil-military cooperation in European air traffic management by establishing a new military liaison function within the Eurocontrol Central Flow Management Unit.

Compiled and edited by Linda Werfelman.

Disappointing LEVEL-OFF

The decade just ended averaged 0.57 major accidents per million departures of Western-built commercial jets.

BY JAMES M. BURIN

"Average" is the best that can be said about the 2009 overall safety performance of the largest segments of professional civil aviation, the operation of commercial and corporate jets, and commercial turboprop airplanes. The year started poorly for operators of commercial jets, and by mid-year, it looked like their rate of major accidents might regress to the level seen 10 to 15 years ago (see "Accident Classification," p. 17).

However, the second half of the year was much safer than the first half, as measured by number of accidents; the rate for the entire year was 0.52 major accidents per million departures of Western-built commercial jets. This was about the average of the previous five years and below average for the decade just ended. The total fatalities for major accidents in all three industry segments was 745 in 2009, up from 688 in 2008 and 763 in 2007, but lower than 903 in 2006.

The corporate jet fleet, which normally averages about 10 major accidents a year, had a significantly better year with six major accidents and 12 fatalities, compared with higher numbers

A Boeing 737 was destroyed in a loss of control accident during approach to Amsterdam Airport Schiphol.

© Bas Czerwinski/Associated Press

in the rest of the decade. The commercial turboprop fleet's year was a bit better than average, as measured by the number of major accidents, but controlled flight into terrain (CFIT) accidents remained prominent in this segment's accident and fatality numbers.

Last year, the commercial jet fleet grew approximately 1 percent from its 2008 size. By year's end, there were more than 21,000 commercial jets in the world, 7 percent Eastern-built. The commercial turboprop fleet decreased approximately 3 percent from 2008 with more than 6,000 commercial turboprops registered, one quarter of which were Eastern-built.

The corporate jet fleet grew approximately 6 percent to almost 16,000 aircraft. However, the active fleets, the aircraft actually in service, are smaller than the total fleets. About 10 percent of the total commercial jet fleet was inactive, a growing percentage. About 13 percent of the total turboprop fleet was inactive. For the first time, there were inactive corporate jets, approximately 3 percent of the total fleet.

Major accidents involving commercial jets totaled 17, killing 609 people, in the data for major accidents in all scheduled and unscheduled passenger and cargo operations for Western-built and Eastern-built types (Table 1), and 14 involved Western-built aircraft.

Nine of the 17 were approach and landing accidents,


© Associated Press

A Boeing 737 overran the runway landing at Kingston, Jamaica.

Major Accidents, Worldwide Commercial Jets
January 1, 2009–December 31, 2009

Date	Operator	Aircraft	Location	Phase	Fatalities	
Jan. 15, 2009	US Airways	A320	New York, USA	Climb	0	
Feb. 25, 2009	Turkish Airlines	737	Amsterdam, Netherlands	Approach	9	🔴 🟡
March 9, 2009	Aerolift	IL-76	Entebbe, Uganda	Climb	11	🟠
March 9, 2009	Lion Air	737	Jakarta, Indonesia	Landing	0	⚪ 🟡
March 23, 2009	FedEx Express	MD-11	Tokyo, Japan	Landing	2	⚪ 🟡
April 9, 2009	Aviastar Mandiri	BAE-146	Wamena, Indonesia	Approach	6	🔵 🟡
April 29, 2009	Bako Air	737	Massamba, DRC	En route	7	
May 31, 2009	Air France	A330	Atlantic Ocean	En route	228	🟠
June 6, 2009	Myanma Airways	F-28	Sittwe, Myanmar	Landing	0	⚪ 🟡
June 30, 2009	Yemenia	A310	Comoros	Approach	152	🔴 🟡
July 15, 2009	Caspian Airlines	TU-154	Qazvin, Iran	Climb	168	🟠
July 24, 2009	Aria Air	IL-62	Mashhad, Iran	Landing	16	⚪ 🟡
Oct. 21, 2009	Azza Transport	707	Sharjah, UAE	Takeoff	6	
Nov. 12, 2009	RwandAir	CRJ-100	Kigali, Rwanda	Taxi	1	
Nov. 19, 2009	Compagnie Africaine d'Aviation	MD-82	Goma, DRC	Landing	0	⚪ 🟡
Nov. 28, 2009	Avient Aviation	MD-11	Shanghai, China	Takeoff	3	
Dec. 22, 2009	American Airlines	737	Kingston, Jamaica	Landing	0	⚪ 🟡

🔴 Loss of control accident
🟠 Possible loss of control accident
🔵 CFIT accident
🟡 Approach and landing accident
⚪ Runway excursion

Source: Ascend, Aviation Safety Network

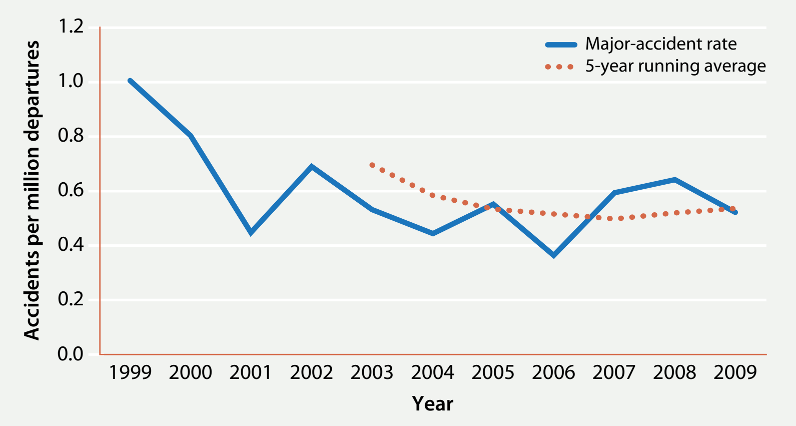
Table 1

and one was a CFIT accident. There were only two confirmed loss of control (LOC) accidents, although three others could receive this classification, pending final accident reports. Six of the 17 commercial jet major accidents were runway excursions.

The major-accident rates for commercial jets since 2000 and the five-year running average both have virtually leveled off (Figure 1). The accident rate is only for Western-built aircraft because even though the number of major accidents for Eastern-built aircraft is known, the industry does not have reliable worldwide exposure data to calculate the rate of accidents.

Even though 2008 and 2009 have been roughly average years for commercial jet major accidents, the accident rate for the decade, as noted above, was impressive, although there was both good news and bad news. The good news is that in the decade ending in 2009, the commercial aviation industry basically halved the rate from the previous decade — an outstanding accomplishment. The bad news is that most of the improvement was in the first half of the decade, the second half of the decade failing to continue the decade's early trend.

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



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

Source: Ascend

Figure 1

There were six major accidents involving corporate jet aircraft in 2009 (Table 2), killing 12 people, the lowest number of corporate jet major accidents since 2000 (Figure 2). The numbers highlight the fact that operators of corporate jets had an outstandingly safe year. Although reliable worldwide exposure data are not available for corporate jets, the number of aircraft and the number of departures increased steadily throughout the decade, so the corresponding accident rates with confidence can be assumed to be decreasing.

Major Accidents, Worldwide Corporate Jets
January 1, 2009–December 31, 2009

Date	Operator	Aircraft	Location	Phase	Fatalities	
Jan. 3, 2009	Aero Jet Services	Lear 45	Telluride, Colorado, U.S.	Landing	0	🔵
Feb. 7, 2009	Air One Executive	Citation III	Trigoria, Italy	Climb	2	🔴
Feb. 12, 2009	Laret Aviation	Falcon 100	St. Moritz, Switzerland	Landing	2	⚪
Oct. 26, 2009	S-Air	Hawker 125	Minsk, Belarus	Approach	6	🔵
Nov. 19, 2009	Pel-Air	IAI Westwind	Norfolk Island, Australia	Approach	0	
Dec. 17, 2009	FL Aviation Group	Falcon 20	Great Inagua Island, Bahamas	En route	2	

🔴 Loss of control accident 🔵 CFIT accident ⚪ Runway excursion

Source: Ascend, Aviation Safety Network

Table 2

The 2009 data include 21 major accidents involving Western- and Eastern-built commercial turboprop aircraft with more than 14 seats (Table 3, p. 16). These accidents caused 124 deaths, compared with 29 accidents and 292 deaths in 2008, the lowest number of the decade and less than the decade's annual average of approximately 28 major accidents.

The most significant safety challenge for commercial turboprops remains the prevention of CFIT accidents. Although progress has been made in reducing the risk of CFIT for commercial jets, as illustrated by the fact that one CFIT accident occurred in 2009, it is not the same positive story for turboprops. In 2008, seven of the 29 turboprop major accidents were CFIT, almost one of every four. In 2009, seven of the 21 turboprop major accidents were CFIT, one in every three.

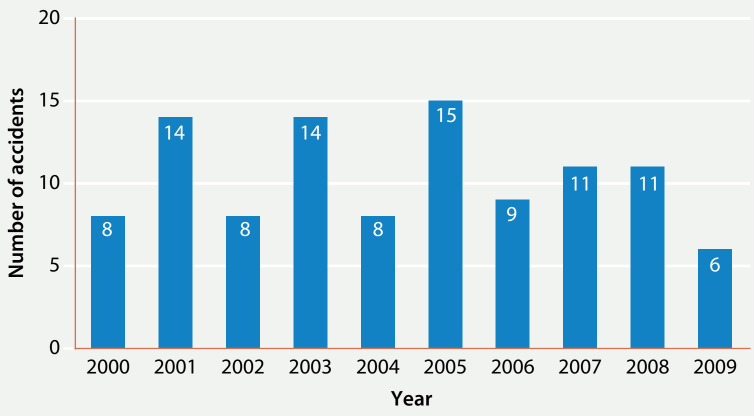
As has been the case for the past 20 years, CFIT, approach and landing, and loss of control classifications continued to represent the majority of accidents and to cause the majority of fatalities in all three industry segments. Trends in the number of CFIT accidents involving commercial jet aircraft since 1997 show the slow, but positive, progress the industry has made in reducing this risk.

In the most recent five-year period, more than 90 percent of the aircraft in the commercial jet fleet had terrain awareness and warning system (TAWS) equipment installed. The commercial jet segment in this period experienced 11 CFIT accidents; none involved an airplane with a functional TAWS.

In contrast, as noted, a substantial proportion of turboprop major accidents continued to be CFIT accidents, and none of those aircraft had a TAWS installed, according to preliminary information. This calls into question why some countries have yet to implement the International Civil Aviation Organization (ICAO) standard for states to require operators to install TAWS in turbine-engine airplanes with maximum certificated takeoff weight greater than 5,700 kg /12,500 lb or authorized to carry more than nine passengers.

By 2008, LOC accidents had surpassed CFIT as the leading killer among commercial jet accidents. In 2009, there were only two confirmed LOC accidents, although three others — an

Major Accidents, Business Jets, 2000–2009



Source: Ascend

Figure 2

A Bombardier Q400 crashed during approach to Buffalo, New York, U.S.

© Dave Sherman/Associated Press

Ilyushin Il-76 accident at Entebbe, Uganda; an Airbus A330 accident over the Atlantic Ocean; and a Tupolev Tu-154 accident in Iran — may be classifiable as LOC accidents. The aviation community awaits the final accident reports to confirm the accident class.

Eleven years ago, Flight Safety Foundation released, in a special issue of *Flight Safety Digest*, the report "Killers in Aviation," which focused on solutions to the global challenge of approach and landing accidents, including those involving CFIT.

It has been eight years since the Foundation released its original safety product for approach and landing accident reduction (ALAR) — the *ALAR Tool Kit*. More than 40,000 copies of the *ALAR Tool Kit* have been distributed as of January 2010, and since 2000, the Foundation's CFIT and Approach and Landing Action Group (CAAG) has conducted 32 ALAR workshops around the world.

The Foundation is completing an update of the original *ALAR Tool Kit*, which had been based on an international task force study of fatal approach and landing accidents from 1985 to 1996. The upcoming new *ALAR Tool Kit*, a more comprehensive product compared with the original, provides data from 1995 through 2007 and looks at *all* approach and landing accidents, not just fatal accidents.

The new data show improvement in areas such as installation of safety equipment and reduction of nonprecision approaches. The data also show that the major causal factors in approach and landing accidents identified in the original ALAR study are still present (e.g., omission of action, poor professional judgment/airmanship and inadequate crew resource management [CRM]). The best news from the latest

Major Accidents, Worldwide Commercial Turboprops
January 1, 2009–December 31, 2009

Date	Operator	Aircraft	Location	Phase	Fatalities	
Jan. 11, 2009	Zest Airways	MA60	Caticlan, Philippines	Landing	0	
Jan. 27, 2009	FedEx Express	ATR-42	Lubbock, Texas, U.S.	Landing	0	
Feb. 7, 2009	Manaus Aerotáxi	EMB-110	Santo Antônio, Brazil	Landing	24	
Feb. 12, 2009	Colgan Air	Q400	Buffalo, New York, U.S.	Approach	49	🔴
Feb. 20, 2009	Aerolift	AN-12	Luxor, Egypt	Takeoff	5	🔵
April 1, 2009	Aberdair	EMB-110	Locbokh, Ethiopia	Takeoff	0	
May 26, 2009	Service Air	AN-26	Isiro-Matari, DRC	Approach	3	🔵
June 2, 2009	Maldivian Air Taxi	DHC-6	Halavelhi, Maldives	Landing	0	🔵
June 26, 2009	TAC Transporte Aéreo de Colombia	LET-410	Capurganá, Colombia	Landing	0	⚪
June 29, 2009	Aviastar Mandiri	DHC-6	Wamena, Indonesia	En route	3	🔵
July 6, 2009	El Magal Aviation	AN-28	Saraf Omra, Sudan	Landing	0	
Aug. 2, 2009	Merpati Nusantara Airlines	DHC-6	Oksibil, Indonesia	En route	15	🔴
Aug. 4, 2009	Bangkok Airways	ATR-72	Koh Samui, Thailand	Landing	1	⚪
Aug. 11, 2009	Airlines PNG	DHC-6	Kokoda, Papua New Guinea	Approach	13	🔵
Aug. 14, 2009	Skydive Portugal	Beech 99	Évora, Portugal	Landing	2	
Aug. 26, 2009	Aero Fret Business	AN-12	Brazzaville, DRC	Approach	6	🔵
Sept. 24, 2009	SA Airlink	Jetstream 41	Durban, South Africa	Takeoff	1	
Oct. 15, 2009	Blue Wing Airlines	AN-28	Kwamalasamutu Airfield, Suriname	Landing	0	⚪
Nov. 9, 2009	Blue Bird Aviation	Beech 1900	Nairobi, Kenya	Approach	2	🔵
Nov. 10, 2009	Kingfisher Airlines	ATR-72	Mumbai, India	Landing	0	⚪
Nov. 19, 2009	Win Win Services	DHC-8	Tarakigne, Mali	Landing	0	

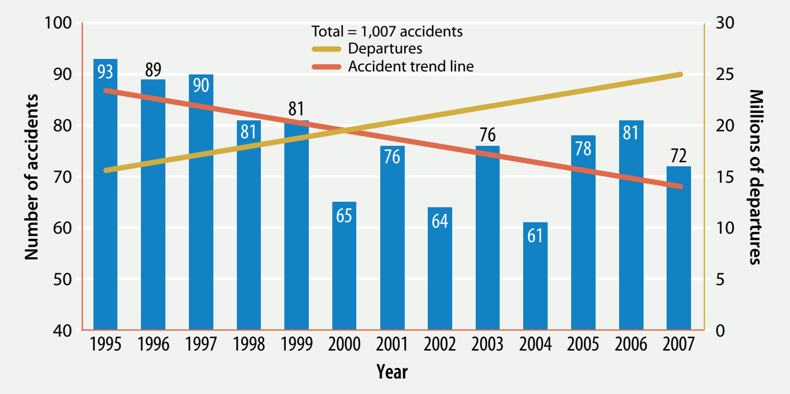
🔴 Loss of control accident 🔵 CFIT accident ⚪ Runway excursion

Note: Data comprise turboprop airplanes with more than 14 seats.

Source: Ascend, Aviation Safety Network

Table 3

Approach and Landing Accidents, 1995–2007



Source: Ascend

Figure 3

ALAR study is that the Foundation's efforts have achieved some success.

In a graphical presentation of approach and landing accidents (Figure 3) from 1995 through 2007, the red line is the best fit for the trend, and it shows that the annual number of these accidents has been decreasing. The yellow line shows the increasing trend for the number of departures over the same period. So, not only did the aviation community reduce the number of approach and landing accidents — which is good — but it also accomplished this while the number of flights steadily increased. The 2009 data analysis for the FSF ALAR program update also shows that both the approach and landing accident rate and the fatal approach and landing accident rate have decreased since the Foundation launched the initiative.

In 2009, the Foundation also released the report of its Runway Safety Initiative, titled "Reducing the Risk of Runway Excursions." Runway excursions are the most common type of accident for commercial aircraft, accounting for almost one of every three major accidents. The report details the conclusions and recommendations of more than two years of work by a Foundation-led, international multidisciplinary team that addressed the challenge of runway excursions.

A recent product published jointly by the Foundation and the International Air Transport Association (IATA) — the *Runway Excursion Risk Reduction Tool Kit* — contains the runway safety report and related information. The runway excursion report also is being incorporated, along with references to the updated ALAR report, in the updated *ALAR Tool Kit*.

It is unfortunate, but true, that a significant gap persists between creating safety interventions to reduce risk and actually implementing these interventions. The U.S. Commercial Aviation Safety Team (CAST), the Foundation, IATA and ICAO, as well as other concerned organizations and individual safety professionals, have generated effective interventions for the civil aviation community that will prevent at least 90 percent of the accidents that occur each year. However, those interventions do no good unless they are implemented.

The Foundation's goal is to make aviation safer by reducing the risk of an accident. The global aviation community has achieved great successes while advancing toward that goal, but as can be seen from last year's safety record, there are still many risks yet to be mitigated. Moreover, in an industry in which risk will never be zero, we all face in 2010 and beyond a constant challenge of meeting the public's expectation of perfection as the minimum acceptable standard.

James M. Burin is FSF director of technical programs.

Accident Classification

Since 2007, Flight Safety Foundation has used "major accident" as its primary accident criterion in place of "hull loss." 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

Something Changed

BY MARK LACAGNINA

The short runway was familiar, but the big new bizjet was not.

The pilots had flown into Fox Harbour Aerodrome in Nova Scotia many times. The runway is short, and the customary procedure was to drop below the visual glide path indication on short final approach to maximize the available roll-out distance after touchdown.

In the afternoon of Nov. 11, 2007, the pilots employed this familiar procedure in an unfamiliar aircraft, a Bombardier Global 5000 that had been acquired by their company only three weeks earlier. Accustomed to flying smaller jets, they had not adjusted fully to the new aircraft,

Transportation Safety Board of Canada

This airplane veered off the runway and came to a stop near a housing complex.

© Martin Eadie/Airliners.net

according to the Transportation Safety Board of Canada (TSB).

The glide path was too shallow for the bigger aircraft, and the captain held an inordinate right-wing-low crosswind correction on short final approach. The aircraft began to sink, and the captain corrected by increasing angle-of-attack. He left the throttles at idle, however.

The aircraft continued to sink, and the right main landing gear collapsed when it struck the edge of the runway threshold. After traveling a short distance with the right wing dragging on the runway, the aircraft veered off the pavement, struck mounds of dirt and came to a stop near a housing complex.

The aircraft was substantially damaged, but there was no fire. The first officer and a passenger were seriously injured; the captain and the other seven passengers sustained minor injuries.

In its final report on the accident, the TSB goes beyond accounting the contributing factors and explores other issues revealed by the investigation, such as a general lack of knowledge about the safety margins provided by visual glide path indicators and how these margins are affected by the sheer size of an aircraft.

The report also presents the board's concerns about maintaining adequate oversight of Canadian business aircraft operators as they transition from the traditional regulatory scheme to the modern concept of the safety management system (see "Red Flags on SMS," p. 22).

Stepping Up

Although the Global 5000 was new to them, the pilots had extensive experience in a variety of business aircraft. The captain had 9,188 flight hours, including 3,196 hours in jets. He had flown into Fox Harbour 75 times in the company's Challenger 604 and Gulfstream G100.

The captain and the first officer had completed Global 5000 ground and simulator instruction at the manufacturer's training center. The captain also had flown the aircraft for 43 hours accompanied by a Bombardier pilot.

After the transition training and familiarization flights, the captain had logged about 20 more hours in the aircraft. He had conducted two approaches to Fox Harbour in the Global 5000 — one with the Bombardier pilot on Oct. 21 and one with the first officer four days before the accident.

The first officer had 6,426 flight hours, including 2,540 hours as captain of the company's 604 and G100. After transition training for the Global 5000, he had flown the Challenger exclusively for more than three months. He had flown three segments in the new aircraft during the five days preceding the accident.

"Had the crewmembers operated more flights and been exposed to more landings, they would have had the opportunity to become more familiar with the aircraft size, its handling characteristics and performance," the report said.

New Plane, Old SOPs

The company, Jetport, had an operations reference manual (ORM) for the Global 5000 but did not use it to develop standard operating procedures (SOPs) for the new aircraft.

Instead, the company adapted its Challenger 604 SOPs to the new aircraft. "The Jetport Global 5000 SOPs contained a lot of good information," the report said. "They also contained some procedures applicable to the CL604 which were not suitable for the Global 5000."

For example, the SOPs required pilots to use visual glide slope indicator (VGSI) guidance on approach and to plan to touch down about 1,000 ft (305 m) from the runway threshold. A note advised that descending below the VGSI glide path "is not a recommended technique and is not normally an accepted practice."

Nevertheless, the SOPs included this exception: "When operating on short runways or when braking action is reduced by contamination on the runway, landing as early as conditions permit is generally considered to be good airmanship."

Short and Damp

The pilots, who were conducting a corporate flight from Jetport's home base in Hamilton, Ontario, did indeed plan to "land early" at Fox Harbour. The runway, 15/33, was 4,885 ft (1,489 m) long and 75 ft (23 m) wide, and it was damp.

"Using performance charts, the captain had estimated that, for the conditions, 4,300 ft [1,310 m] of runway was required for landing," the report said.

The airport did not have weather-reporting services. "Aside from the wind sock located near the threshold of Runway 33, there is no equipment available to give accurate wind speed and direction information," the report said.

The nearest station, 28 nm (52 km) northeast, was reporting winds from 360 degrees at 21 kt, gusting to 33 kt; 7 mi (11 km) visibility with light rain; and a 900-ft overcast.

As they neared Fox Harbour, the pilots decided that their reference landing speed (V_{REF}) would be 113 kt, with 5 kt added for gusts during the approach.

They conducted the global positioning system approach to Runway 33. The captain disengaged the autopilot about 1.4 nm (2.6 km) from the runway and used right aileron and left rudder for crosswind correction. The crosswind component was 18 kt at this point but decreased as the aircraft descended.

Wrong Technique

The captain's use of the wing-low, or sideslip, technique for crosswind correction was contrary to the ORM's recommendation of a wings-level, crabbed approach.

"This [recommended] technique requires that, on approach, the pilot apply a drift correction to track the runway centerline and, as the flare is commenced, gentle application of rudder is used to align the fuselage parallel with the runway centerline," the report said.

The crab technique is preferred because the Global 5000 has an automatic roll-assist feature that deploys the multifunction spoilers on the wing that is being held low.

The sideslip and the extra drag created by the spoilers "resulted in a decrease in lift, which made the aircraft more difficult to control, increasing [the captain's] workload, which was already high due to the combination of gusty winds and a low approach angle," the report said.

From about 0.5 nm (0.9 km) out, the aircraft intentionally was flown below the on-path indication provided by the runway's abbreviated precision approach path indicator (APAPI). The captain began the flare about 50 ft above the ground. Although the crosswind component had dwindled to 8 kt, he was still using "considerable aileron and rudder input," the report said.

The autothrottles reduced power to idle, and airspeed decreased to 102 kt — 11 kt below V_{REF}. The captain felt the aircraft sinking and rapidly increased the pitch attitude to 10.6 degrees.

Bombardier Global 5000


© Bombardier

The Global 5000 was introduced in 2004 as a slightly smaller version of the Global Express, which predated it by six years. The fuselage is 6 ft (2 m) shorter, and fuel capacity and operating weights are lower, allowing better takeoff and landing performance, and operation on shorter runways.[1]

Compared with the Global Express, the Global 5000 has a balanced field length of 5,000 ft (1,524 m), more than 800 ft (244 m) shorter. Its maximum range, however, is 4,800 nm, nearly 1,200 nm less than the larger aircraft.

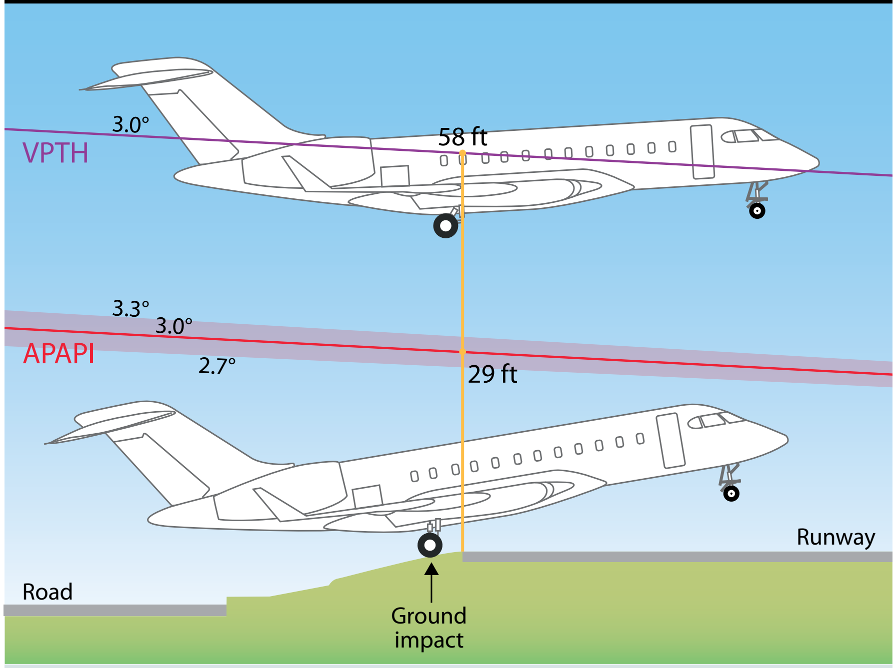
Both airplanes have accommodations for up to 19 passengers and are powered by Rolls-Royce Deutschland BR710A2-20 engines rated at 65.6 kN (14,751 lb thrust). The Global 5000 has a maximum takeoff weight of 87,700 lb (39,781 kg) and a maximum landing weight of 78,600 lb (35,653 kg). Maximum cruising speed is 0.89 Mach; normal cruising speed is 0.85 Mach. Maximum altitude is 51,000 ft.

Note

1. Operating weights were increased in 2008, two years after the accident aircraft was manufactured.

Source: *Jane's All the World's Aircraft*

Short Touchdown vs. Glide Path Guidance



VPTH = vertical flight path generated by the flight management system
APAPI = abbreviated precision approach path indicator

Source: Transportation Safety Board of Canada

Figure 1

The aircraft touched down 7.5 ft (2.3 m) from — and 18 in (46 cm) below — the runway. The right main gear collapsed, and "the aircraft continued down the runway with the right wing dragging," the report said. It veered off the runway about 640 ft (195 m) from the threshold and traveled about 360 ft (110 m) before coming to a stop about 200 ft (61 m) from a condominium.

Eye-to-Wheel Height

The report said that interviews during the investigation with several pilots holding airline transport pilot licenses revealed a general lack of knowledge about *eye-to-wheel height* (EWH) and how it applies to different types of VGSIs.

EWH is "the vertical distance from a pilot's eyes to the lowest portion of the aircraft in the landing attitude," the report said. "This distance varies from less than 4 ft to 45 ft [1.2 to 13.7 m] for some wide-body aircraft, such as the Boeing 747."

Nav Canada's *Canada Air Pilot* shows that EWH is the differentiation among four types of PAPI installations. Those with the symbol P_1 are appropriate for aircraft with EWHs up to 10 ft (3 m). The symbols P_2 and P_3 designate installations appropriate for EWHs up to 25 ft (7.6 m) and 45 ft, respectively.

APAPI installations — which have two, rather than four, lamps in their light bars — are designated with the symbol A_P and, like P_1 installations, are appropriate for aircraft with EWHs up to 10 ft.

However, EWH information is not readily available to pilots. The Global 5000 aircraft flight manual, for example, does not include this information. "The manufacturer had to complete calculations to determine [the aircraft's] EWH," the report said.

Bombardier determined that the Global 5000's EWH is 17.2 ft (5.2 m), which is about 5 ft (1.5 m) greater than the height for the Challenger 604.

The report said that although the APAPI installation at Fox Harbour was not appropriate for the Global 5000, if the crew had followed its guidance to touchdown, the main gear would have cleared the runway threshold by about 8 ft and the aircraft would have touched down about 500 ft (152 m) from the threshold.

Moreover, if they had followed the vertical guidance provided by the on-board flight management system, the aircraft would have crossed the threshold at 58 ft and touched down 1,000 ft from the threshold (Figure 1).

'False Assumption'

Based on the interviews conducted during the investigation, the report concluded that most pilots believe an on-path indication from a VGSI is assurance that they are on a safe glide path.

"This false assumption can lead pilots to rely on VGSI guidance that is unsuitable for the aircraft type they are operating," the report said. "Vertical guidance should only be used after confirmation that the VGSI type is appropriate for the aircraft type operated."

Among the recommendations generated by the investigation, TSB called on Transport Canada to ensure that EWH information is available to transport aircraft pilots and that comprehensive training on VGSIs is provided to pilots, "so they can determine if the system in use is appropriate for their aircraft."

This article is based on TSB Aviation Investigation Report A07A0134, "Touchdown Short of Runway; Jetport Inc.; Bombardier BD-700-1A11 (Global 5000), C-GXPR; Fox Harbour Aerodrome, Nova Scotia; 11 November 2007."

RED Flags on SMS

Friction builds in Canada's push for safety management systems.

© Peter Tsagaris/Airliners.net

BY MARK LACAGNINA

Most aviation safety specialists worldwide have hailed the safety management system (SMS) as a key to further reduction of aircraft accidents. However, cautions recently have been expressed about overextension of the concept and about the risks of relaxing government oversight of operators as they struggle toward full SMS implementation.

It is not surprising that most of the red flags have been raised in Canada, which is leading most of the world in aggressively pushing for SMS implementation by all aviation certificate holders in the country.

Hoisting one of the red flags is Daniel Slunder, national chair of the Canadian Federal Pilots Association (CFPA), a union representing about 470 pilots employed by Transport Canada, Nav Canada and the Transportation Safety Board of Canada.

Slunder contends that safety actually may suffer as self-regulating operators create a deluge of SMS paperwork that can conceal less-than-sterling practices.

"Transport Canada describes SMS as a partnership: Industry agrees to take on more responsibility for ensuring compliance with safety requirements in exchange for less direct oversight by government inspectors," Slunder said in a CFPA news release issued in July 2009.

"As SMS has been introduced, however, key safety audit programs have been canceled," he said. "In fact, Transport Canada recently canceled its practice of requiring a specific frequency of audits and inspection and replaced it with a program of SMS assessments and program validations."

The result, contends Slunder, is that few audits and inspections are being conducted to ensure compliance with regulations; the focus now is to ensure that operators have a functioning SMS in place.

'Sugarcoating'

Slunder says that, under SMS, operators provide reams of data to show that they are operating safely; consequently, data analysis has taken the place of direct oversight through inspections and audits.

"The trouble is, all these data are unverified," he said. "In other words, the door is open to airlines to sugarcoat their reports in order to keep their planes in the sky, earning money.

"Transport Canada inspectors have become deskbound, relying on the paperwork assurances of the airlines that everything is OK instead of inspecting airplanes and crews."

Slunder says that civil aviation authorities (CAAs) worldwide must maintain adequate oversight by directly conducting inspections and audits. "Such functions cannot be delegated,"

he warned. "Otherwise, aviation personnel, maintenance organizations, general aviation, commercial operators, aviation service providers, aerodrome operators, etc., will in effect be regulating themselves and will not be effectively monitored by CAA inspectors."

'Sadly Misguided System'

Criticism of SMS also has been expressed by an organization based in the United States — the Aircraft Electronics Association (AEA), which represents more than 1,300 businesses specializing in general aviation avionics and electronics equipment.

In the January issue of *Avionics News*, AEA board chairman Barry Aylward dubbed SMS the "sadly misguided system" and an "unproven theoretical model based on the faulty premise that if the paperwork is good, the aircraft is good."

He contends that SMS never was intended to be applied beyond the airlines. "Yet, aviation regulatory authorities are embracing this concept with zeal and forcing broad-brush implementation across all sectors."

Aylward said that SMS "imposes an enormous and very costly administrative burden on an aviation business, and it does so with no evidence whatsoever that it will improve aviation safety or compliance with existing aviation regulations.

"The fact is, SMS has not been successful in improving the safety record of the rail industry in Canada," which introduced SMS in 2001.

'Aviation regulatory authorities are forcing broad-brush implementation across all sectors.'

'Extra Layer of Protection'

Transport Canada steadfastly dismisses any suggestion that introducing SMS clears the path to deregulation (*ASW*, 1/09, p. 24). On the contrary, the regulator characterizes SMS as a proactive tool that complements government oversight of operators in all segments of aviation — "an extra layer of protection to help save lives."

"Transport Canada inspects aviation operations to make sure they meet safety regulations and enforces the law when they don't," says a statement on the organization's Web site. "Transport Canada's role now goes even further, as it also measures how well industry safety management systems are working."

The rail industry and the international maritime industry were the first transportation modes targeted for SMS implementation. When the concept was extended to the aviation industry, Transport Canada established a four-phase process for SMS implementation.

Canadian air carriers and their associated maintenance organizations have completed all four phases of SMS implementation, and international airports and air traffic service providers are entering the third phase.

The target for SMS implementation by all remaining aviation certificate holders is 2015. They include commuter operators governed by Canadian Aviation Regulations (CARs) Subpart 704 and air taxi operators governed by Subpart 703.

Among the deadlines established by the International Civil Aviation Organization for SMS implementation were January 2009 for commercial aircraft operators and November 2010 for private, or business, operators of large turbine airplanes.

However, SMS implementation worldwide is proceeding at a slow pace, with much confusion remaining among some operators and regulators about how to proceed (*ASW*, 1/08, p. 14). Transport Canada has conceded that implementation has been far more complex than originally envisioned.

'Tendency to Stay on Course'

In a presentation at Flight Safety Foundation's 2009 International Air Safety Seminar in Beijing, Robert Dodd, general manager of Qantas Airways, posed a question that is on the minds of many safety specialists and aviation operators: Has SMS been oversold?

His answer: "I don't believe so, but I do feel that in many ways the performance improvement to be gained from SMS implementation will be much tougher to get than previous gains. In part, this is just the obvious effect of trying to improve an already extremely impressive accident rate."

In his discussion about gauging the effectiveness of an SMS, Dodd said, "In all probability, the system won't be right when it starts up. … In large

'Organizations have a natural tendency to stay on course.'

part, this is because existing, presumably successfully functioning organizations have a natural tendency to stay on course and keep doing what they were doing and how they were doing it before they installed the brand new SMS."

These comments unintentionally cut to the core of concerns about SMS implementation that were generated by the investigation of a business airplane accident in Canada. The accident involved a company that purportedly had been operating under an SMS for three years but actually was doing what it was doing before installing the SMS.

'Evolving Environment'

The accident occurred on Nov. 11, 2007, at Fox Harbour Aerodrome in Nova Scotia (see "Something Changed," p. 18). It involved a Bombardier Global 5000 that had recently been acquired by Jetport, which specializes in air taxi operations and aircraft management.

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For operation of the Global 5000, Jetport had adapted standard operating procedures developed for its Challenger 604, a much smaller airplane. Some of the procedures did not conform with the manufacturer's recommendations and were not suitable for the new airplane.

Chief among them was tacit consent to duck below the visual glide path on approach to a short and/or contaminated runway. This, along with the flight crew's use of an inappropriate crosswind technique and inadequate response to an excessive sink rate on short final, was among the factors that led to the collapse of the right main landing gear when the big airplane touched down short of the runway. Damage was substantial, and two of the 10 people aboard the airplane were seriously injured.

In its final report, the Transportation Safety Board of Canada (TSB) said that the accident "needs to be considered in the context of a relatively new and evolving safety regulatory environment."

The environment is unique and complex. Canada is alone in requiring business aviation operators, under CARs Subpart 604, to obtain a private operator certificate (POC) for any airplane that is pressurized and turbine-powered, and weighs more than 5,700 kg/12,500 lb.

Self-Regulation

Transport Canada and the Canadian Business Aviation Association (CBAA) began discussions in the late 1990s about the possibility of self-regulation of business aircraft operators.

At the time, Transport Canada had 16 inspectors responsible for the oversight of 121 POC holders operating 193 aircraft and employing 672 pilots. The inspectors "carried out routine regulatory audits, conducted PPCs [pilot proficiency checks], performed safety visits, monitored, and carried out follow-ups on incidents," the TSB report said.

The discussions between Transport Canada and the CBAA led to a joint feasibility study concluding that self-regulation was possible. A follow-up study in 2001 generated the recommendation that business aircraft operators implement SMS based on performance-based rules and standards developed by the CBAA.

The studies also concluded that, to mitigate the risks of self-regulation, continued oversight in the form of CBAA audits of POC holders would be required and that any deficiencies in CBAA's oversight must be identified and corrected by Transport Canada. Because of the cost of hiring auditors, it was agreed that the audits would be performed by independent contractors accredited and monitored by the CBAA.

In January 2003, the CBAA issued business aviation operational safety standards (BA-OSS) and SMS-audit guidelines to auditors and POC applicants. Notably, the guidelines advise that "the implementation and operation of an SMS take time, even for mature aviation departments; therefore, the auditor must determine a reasonable level of performance that can be expected when evaluating the SMS."

'Twice Removed'

During its investigation of the Fox Harbour accident, TSB found that the business aviation regulatory environment has not evolved as planned.

Figure 1 shows that, as of 2008, three CBAA staff members were assigned to the POC program, and 14 accredited independent contractors were conducting audits of 320 business aviation operators. However, no audits of the auditors or the operators were being conducted by the association.

In effect, business aviation operators had been "twice removed" from Transport Canada's scrutiny, the TSB report said. "This is a significant departure from the feasibility studies. The current model consists of informal communications between the CBAA and its accredited auditors and operators during liaison visits and trade shows. … Transport Canada has not ensured that the CBAA is fulfilling its responsibilities for oversight."

The plan called for CBAA audits of business aviation operators to be conducted at three levels. The first audit determines whether an applicant has an SMS infrastructure in place; if so, a POC is issued. During the second audit, the POC holder must show that the SMS is functioning. Finally, the operator must show that SMS activities have been fully integrated and that a positive safety culture is being maintained.

No firm deadlines for SMS implementation have been set. "CBAA indicated that very few POC holders have advanced beyond level one and suggested that, in some cases, it could be many years before they do," the TSB report said.

The accident investigation revealed that, after receiving a POC for its Challenger in 2004, Jetport presented basically the same SMS documentation during three subsequent audits, none of which found that it did not meet the BA-OSS standards.

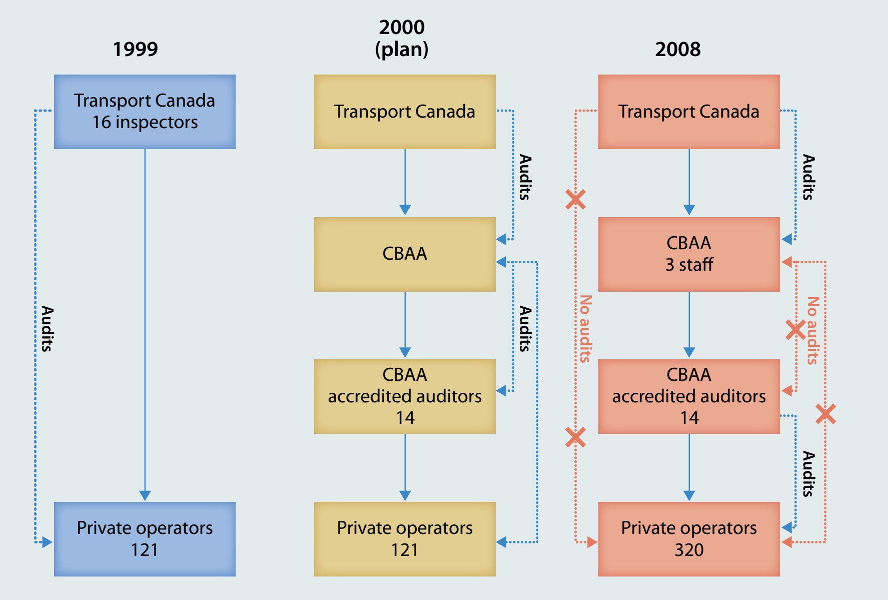
Moreover, the company had a "traditional, reactive safety management process in place" and did not conduct a formal assessment of the risks involved in operating the Global 5000 at Fox Harbour Aerodrome, the report said.

TSB concluded that these findings point to the absence of effective quality assurance of the CBAA's POC program.

"As with the transition to any new system, the introduction of SMS in the Canadian aviation industry is facing challenges," the report said. "Many operators, although willing to progress to SMS, still do not possess a good understanding of how to do it. … The confusion is not limited to the operators, as some of the people tasked with assessing SMS programs misinterpret performance indicators expected from a functioning SMS.

"With time and experience, operator and assessor knowledge should improve and eventually provide the level of protection expected of a mature SMS. … During this transition, it is essential that oversight not be relaxed."

Canadian Business Aviation Oversight



CBAA = Canadian Business Aviation Association

Source: Transportation Safety Board of Canada

Figure 1

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Fatal Descent

BY LINDA WERFELMAN

Inadequate weather assessment and weak risk management helped set the stage for a HEMS crash in a cloud-covered, wooded area.

The pilot of a Maryland State Police Aerospatiale SA 365N1 on a medical evacuation flight was descending to avoid low clouds when the helicopter struck the ground during a late-night instrument landing system approach to Andrews Air Force Base (ADW) in Camp Springs, Maryland, U.S., on Sept. 27, 2008.

Four of the five people in the helicopter were killed, the fifth suffered serious injuries, and the helicopter was substantially damaged in the crash, one in a cluster of fatal helicopter emergency medical services (HEMS) accidents that occurred in the United States in 2008, prompting government hearings and industry review boards to examine reasons for the surge in accidents and recommend actions to prevent similar events.

The U.S. National Transportation Safety Board (NTSB), in its final report on the accident, said that the probable

cause was "the pilot's attempt to regain visual conditions by performing a rapid descent and his failure to arrest the descent at the minimum descent altitude during a nonprecision approach."

Contributing factors included the pilot's limited recent instrument flight experience, the "lack of adherence to effective risk management procedures" by the Maryland State Police (MSP) and the pilot's "inadequate assessment of the weather, which led to his decision to accept the flight." The report also cited the failure by air traffic control to provide the pilot with current weather information for ADW and the increase in the pilot's workload because of "inadequate FAA [U.S. Federal Aviation Administration] air traffic control handling by the Ronald Reagan National Airport Tower and PCT [Potomac Consolidated Terminal Radar Approach Control] controllers."

'We're Going to Try'

A duty officer at the MSP System Communications Center (SYSCOM) received the request that initiated the flight about 2302 local time and notified the pilot of the accident helicopter that the flight — to transport two victims of a car accident to Prince George's Hospital Center in Cheverly — would originate on the property of an elementary school in Waldorf.

Because weather conditions at the time were only slightly better than MSP minimums and forecast to deteriorate, flights were accepted on a "call by call" basis, with pilots required to review weather every two hours.

The pilot told the duty officer, "I don't know if we can get to the hospital," and the duty officer replied, "Well, that's fine. If you can't make the mission, you can't make the mission."

Their conversation continued, and the pilot commented on the reported 800-ft ceiling at College Park Airport, about 1 nm (2 km) from the hospital. After a brief discussion of landing zone coordinates, the pilot said, "Maybe they will change their mind."

The duty officer then said, "Well, hold on. They ain't going to change their mind; if you tell them you will go, they want you to go. … That's up to you. Do you think you can fly it?"

The pilot again commented on the 800-ft ceiling at College Park and noted that Ronald Reagan Washington National Airport (DCA) had reported a 1,200-ft ceiling. Then he said that another emergency medical services

© Jose Luis Magana/Associated Press

The pilot of the Aerospatiale SA 365N1 was trying to return to visual meteorological conditions when the helicopter crashed in a wooded park.

Track of Accident Flight

Source: U.S. National Transportation Safety Board

Figure 1

helicopter operated by a private company had completed an interhospital transfer flight in the area, adding, "If they can do it, we can do it."

The duty officer responded, "OK. It is up to you," and the pilot said, "Yeah, we ought to be able to do it. … We're going to try it."

The accident helicopter took off from ADW at 2310 for the Waldorf elementary school pickup site, landed there at 2319 and departed about 2337, carrying the two patients, a local emergency medical technician who boarded the helicopter with the patients, a flight paramedic and the pilot (Figure 1).

The pilot contacted the DCA tower at 2337:45 to report departing from Waldorf en route to Prince George's Hospital Center. The helicopter entered Class B controlled airspace east of the airport at 2341, headed north at 1,000 ft.

During initial contact, the DCA tower controller told the pilot that he had received a report from another helicopter pilot — the pilot of the same helicopter that the pilot had discussed in his earlier conversation with the SYSCOM duty officer — 30 minutes earlier that described cloud bases at 900 ft and lower to the north.

About 2344, the accident pilot said, "We just ran into some heavy stuff. I don't think we're going to be able to make it all the way to the hospital. I'd like to continue on about three more miles and see what happens, and if I don't see a hole, I'll have to go IFR (instrument flight rules) back to Andrews."

The pilot continued north at about 900 ft until the helicopter was about 0.25 nm (0.46 km) east of the hospital. Then, at 2347, he began a 180-degree turn and told the controller that he wanted to climb to 2,000 ft for an instrument approach to ADW. The controller approved the plan and handed the pilot off to PCT.

At 2348, the pilot twice repeated the request to a PCT controller, and the controller began providing vectors for the instrument landing system (ILS) approach to Runway 01R. At the time, ADW was reported to have a broken ceiling at 1,800 ft.

At 2353, the controller told the pilot to turn right to a heading of 170 degrees to intercept the ILS localizer for Runway 19R. That heading, however, would not have resulted in a successful localizer intercept, the report said.

The pilot continued the turn to 210 degrees and intercepted the localizer 1 nm (2 km) from the final approach fix. About 2355, he told an ADW tower controller that he had no glideslope indication. At 2357, he requested an airport surveillance radar approach, but the controller said she was not current and could not provide that service.

There were no further radio communications. The last radar contact occurred about 2357:50 when the helicopter was at 800 ft above Walker Mill Regional Park, and the last automatic dependent surveillance-broadcast (ADS-B) target was at 2358:04 at 325 ft, near the site where the wreckage was found, in a heavily wooded area of the park at an elevation of 200 ft.

State Trooper Since 1970

The pilot had a commercial pilot certificate for helicopters and an instrument rating, as well as a flight instructor certificate with ratings for helicopters and instrument helicopters and a private pilot certificate for single-engine land airplanes.

He was hired by the MSP in 1970 as a state trooper and began working in the State Police aviation division in 1981. He had 5,225 flight hours, all accumulated during his State Police employment. Of his total flight time, 2,770 hours were flown in the same make and model as the accident helicopter, and 1,920 hours were flown at night. Investigators could not determine his total instrument flight time.

His most recent annual flight evaluation was conducted Oct. 27, 2007, and included an instrument proficiency check in which he flew one ILS approach and one nonprecision approach to Runway 01L at ADW. The instructor conducting the evaluation described the accident pilot's instrument skills as "slightly above average." During the evaluation, the pilot was approved to "act as single pilot PIC [pilot-in-command] for IFR operations, which allowed him to file a flight plan and fly in IMC [instrument meteorological conditions], if necessary, to fly a patient to a trauma center, reposition the helicopter to a maintenance facility, return to base from a flight, or conduct a VIP (very important person) transport," the report said.

The pilot also completed a subsequent instrument proficiency check on May 13, 2008, conducting an ILS approach, a nonprecision approach and a global positioning system (GPS) approach in Leonardtown, Maryland. The instructor said that the pilot "did pretty well" and had no difficulty with the approaches and that his performance was "above average" compared with other pilots.

In the year before the accident, he recorded 2.1 hours of instrument time and four instrument approaches. During the two years preceding the accident, he completed 25 instrument approaches at ADW, including four nonprecision approaches; three GPS approaches at other airports; and two approaches in a simulator. Before the accident flight, his last recorded night flight was on Sept. 16, 2008, and his last recorded flight in night IMC was Oct. 29, 2006.

The pilot held a second-class medical certificate. Records from his most recent airman's physical examination on Sept. 26, 2008, showed that he was 6 ft 3 in (191 cm) tall, weighed 293 lb (133 kg), and had a body mass index of 36.6, which is considered obese. His obesity — and the loud snoring for which the report said he was notorious among his colleagues — are both common among people with sleep apnea, a disorder that can disrupt breathing hundreds of times during a typical eight-hour sleep period (*ASW*, 9/09, p. 24). The pilot had not been diagnosed with sleep apnea, however.

The accident helicopter was manufactured in 1988 and had accumulated 8,869 total flight hours and 34,575 total landings. It had a night vision imaging system for law enforcement flights, but it was not used during the accident flight. The helicopter also had a radio altimeter, and an autopilot that could be fully coupled to an ILS; it did not have a terrain awareness and warning system (TAWS).

The helicopter was maintained in accordance with the manufacturer's recommendations under an approved inspection program. Its most recent 100-hour airframe and engine inspection was performed on Sept. 22, about 3.2 flight hours before the accident. The no. 1 (left) engine had 7,077 hours total time and 1,120 hours since overhaul; the no. 2 engine had 7,427 hours total time and 575 hours since overhaul.

The helicopter was within weight and balance limits throughout the accident flight. Instrument approach charts were readily accessible to the pilot, State Police aviation authorities said.

'Below the Clouds'

Weather at ADW three minutes before the accident included visibility of 4 mi (6 km) in mist, scattered clouds at 200 ft and broken clouds at 500 ft. The fire chief at ADW said that visibility at the time of the accident was about ¼ mi (0.4 km). A man who lived 1.8 mi (2.9 km) southwest of the accident site said that he saw a helicopter flying over his house "below the clouds in a descending attitude" and estimated that the clouds were 100 to 150 ft above the trees.

The pilot had obtained a weather briefing about 1851 from the FAA direct user access terminal (DUAT) service, including weather radar data, terminal forecasts and winds aloft forecasts. The ADW terminal forecast valid from 1800 through 0100 the following morning called for visibility of 7 mi (11 km) and scattered clouds at 2,000 ft. By 0200, however, the forecast was for visibility of 3 mi (5 km) in mist, a broken ceiling at 500 ft and overcast at 1,000 ft.

Aerospatiale SA 365N Dauphin

© Fred Johnston/Airliners.net

The Aerospatiale (now Eurocopter) SA 365N, first flown in 1979, is a twin-engine helicopter designed to carry two pilots and up to eight passengers. The accident helicopter had two front seats with dual controls and an aeromedical interior with four seats and two litters.

The SA 365N1 is equipped with Turbomeca Arriel 1C1 engines, each rated at 540 kW (724 shp) for takeoff.

Empty weight is 4,764 lb (2,161 kg) and maximum takeoff weight is 9,039 lb (4,100 kg). Maximum cruising speed at sea level is 153 kt, maximum rate of climb is 1,300 fpm and service ceiling is 11,810 ft. Maximum range, with standard fuel at sea level, is 460 nm (852 km).

Sources: *Jane's All the World's Aircraft*, U.S. National Transportation Safety Board

The pilot did not request information on weather hazards; if he had, the DUAT briefing would have included an airman's meteorological information (AIRMET) for IFR conditions in an area north and east of ADW, and including the hospital's landing area, valid until 2300.

This apparently was the pilot's last use of DUAT, the report said.

Subsequent weather information, issued later the night of the accident, contained forecasts of visibilities less than 3 mi (5 km) for the entire route of the accident flight. Another pilot saw, when he arrived at the hangar at 0310 the morning after the accident, that the pilots' computer was turned on and an experimental HEMS weather tool — authorized for use only in visual meteorological conditions (VMC) — was on the screen.

The duty officer said that the weather tool indicated that marginal VMC prevailed in most of the state and that all State Police aviation bases were operating "call by call" — an indication that weather was near the agency's minimums.

Current surface weather observations for ADW and nearby Fort Belvoir were not available at 2300 because of a technical problem affecting U.S. Defense Department weather dissemination. As a result, the ADW weather being reported on non-Defense Department weather outlets was from 1855, about five hours before the accident.

"It appears that the pilot based his decision to launch solely on the weather observations at College Park and DCA and the suitable conditions implied by the other medevac helicopter's completed flight," the report said. "Other pertinent weather data — the low temperature/dew point spreads at ADW and College Park, the AIRMET for IFR conditions encompassing the route of flight and the continuing deterioration of the weather conditions as the evening progressed — were either discounted by the pilot or not obtained. If the pilot had thoroughly obtained and reviewed all of the available weather information, it is likely he would have realized that there was a high probability of encountering weather conditions less than MSP minimums on this flight and this would have prompted him to decline the flight."

The report quoted the MSP Aviation Command safety officer as saying that, at the time of the accident, MSP did not have a formal risk management program but instead provided optional guidance with a "risk assessment matrix" that said pilots should consider a flight to be of medium risk if it was conducted with a temperature/dew point spread of less than 2 degrees C. However, the matrix provided no guidance about pilot actions concerning medium risk flights, the report said, adding that there was no indication that the pilot had consulted the matrix before the flight.

"Even if he had referred to it, the pilot might not have changed his decision to accept the flight, since the matrix did not provide clear guidance on medium risk flights," the report said. If the MSP had used a formal risk evaluation program, however, it might have led to cancellation of the flight, the report said.

Confusing Information

Almost immediately after loss of radar contact, the ADW airport traffic controller began trying to contact the pilot. At 2359:50, she notified the ADW fire department chief, who contacted the State Police and the Prince George's County communications center.

The SYSCOM duty officer mistakenly believed that the helicopter had landed at ADW. The report quoted the State Police as saying that the equipment installed on their helicopters for ADS-B tracking "does not function well at low levels" and that police personnel had been conditioned to assume that when an ADS-B signal was lost, the helicopter had landed safely.

Confusion surrounded information exchanged by the State Police, the ADW controller and the Prince George's County Police about the last reported location of the helicopter. The wreckage was found after the pilot and medic assigned to another State Police helicopter talked by phone with the ADW controller, who said radar contact was lost when the helicopter was "about 2 miles out on approach to Runway 19R." The pilot drew a line on a map to correspond with the extended runway centerline; the line intersected the spot where they had plotted the original coordinates for the last contact. The two drove to the area and then walked toward the spot, where they located the wreckage and the survivor at 0158.

Fatigue

The report said that, considering the time of day, the pilot's risk factors for sleep apnea and his decision to deviate from published approach procedures, he probably was "less than alert" during the flight and fatigue "may have contributed to his deficient decision making."

The report said that the pilot might have been encouraged to "deviate below the glideslope and attempt to duck under the cloud ceiling" because of his "expectation that he could descend below the cloud ceiling at an altitude above the minimum descent altitude for the approach, his familiarity with [ADW] and the reduction in workload a return to visual conditions would have provided."

Nevertheless, he "failed to adhere to instrument approach procedures when he did not arrest the helicopter's descent at the minimum descent altitude," the report said, adding that the pilot probably did not monitor cockpit instruments because he was preoccupied with looking for the ground.

The report said that the pilot's workload had increased "substantially and unexpectedly" after the helicopter entered IMC and that, although he met the recent-experience requirements to serve as PIC under IFR, he was "not proficient in instrument flight." Changes in the MSP instrument training program about 10 months before the accident — eliminating the requirement for six instrument approaches every six months and replacing it with two instrument proficiency checks every year — "did not promote instrument proficiency," the report said.

If the helicopter had been equipped with a TAWS, the device would have generated a "glideslope" aural alert about 24 seconds before the initial impact, followed by terrain warnings that would have begun seven seconds before impact, the report said.

The report cited air traffic services provided by the DCA airport traffic control tower and the PCT for "numerous procedural deficiencies, including unresponsiveness, inattention and poor radar vectoring. These deficiencies were a distraction to the pilot and increased his workload by requiring him to compensate for the poor services provided."

In addition, the approach controller did not give the pilot current weather information for ADW, an omission that "likely led the pilot to expect that he could descend below the cloud ceiling and establish visual contact with the ground at an altitude well above the minimum descent altitude for the approach," the report said.

The report also challenged the FAA's classification of all medical evacuation flights involving government-owned aircraft as public operations,[1] noting that the classification "creates a discrepancy in the level of FAA safety oversight of [HEMS] aircraft operations carrying passengers and is contrary to the intent of [the law that] states that aircraft carrying passengers are excluded from operating as public aircraft."

Six months after the accident, the MSP told NTSB accident investigators of a number of changes, including development of a new mission-specific flight risk assessment tool; implementation of new pilot training requirements, including completion of at least two instrument approaches per month; and training all aviation command personnel and MSP field personnel in the use and interpretation of geographic coordinates.

This article is based on NTSB Aircraft Accident Report No. AAR-09/07, *Crash During Approach to Landing of Maryland State Police Aerospatiale SA 365N1, N92MD, District Heights, Maryland, September 27, 2008.*

Note

1. Aircraft used in public operations — including those operated by state governments for non-commercial purposes — generally are exempt from U.S. Federal Aviation Regulations.

Rough Ice

A new concept in understanding in-flight icing gathers believers.

BY JOHN P. DOW SR. AND JOHN MARWITZ

In the early days of aviation, at the advent of thermal ice protection system development, aircraft designers believed that in fighting in-flight icing, the critical variables were the mass of supercooled water that an airplane would transit and the temperature. The measure of mass is liquid water content (LWC). Droplet size of supercooled water, which influences potential icing severity, is measured by the median effective diameter. Droplet size also determines how far back on the airfoil the ice collects. Temperature, mass and location of the ice on the airfoil determine the amount of heat required and the extent of ice protection needed for thermal systems to prevent phase change of water to ice.

Out of the extensive airborne sampling of icing conditions starting in the late 1940s, U.S. Federal Aviation Regulations (FARs) Part 25 Appendix C was developed and defined most of the icing envelope used for certification. While well suited to anti-icing systems, Appendix C does not define the environment adequately to prevent all hazards to deicing systems. Vestiges of this concept of calculating the potential for threats from the development of icing by relying on the measure of mass alone have been slow to be revised, even in the face of icing events to the contrary.

While common usage simplifies the character of the in-flight ice to two descriptors — glaze ice and rime ice — the shape, location, thickness and distribution of ice features, including roughness, are the true discriminators of the effect of ice on aircraft aerodynamics.

Large ice shapes may be problematic, but research is showing that thin, rough ice can have a much greater effect on aircraft performance. These new findings call for a reconsideration of aircraft certification.

This new way to consider icing and its effects began to evolve in 1967 when the University of Wyoming (UW) started operating a variety of state-of-the-art aircraft outfitted for cloud physics work. For the past 40-plus years, UW researchers participated in various weather modification projects, beginning with a search for supercooled liquid water[1], without which there is no weather modification potential.

Data and experience collected in this process inadvertently produced a new concept of in-flight icing: The shape and distribution of the accreted ice, and primarily the roughness, are more significant in terms of performance degradation, by an order of magnitude, than the mass of ice. Pilots often comment on how much ice they are able to handle, creating a misplaced sense of confidence about accretion of lesser thickness that may be far more adverse. Icing severity as often forecast and reported by pilots does not always equate with severity of effect.

Further, the UW observations expanded awareness of the critical factors influencing in-flight icing beyond high LWC to include an understanding of atmospheric temperature and the largest droplets, particularly when considering the performance of deicing systems. There tends to be an "optimum bad" value for each of these parameters: For the flight conditions of the research airplane static air temperature, it is around minus 8 degrees C (18 degrees F). Conditions warming to temperatures well above 0 degrees C (32 degrees F) result in run-back ice — water freezing as it flows — or no ice; at colder temperatures there is mostly ice, no water. Run-back ice can also form ridges aft of ice-protected areas, which can create adverse effects.

The largest "optimum bad" droplet size seems to be around 100 microns in diameter, approximately 2.5 times the thickness of a human hair. These droplets collect on the airfoil in the area of 5 percent to 15 percent of chord. They result in the formation of ice resembling small, pointed "shark's teeth" with the teeth oriented into the local airflow. Smaller droplets collect on the leading edge of the airfoil and cause little

Is Bad Ice

performance degradation. Larger droplets with higher mass inertia and thermal inertia[2] cover the airfoil with a relatively smooth coating of ice, which does not usually significantly degrade the performance of the airfoil.

The "optimum bad" value for LWC is around 0.4 g per cu m. At smaller values of LWC, the rate of ice accretion and rate of performance degradation are low. At high values of LWC, thermal inertia is dominant and, therefore, run-back ice, ice horns and smooth ice occur. And importantly, these droplet sizes can occur either in conditions defined by Appendix C or outside them. However, it was found that specific combinations of droplet size and liquid water content produce the most rapid change in aircraft performance.

Despite a high degree of confidence about the concept, there existed no significant theoretical or icing tunnel data suitable for guidance in the selection and combination of specific, measurable icing parameters. A value was selected — 80VD[3] — as a new parameter to represent the largest droplets, and LWC as the best parameter for cloud composition. The effect of the combined parameters was expressed as simply the first parameter times the second, and the resulting value showed a remarkable correlation to adverse affect on aerodynamic performance. The ice accretion that creates the most adverse conditions is not large.

The massive changes in U.S. icing regulations spawned by the ATR 72 accident at Roselawn, Indiana, on Oct. 31, 1994, finally will be incorporated into an operational airplane 20 years after the event, yet ice roughness in this context has yet to be fully defined or addressed in the FARs, unlike other key milestones in the understanding of icing risk.

Evolution of the regulatory icing envelope defined in Appendix C occurred from 1920 to 1950. There were important milestones in that period.

In 1928, the National Advisory Committee for Aeronautics (NACA) reported "the ice forms in

Two views of distributed-roughness icing, showing the thin layers involved.

University of Wyoming

Svetlana Bakavets/iStockphoto, Screammm/Dreamstime and Susan Reed

dangerous amounts only within a small range of temperature below 32 degrees F [0 degrees C].”

Not long after this report, a fatal accident attracted wide attention in the United States. On March 31, 1931, a Fokker F-10 departed Kansas City, Missouri, with an en route stop at Wichita, Kansas, and encountered severe icing. The airplane suffered an in-flight structural wing failure resulting in fatal injuries to all eight occupants, including legendary Notre Dame University football coach Knute Rockne.

The icing aspect of the accident received inadequate attention as a causal factor that forced the airplane into an attitude that resulted in structural failure, the failure becoming the public focus. Nonetheless, it was the first high profile occurrence involving in-flight icing.

After the Fokker accident, and before the natural icing environment was measured or quantified, wind tunnel testing by Eastman Jacobs and Albert E. Sherman demonstrated that the degree of in-flight icing hazard was primarily a function of the location and shape of the accreted ice, and secondarily its mass or thickness. The logic is still sound and its method effective against the shape and/or ridge icing threat.

It wasn’t until 1930 that the “Ice Removing Overshoe,” a predecessor of the pneumatic deicing boot used today, was introduced by B.F. Goodrich, and mechanical systems entered the discussion.

In December 1940, famed Lockheed Aircraft designer Clarence L. (Kelly) Johnson wrote about his wind tunnel research using artificial ice shapes to estimate aerodynamic degradation of stability, control, stall angle and drag. One of Johnson’s conclusions was this: “The icing problem is relatively less severe on large airplanes than on small ones.” Johnson’s conclusion on scale was later quantified as the ice thickness (k) to chord (c) ratio or “k/c.” The effects of a certain thickness of ice were less severe for a larger chord (smaller k/c) than a smaller chord (larger k/c).

Researcher J.K. Hardy in 1944 may have been the first to comment on the need for an icing envelope definition, obviously referring to thermal systems: “This [lack] has retarded development, since it has not been possible to analyze the performance of the system under conditions of icing.”

Immediately after World War II, a number of military aircraft gathered data used to form the basis of Appendix C icing condition envelopes still in use. Regulations developed in the early 1950s addressed only pneumatic ice protection systems, however. It was not until 1955 that Amendment 4b-2 to the Civil Aviation Regulations introduced the icing envelopes we have today.

In 1958, the U.S. Federal Aviation Administration (FAA) and the National Aeronautics and Space Administration came into existence, replacing the Civil Aeronautics Authority and NACA, respectively, and the regulations for aircraft were codified in the FARs.

In 1965, FARs Part 25.1419 set forth more comprehensive regulations for transport airplanes and icing condition definitions with no discrimination between thermal systems and mechanical systems; the requirements defined how the applicant would show compliance.

In 1971, FAA Advisory Circular (AC) 20-73 was published. It discussed acceptable means of showing compliance with the icing regulations. For ice protection systems, the concept of impingement limit — or how far back droplets would strike the airfoil surface — was addressed, and the suggested means of designing a compliant system was to use a simple scheme to determine impingement in various flight conditions. The limit of the ice protection system was typically based on how far aft 20-micron and 40-micron diameter droplets would impact the surface. The importance of roughness effects was not recognized or addressed. Thermal anti-ice protection systems predominated in jet transport design.

Groundbreaking research in the academic community started in early 1982 with UW’s work using a Beech King Air 200T. During one notable flight, the drag resulting from in-flight icing reduced the aircraft’s climb capability at maximum power to approximately zero in less than 15 minutes, with airframe buffet indicating stall onset approximately 30 kt above normal uncontaminated stall speed.

While gathering icing data was not part of the UW effort, the airplane performance degradation was so severe that the researchers began an immediate in-depth examination of the recorded cloud physics data and aircraft performance data to understand the cloud characteristics. This was a unique effort to determine a cause and effect relationship. Further, unlike contemporary studies, they recognized the icing variables and associated consequences.

Two potentially hazardous in-flight icing encounters were evaluated. The performance degradation was far greater than was predicted on the basis of LWC or another cloud composition parameter called MVD.[4] The performance degradation comprised an increase in stall speed, a decrease in the coefficient of lift (C_L) and a decrease in climb capability. Both encounters involved substantial numbers of supercooled drizzle droplets (SCDD) in the range of 40–300 microns; the maximum theoretical droplet size in Appendix C's "Intermittent Maximum" envelope is 135.5 microns.

In 1997 and 1998, Ashenden and Marwitz presented additional detailed data from 13 flights in the UW King Air. They presented analysis of performance degradation in conditions of freezing drizzle, freezing rain, warm rain, SCDD, SCDD with high LWC, mixed phase clouds of ice and water, and ice-only clouds.

Change in drag rate, or how quickly drag increased, was selected as the best measure of one aerodynamic hazard because a dramatic increase in drag occurred when the MVD was between 10 and 200 microns. The increase in drag was sometimes large and sometimes small. That is, for a given MVD there was a large range in how rapidly drag increased, but flight experience indicated that the largest droplets combined with the LWC had the most adverse effect on aircraft.

Analyzing flight data, it became clear that the UW pilots inadvertently had flown through freezing rain four times without incident. A number of other experienced pilots related similar experiences in which they had occasionally landed in freezing rain, taxied up to the hangar, and needed assistance from ground personnel to open a cabin door sealed shut by a coating of glaze ice.

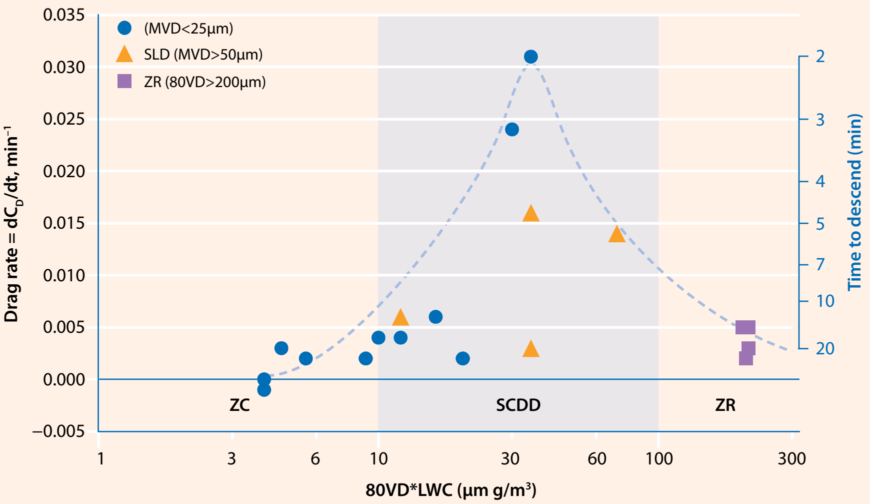
Freezing raindrops are large, greater than 500 microns. This size droplet has large inertial mass and thermal inertia, compared with other droplets. Freezing raindrops, therefore, penetrate the airflow surrounding the airfoil to hit the wing, but do not freeze on contact. Rather, they strike the airfoil, spread downwind and coat the entire aircraft with glaze ice.[5] The coating of ice is rather smooth, and the airfoil is just slightly larger and slightly heavier. The airfoil is still fairly efficient, and the weight of the ice coating is not a significant factor.

The UW researchers found that as the largest droplets increased in size above approximately 30 microns in diameter, the accreted ice from SCDD was not a solid or monolithic formation but formed into the shape of shark's teeth, similar to 10–20 grit, or grain per inch (2.5 cm), sandpaper.

This implied that the thermal inertia of SCDD is small. The smaller SCDDs, therefore, freeze on contact. The obvious deduction was that as the droplets get larger and/or the LWC increases, the thermal inertia will prevent freezing on contact and the ice will tend to be relatively smooth, glaze ice.

The problem was to identify a specific environment that would represent these mass and thermal inertial regulating processes. The parameter selected was the product of 80VD and total LWC. This product was abbreviated as 80VD*LWC and the accompanying graph was produced (Figure 1). Notably, the peak in the curve near 40 would be the same if 80VD on the Y axis was 400 microns and LWC on the X axis was 0.1 g per cu m, or if the Y axis was 100 microns and the X axis was 0.4 g per cu m.

Drag Rate vs. 80VD*LWC



C_D = coefficient of drag; LWC = liquid water content ; min = minutes; µm = micron;
MVD = median volumetric diameter; SCDD = supercooled drizzle droplets;
SLD = supercooled large droplets; ZC = freezing cloud drops; ZR = freezing rain drops

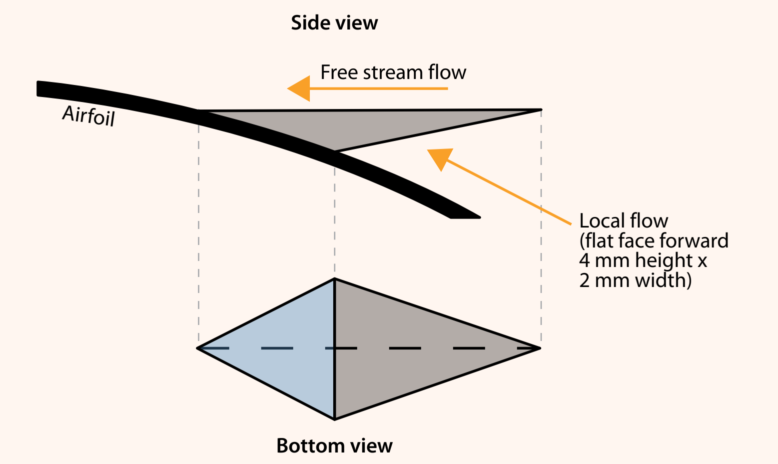
Source: John P. Dow Sr. and John Marwitz

Figure 1

The figure's vertical axis has a second scale showing the time until descent was required to prevent a stall. The C_D for a clean aircraft is approximately 0.045, based on clean aircraft tests, and the C_D when the aircraft has no more climb capability is 0.12. Therefore, the time to a forced descent is inversely related to drag rate.

The worst case shows that the aircraft would be forced to descend in two minutes. These infrequent but consistent conditions contrasted with more common in-flight icing encounters, those involving supercooled cloud droplets and encounters with freezing rain, in which the pilot had roughly 20 minutes to recognize the threat and respond. The major counterintuitive finding has been that this most-adverse condition is not related to the thickness of the ice formation. Therefore, the practice of associating icing severity and threat with only the thickness of ice accumulation is seriously flawed.

Stylized Representation of 'Shark's Teeth' Distributed Ice Elements



Source: John P. Dow Sr. and John Marwitz

Figure 2

Atmospheric conditions that form a shape are better understood by viewing the shape itself. Specifically, a stylized drawing (Figure 2) can depict critical parameters of these distributed elements on the order of only 2 to 4 mm (0.08 to 0.16 in) in length covering 15 to 30 percent of the airfoil surface area.

From 1991 to 1994, the FAA focused on the hazards and remedies for ice-contaminated tailplane stalls. One recommendation was to expand research into conditions beyond Appendix C into freezing rain and drizzle. One reason for the research was that pilots had no means to identify when the icing conditions were beyond the certification envelope and so, beyond the capabilities of the ice protection system.

Initially, the FAA concluded that, in consideration of resources available, "This does not appear to be a program that should be supported at this time." However, a little more than a month later, the Roselawn ATR 72 crash occurred. The airplane was in a holding pattern at an altitude above the freezing level. The flaps were extended in SCDD conditions.

The crew operated the ice protection system, but the reduced angle of attack associated with the flap extension and the large droplets impinging aft of the deicing boots allowed ice growth from droplets running back from the leading edge. This resulted in a sharp-edged ice ridge forming aft of the boots, where it could not be removed, and forward of the ailerons. This ice ridge eventually caused the ailerons to self-deflect to the right-wing-down position; the crew could not regain control, and the crash killed all the occupants.

As a result of this accident, researchers launched an icing tanker test focused on SCDD large droplet conditions. The work by ATR, the U.S. National Transportation Safety Board, FAA, UW and the U.S. Air Force rapidly identified the principal causal factor of the accident. The drag increase — with this form of ice on this airplane in these conditions — was untypically low at 5 percent, plus or minus 5 percent. The industry was then focused again on the size, location and shape of the ice.

The FAA required a quarter-round piece of wood, flat side forward, to be tested just in front of the ailerons. This was termed the "stick test" and employed the principle of the same kind of "protuberance" used six decades earlier, but applied this time for identifying control issues rather than just lift degradation.

As a result of the post-accident research, the FAA issued airworthiness directives that brought attention to the visual cues associated with the droplets of the Roselawn icing conditions. The larger droplets in the test provided distinctive visual cues. However, distributed roughness elements from smaller, yet hazardous-sized, droplets may not present the same visual cues, nor would they form large ice shapes.

During the Roselawn accident investigation, the phrase "supercooled large drop" (SLD) was coined. SLD was defined to refer to drop sizes where MVD exceeded 50 microns, i.e., outside the Appendix C envelope. The problem with this phrase is it includes both SCDD and freezing rain.

On Jan. 7, 1997, an Embraer EMB-120 crashed in Monroe, Michigan, U.S., near Detroit, with fatal injuries to all 29 occupants. Neither droplets outside the definitions in Appendix C nor a long exposure were likely. The most probable ice present was thin and rough and not a ridge, as in the Roselawn accident.

In addition to the Monroe accident, there have been a disturbing number of other accidents paradoxically involving thin ice or small amounts of roughness on airplanes equipped with deicing boots, and not all of these have been in the droplet size region beyond the certification requirements.

On Aug. 16, 2006, the FAA issued AC 20-73A. It introduced a revised concept of assessing ice protection that suggests some of these issues be addressed during certification. While distributed-roughness effects are discussed, the shapes are derived from the icing tunnel, which is not typically representative of natural SCDD conditions and resulting shapes.

Distributed-roughness icing can form within or outside the icing conditions described in Appendix C. The primary mechanism for distributed-roughness icing formation seems to involve a deposition of droplets ranging in size greater than the larger size droplets of the 40 to 109 micron range in Appendix C. This deposition process must be long enough to form a grid or matrix of distributed elements and subsequent ice shape formation, but not so long as to allow the distributed elements to merge into a monolithic shape.

Accordingly, the LWC of the larger droplets can be low. The matrix elements are close but do not touch, and the initial effect of this formation is neither visually extraordinary nor of noticeable aerodynamic consequence. The mechanism of formation is not totally understood, but the data describing the results have been observed and documented.

The visual appearance of distributed-roughness icing formation may be innocuous, with a thickness or element height less than 1/8 in (0.32 cm). If this occurs on a black deicing boot, part of this formation may appear gray. There may be other ice formed at the leading edge as well. While this icing forms quickly and usually is not effectively removed by deicing boots, once outside the cloud, the adverse effects of the small elements, disproportionate to their size, tend to diminish as quickly as they occurred.

Precise effects of ice roughness element shape remain to be determined. Common types of solid geometric shapes are used in icing effects research, but the rapid onset of degradation of aerodynamic characteristics in distributed roughness — without change in location of the ice on the airfoil or the formation of large sizes — strongly suggests sharp-edge features and shape play an essential role. This infrequent condition can result in a hazardous ice shape that is two to five times thinner than even that recommended for operation of deicing boots. Moreover, distributed-roughness icing is not effectively removed even if the deicing boots are operated, or if thermal anti-icing use is delayed.

More work needs to be done to fully define this problem, but it is imperative that flight crews realize that a major performance degradation can be caused in a fairly short time by a relatively small amount of ice that cannot be countered by most deicing systems, with smaller airfoils being more susceptible to severe effects than larger airfoils. And, finally, aircraft certification standards and guidance must be reconsidered.

John P. Dow Sr. is a consultant in aircraft certification and icing with more than 25 years of experience in airplane icing issues relating to airplane certification and accident investigation.

John Marwitz is professor emeritus, University of Wyoming and president, Wyoming Weather Inc.

Notes

1. Supercooled liquid water can exist in the liquid phase at temperatures as cold as minus 40 degrees C (minus 40 degrees F).
2. Water at a temperature slightly below freezing must reject approximately 80 calories per gram to change state from liquid to solid (ice). This takes a discrete amount of time for the heat transfer process and is referred to as "thermal inertia."
3. The proposal was to begin with the common cloud measurement called the "droplet spectrum cumulative mass 80th percentile diameter, in microns," abbreviated as 80VD.
4. The measurement is called the "droplet spectrum cumulative mass 50th percentile diameter, in microns," abbreviated as MVD.
5. Freezing rain has a low freezing fraction, a measure of the fraction of water that freezes on the surface area it strikes. A freezing fraction of 1.00 means all the water that impacts a surface freezes on that area. A freezing fraction of 0.0 means none of the water impacting an area on the surface freezes there.

Rest in Place

BY LINDA WERFELMAN,
CLARENCE E. RASH AND
SHARON D. MANNING

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Some aviation officials and aeromedical specialists recommend controlled napping to help keep pilots alert; others say naps aren't the answer.

Controlled in-seat napping on the flight deck has been recommended for years as one element of an effective plan to help pilots ward off fatigue. Most recently, the Aerospace Medical Association (AsMA) said that the aviation industry should end its prohibition against in-seat napping — a practice the organization characterizes as a safe and effective risk-management tool that could greatly improve pilot alertness.[1]

"Taking a nap when it is convenient is better than trying to stay alert and productive for hours on end without sleep," says J. Lynn Caldwell, a crew rest expert at the U.S. Air Force Research Laboratory and a member of the AsMA fatigue countermeasures subcommittee, which drafted the recommendations endorsed in 2009 by the organization. "A nap can make a noticeable difference in performance, alertness and mood."

Although in-seat napping is sanctioned by some civil aviation authorities — only in accordance with guidelines to ensure operational safety — and used by the pilots of some international air carriers, not everyone considers napping a solution to the fatigue problem.

For example, the U.S. Federal Aviation Administration (FAA) does not permit napping by on-duty flight crewmembers. An upcoming revision of the agency's rules for pilot rest will not change that policy, says Margaret Gilligan, FAA associate administrator for aviation safety.

"The crew needs to come to work prepared for the schedule that they are undertaking," Gilligan said during a December 2009 hearing on pilot fatigue before the aviation subcommittee of the U.S. Senate Committee on Commerce, Science and Transportation. "We believe that we can manage and mitigate their fatigue through the new regulations sufficiently that they should be alert throughout the flight."

John Prater, president of the Air Line Pilots Association, International (ALPA), told the subcommittee that napping should only be used as a "last-ditch effort" to help pilots stay alert during critical phases of flight.

Prater said, however, that he fears that sanctioned napping could become a means for "somehow keeping pilots on duty even longer."

He said he envisions conversations in which a pilot tells a scheduler that he or she must decline a flight because of fatigue, and the scheduler responds, "Don't worry — you can catch a nap en route."

"That's not a sound strategy for being alert on the other end," Prater said.

Supporters of controlled napping, including Flight Safety Foundation President and CEO William R. Voss, told the subcommittee that an in-seat nap would be

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"an exception, not the rule," a tactic to be used as "one last layer of defense" against crew fatigue.

This "last layer," which also includes such fatigue countermeasures as the "timely intake" of caffeine, "recognizes the inevitable fact that crews sometimes experience significant fatigue despite their — and the operator's — best efforts to prevent it," Voss said. "It includes those actions that can be invoked to manage the risk until the flight is safely concluded."

'It's … a smarter approach than to run the risk of both pilots falling asleep.'

Basil J. Barimo, Air Transport Association of America vice president of operations and safety, agreed, calling on the FAA to endorse controlled cockpit napping "conducted in accordance with FAA-approved procedures to facilitate alertness during the critical phases of flight."

"We don't view napping as a silver bullet for fatigue," Barimo said. "Airlines would not build schedules that incorporate napping as a requirement to complete a trip. … It's a way to manage fatigue as it arises on a real-time basis — a smarter approach … than to run the risk of both pilots falling asleep."

Controlled napping should be one of the fatigue-fighting tools incorporated into the FAA's new rules, Barimo said, citing studies showing that scheduled in-flight naps can improve alertness and performance, especially when pilots do not obtain the recommended eight hours of sleep in each 24-hour period.

NASA Research

One such study, conducted in 1994 by the U.S. National Aeronautics and Space Administration (NASA), divided 21 participating pilots — each a member of a three-person flight crew — into a "rest" group whose members were allowed a 40-minute controlled rest period during the cruise portion of flight and a "no-rest" group whose members continued their usual flight activities during that 40-minute period.[2]

Pilots in the rest group typically fell asleep quickly, slept "efficiently" for an average of 26 minutes and, after awakening, displayed "improved physiological alertness and performance," compared with colleagues in the no-rest group, according to the researchers' report.

"The benefits of the nap were observed through the critical descent and landing phases of flight," the report said. "The nap did not affect layover sleep or the cumulative sleep debt displayed by the majority of crewmembers. The nap procedures were implemented with minimal disruption to usual flight operations, and there were no reported or identified concerns regarding safety."

The NASA sleep researchers and others believe that properly planned napping strategies can be effective against fatigue, preventing many of the attention lapses and microsleeps — periods of sleep that last only several seconds and often are not recognized — encountered during long-range flight operations.

In addition to its benefits, napping also has a negative aspect. "Practically everyone," Caldwell said, "experiences post-nap grogginess."

This grogginess also is referred to as "sleep inertia," which manifests itself in degraded vigilance, increased drowsiness and diminished performance[3] for one to 35 minutes after awakening.[4]

Sleep inertia is an important consideration in the scheduling of cockpit naps, sleep researchers have said. ALPA's Prater agreed, adding, "Trying to come up out of a nap to make a snap decision … is difficult."

Those who favor in-seat napping agree that planning must take into consideration several factors. AsMA's recommendations call for no more than 40 minutes to be set aside for an on-duty, in-seat nap. The time limit was derived from the NASA studies and other sleep research that has shown that a sleep period of less than 30 minutes is less likely to be followed by excessive sleep inertia.

In the 1994 NASA study, only 8 percent of participants entered "slow-wave sleep" — also called deep sleep or non-rapid eye movement (NREM) sleep — the stage of sleep conducive to subsequent sleep inertia. NREM sleep typically begins about 30 minutes after a person falls asleep; REM sleep, the stage of sleep associated with dreaming, typically begins 60 to 100 minutes after the start of a regular eight-hour sleep period.[5]

When a pilot is planning an off-duty nap, however, the strategies differ. An off-duty nap should be scheduled in proper relation to the sleep loss period and the natural circadian rhythm. Also, most studies indicate that a nap of at least one hour improves performance and alertness; as might be expected, the longer the nap length, the better. Finally, the quality of the nap is determined by the amount of time spent in deep sleep.[6]

No Adverse Effects

A number of international carriers, including Air Canada, Air New Zealand, British Airways, Emirates and Qantas, allow one pilot to nap in his or her seat during routine cruise segments of long-range flights. The 2009 AsMA report said that these naps have been taken "without producing adverse effects."[7]

The AsMA report also cited a 1999 NASA report on a survey of U.S. commercial pilots, noting that, despite the FAA's prohibition, 56 percent of flight crewmembers who responded to a regional airline operations survey said they had been on a flight during which one pilot arranged to sleep in the cockpit.[8] Of those pilots responding to a related corporate/executive pilot survey, 39 percent said that they had been on flights in which similar arrangements were made, according to a 2001 NASA report.[9]

Several years earlier, in a 1991 NASA study of long-range flight crews, pilots were observed napping 11 percent of the available time, with naps that lasted an average of 46 minutes.[10]

In addition, the AsMA report cited a 2002 opinion poll conducted by the U.S. National Sleep Foundation, in which 86 percent of respondents said that they completely or mostly agree with this statement: "An airline pilot who becomes drowsy while flying should be allowed to take a nap if another qualified pilot is awake and can take over during the nap."[11]

Nevertheless, Voss noted in his testimony that in the United States, "the idea of controlled rest in the cockpit is unfortunately colored by well-publicized episodes of uncontrolled rest." He referred, in part, to a February 2008 incident in which a go! Airlines Bombardier CL-600-2B19 overflew its destination in Hilo, Hawaii, because both pilots had unintentionally fallen asleep (*ASW*, 9/09, p. 24). The pilots awakened and returned to Hilo for an uneventful landing. The U.S. National Transportation Safety Board said the timing of the incident in the mid-morning was an indication that the pilots were fatigued.

"We hope that the FAA will consider the science and the successful experiences in many other countries to guide them … rather than alarmist concerns from individuals who have not studied this issue," said Voss, although he acknowledged that the idea of planning a nap for a pilot might seem "counterintuitive to folks in the back of the plane.

"Many countries and airlines allow for controlled napping, including France, Australia, Singapore and Canada. The aviation safety records of those countries speak for themselves," he said.

Canadian Aviation Regulations (CARs) Part 720.23, "Controlled Rest on the Flight Deck," spells out the requirements for Canadian operators whose pilots participate in in-seat napping programs. Training in general principles of fatigue and fatigue countermeasures is required, along with training in the specifics of the operator's program.

According to the CARs, rest periods are planned during a pre-flight briefing "to enable them to anticipate and maximize the sleep opportunity and to manage their alertness"; sometimes, however, the briefing may be conducted during the flight. A five-minute "pre-rest period" is designated for transfer of duties, an operational briefing and coordination with flight attendants before the rest period begins. The rest period itself is limited to 45 minutes during the cruise phase of flight and must be completed at least 30 minutes before beginning the descent. A "post-rest period" of at least 15 minutes with no flight duties is provided after the crewmember awakens "to allow sufficient time to become fully awake before resuming normal duties."

The Canadian procedure "takes into account all possible variables and leads to safer operations," Voss said.

After all, he added, "If a pilot unexpectedly is extra-fatigued, it is far safer to have a procedure in place to allow the fatigued pilot to sleep for a prescribed amount of time with the full knowledge of the copilot and the rest of the crew."

Clarence E. Rash is a research physicist with 30 years experience in military aviation research and development. He has authored more than 200 papers on aviation display, human factors and protection topics.

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Notes

1. Caldwell, John A.; Mallis, Melissa M.; Caldwell, J. Lynn; Paul, Michel A.; Miller, James C.; Nerei, David F.; AsMA Fatigue Countermeasures Subcommittee of the Human Factors Committee. "Fatigue Countermeasures in Aviation." *Aviation, Space and Environmental Medicine* Volume 80 (January 2009): 29–39.
2. Rosekind, Mark R.; Graeber, R. Curtis; Dinges, David F.; Connell, Linda J.; Rountree, Michael S.; Spinweber, Cheryl L.; Gillen, Kelly A. *Crew Factors in Flight Operations IX: Effects of Planned Cockpit Rest on Crew Performance and Alertness in Long-Haul Operations* (NASA Technical Memorandum no. 108839). Moffett Field, California, U.S.: NASA. 1994.
3. Muzet, A.; Nicolas, A.; Tassi, P.; Dewasmes, G.; Bonneau, A. 1995. "Implementation of Napping in Industry and the Problem of Sleep Inertia." *Journal of Sleep Research* Volume 4 (suppl. 2): 67–69.
4. Akerstedt, T.; Torsvall, L.; Gillberg, M. "Shift Work and Napping." In Dinges, D.F.; Broughton, R.J. *Sleep and Alertness: Chronobiological, Behavioral and Medical Aspects of Napping*. New York: Raven Press. 1989.
5. Rosekind et al.
6. Caldwell, J. Lynn. "Napping: Power or Poison?" *Flying Safety*. October 2002. 16–17.
7. Caldwell, John A. et al.
8. Co, E.L.; Gregory, K.B.; Johnson, J.M.; Rosekind, M.R. *Crew Factors in Flight Operations XI: A Survey of Fatigue Factors in Regional Airline Operations*. Moffett Field, California, U.S.: NASA Ames Research Center, Report No. NASA/TM-1999-208799. 1999.
9. Rosekind, M.R.; Co, E.L.; Gregory, K.B.; Miller, D.L. *Crew Factors in Flight Operations XIII: A Survey of Fatigue Factors in Corporate/Executive Aviation Operations*. Moffett Field, California, U.S.: NASA Ames Research Center, NASA Technical Memorandum No. 2001-211385. 2001.
10. Gander, P.H.; Graeber, R.C.; Connell, L.J.; Gregory, K.B. *Crew Factors in Flight Operations VIII: Factors Influencing Sleep Timing and Subjective Sleep Quality in Commercial Long-Haul Flight Crews*. Moffett Field, California, U.S.: NASA. Technical Memorandum No. 103852. 1991.
11. National Sleep Foundation. *2002 Sleep in America Poll*. <www.sleepfoundation.org/article/sleep-america-polls/2002-adult-sleep-habits>.

Further Reading From FSF Publications

Rosenkrans, Wayne. "Fatigued in the Back." *AeroSafety World* Volume 4 (June 2009): 34–37.

Werfelman, Linda. "Easing Fatigue." *AeroSafety World* Volume 4 (March 2009): 22–27.

Werfelman, Linda. "If You Don't Snooze, You Lose." *AviationSafety World* Volume 1 (November 2006): 13–17.

FSF Editorial Staff. "Lessons From the Dawn of Ultra-Long-Range Flight." *Flight Safety Digest* Volume 24 (August–September 2005).

FSF Fatigue Countermeasures Task Force. "Principles and Guidelines for Duty and Rest Scheduling in Corporate and Business Aviation." *Flight Safety Digest* Volume 16 (February 1997).

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China Southern Airlines prepares flight crews to optimize operational safety and profit.

BY WAYNE ROSENKRANS | FROM BEIJING

A simple drawing of a circle overlapping a square can help clarify how airline captains simultaneously must be safety professionals and line managers of their companies, says Zhou Yizhi, an Airbus A330 captain instructor for China Southern Airlines. Called the *square-circle model,* this visual aid to risk assessment and management also has been an instructional tool to improve the *executive ability* — analytical skills that can be taught and improved — of flight crews. The model helps in adequately considering company profit in relation to operational risk assessment,

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especially in abnormal or emergency situations, he said.

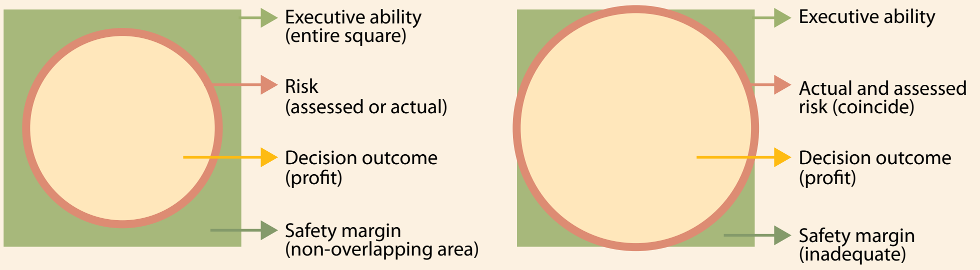
In crew debriefings, for example, the model has been used to address decisions made impulsively without scientific analysis of the actual margin of safety. “Profit yield will be significantly less if the crew’s improper decisions lead to unnecessary diversion or the cancellation of flights,” he said.

Zhou, who also is a crew resource management instructor for the International Air Transport Association (IATA) and a member of the IATA Safety Group, presented three case studies during the joint meeting of the 62nd annual Flight Safety Foundation International Air Safety Seminar (IASS), IATA and International Federation of Airworthiness 39th International Conference, held here in November.

When an airline flight concludes safely, this does not necessarily validate that the flight crew’s decisions were logical or reasonable — or that the margin of safety was adequate, he said. China Southern teaches that “decision making primarily shall be based on safety factors,” Zhou said.

“Within the safety margin, however, the crew must consider the company profit. A low profit of the company could be caused by improper risk assessment and excessively conservative decisions, while the potential threats could be increased as a result of unchallenged bold decisions.” In his experience, favorable outcomes of flight crew decisions tend to depend largely on consistent application of executive ability.

Square-Circle Model and Landing at Jiuzhaigou



Notes: The left drawing identifies common elements used in square-circle model analysis. The right drawing shows risk for an actual landing with an asymmetric trailing edge flap malfunction on approach to this high-altitude airport. Risk factors included tail wind, wet runway with partial standing water, nonadherence to procedures and no braking action report.

Source: Zhou Yizhi, China Southern Airlines

Figure 1

Square-Circle Model

In the model, a square signifies executive ability, with a larger size signifying better executive ability. The perimeter of a circle signifies the actual risk or the crew’s assessed risk (Figure 1). The area of the circle signifies the effect on company profit of one decision compared with others. By superimposing the “assessed risk,” “actual risk” or both circles on the square, parts of the square covered or revealed can be interpreted.

“The non-overlapping area represents the safety margin,” Zhou said. “We want both a safety margin and a greater company profit; they can vary from big to small. In different risk assessments, we will have different company profits. If the circle is too small, the safety margin appears larger, but the company’s profit will be the inverse [that is, decreased]. Some circles are just inside the square, so the square covers the circle. Then executive ability can cover the decision making required. If the size of the circle extends beyond the boundaries of the square — the crew’s decision exceeds their ability — an unsafe event would occur.”

Model Applications

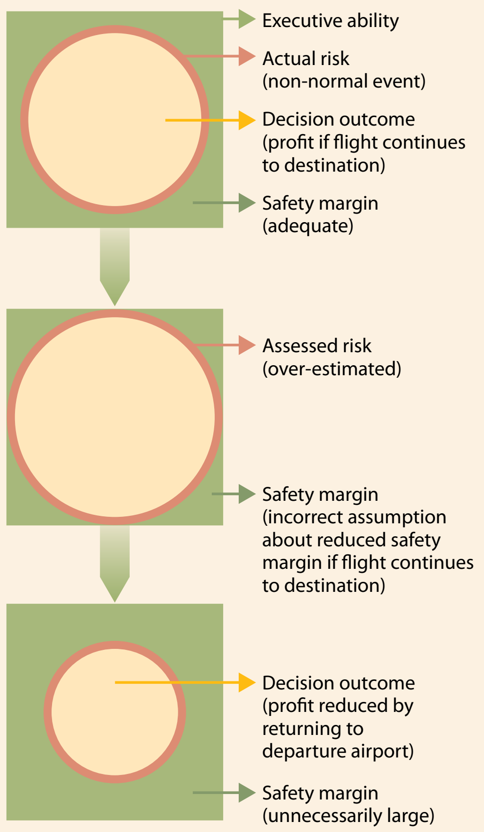
One case study looked at risk factors during a final approach at sunset after an asymmetric trailing edge flaps malfunction on a China Southern Boeing 757 operating from Chengdu to Jiuzhaigou. This uneventful flight was flagged for safety analysis.

“Jiuzhaigou is a most challenging airport to fly into,” Zhou said. “They just cut off the top of a mountain and set up the runway. The airport elevation is 11,311 ft, and only Runway 20 may be used due to terrain limitations. The flaps seized between positions 20 and 25 at about 2,000 ft above ground level [AGL] roughly 7 nm [13 km] from touchdown, or two minutes to go. In normal conditions, the Boeing 757 aircraft lands at this airport with flaps set at 25. In this case, there was a tail wind at 3 to 4 mps [6 to 8 kt], a wet runway with partial standing water, no braking action reports and time pressure.”

Pilots with the desired executive ability consistently recognize that timely decisions to go around are essential when critical tasks cannot be completed before landing. “[In this 757 approach] at the edge of night, some of the crew did not think in that way,” he said. “On the actual flight, both pilots had captain qualification per company policy. The copilot on the observer’s seat carried the quick reference handbook [QRH, and one minute elapsed as the non-normal checklist was performed]. Immediately after completion of the non-normal checklist and normal checklist, the height of the aircraft was 500 ft AGL, so the crew mostly could see the runway. The captain could see the increased landing distance and selected maximum autobrakes. Finally, the aircraft landed safely.”

The risk of this landing was analyzed retrospectively. If braking action on the 3,000-m (9,843-ft) wet runway had been good, the required landing distance for this non-normal configuration of flaps setting 20 and V_{REF20} (landing reference speed) of 144 kt would have been 1,584 m (5,197 ft), providing an adequate safety margin. If braking action had been medium, the distance would have been 2,465 m (8,087 ft) and if poor, 3,253 m (10,673 ft), he said.

Incorrect Risk Assessment Near Guangzhou



Note : The flight crew observed a “trailing edge flaps disagree” message after takeoff from Guangzhou on a five-hour flight to Urumqi. They returned to Guangzhou.

Source: Zhou Yizhi, China Southern Airlines

Figure 2

For all these landing distances in the QRH, however, the aircraft must be 50 ft over the runway threshold and land at the touchdown point, and the crew must apply maximum manual braking and select maximum thrust reversers.

Zhou analyzed the crew’s decision to land with medium braking action assumed, leaving a safety margin of 535 m (1,755 ft) and touchdown groundspeed of 190 kt (98 mps). “Clearly, the threat on that day was significant,” he said. “This crew did not consider properly the non-normal landing distance [or the need] to apply maximum braking and maximum reverse thrust. Their groundspeed was almost 100 mps [328 fps].” Thus, every second of flight before flare reduced the runway available for deceleration by 100 m (328 ft) so just a two-second aircraft handling error would have reduced the distance safety margin to 339 m (1,112 ft) with maximum manual braking — and less with the maximum autobrakes used.

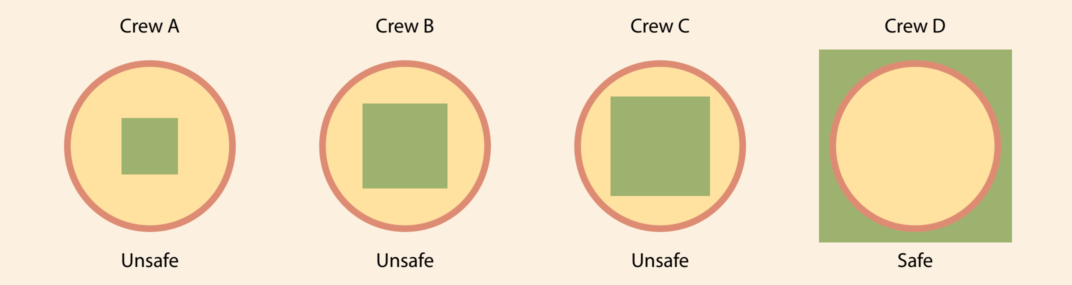
The square-circle model (Figure 1) showed the perimeter of the “actual risk” circle coinciding with the “assessed risk” circle. Overlaying both circles on the “executive ability” square left some safety margin visible. “Probably, they did not have enough safety margin, so I can say that even with a safe flight, the decision to land probably was not reasonable,” he said.

Another case study looked at the decision by a captain operating a 757 from Guangzhou to Urumqi (Figure 2); the crew had returned to the departure airport. “Just as the crew lifted off and during the process of aircraft acceleration and flap retraction, the message ‘TRAILING EDGE FLAPS DISAGREE’ appeared,” Zhou said. The crew complied with standard operating procedures, engaging the autopilot, reducing airspeed to flap maneuvering speed, climbing to a safety altitude of 1,200 m (3,900 ft), notifying air traffic control and conducting the corresponding non-normal checklist.

“One of the last items was ‘Alternate Flaps Selector — Set. Extend or retract flap as required.’” Zhou said. Executive ability influenced the decision. “The actual situation was ‘flaps extension and retraction [are] normal in alternate mode,’” he added. The crew had told safety investigators, “Possible problems after flap retraction were considered at the time, and there was no guarantee that problems wouldn’t occur during the remaining [five-hour] flight.”

The square-circle model showed that the crew had created an “unnecessary safety margin,” he said. “By correctly assessing the threat, within the safety margin, the crew’s decision should minimize operational cost as much as possible,” Zhou said.

Flight Crew Decisions With Different Executive Abilities: Kunming Arrival



Note: In these hypothetical scenarios, the flight crew is alerted soon after takeoff that both aircraft systems for automatic control of cabin altitude are inoperative. Perimeters of circles signify almost the same initial risk in continuing the flight using manual control. Squares signify different executive abilities demonstrated by these crews (bigger size means greater ability) while continuing to the destination.

Source: Zhou Yizhi, China Southern Airlines

Figure 3

Another case study interpreted actual and hypothetical crew responses to a dual malfunction of the automatic cabin pressurization systems. The actual flight cited was from Guangzhou to Kunming, which has an airport elevation of 6,220 ft. "After departure, the crew was instructed to climb to Flight Level 197 [6,000 m, approximately 19,700 ft]," he said. "While climbing through 6,000 ft, a malfunction occurred with the annunciation 'CABIN AUTO INOPERATIVE 1 AND 2.'" The crew correctly leveled off above the safety altitude, but below 10,000 ft, and conducted the non-normal checklist as they were trained.

"If the cabin altitude cannot be controlled manually, the crew obviously will return to the departure airport," Zhou said. "[When it can be controlled manually,] the choice the crew must make is to continue or return to the departure airport, considering the safety margin and company profit."

If the decision is to continue to the destination, the crew implicitly accepts responsibility to comply with a deferred item — select landing altitude — on the normal checklist; a procedure for manually adjusting cabin altitude during descent based on the specific change of altitude; and a deferred item on the non-normal checklist for which the QRH says, "When at pattern altitude: CABIN ALTITUDE MANUAL CONTROL — CLIMB. Position to CLIMB until outflow valve [is] fully open."

"Suppose that at the cruise altitude to Kunming — which was 8,400 m or 27,600 ft — the cabin altitude is 3,000 ft and after about two hours, the aircraft will descend," he said. "Also suppose we have four crews [Crew A, Crew B, Crew C and Crew D of different executive abilities]."

Crew A forgets to select the pressurization setting item in the normal checklist and the non-normal checklist items, so the cabin door cannot be opened safely.

Crew B forgets during descent the landing-altitude setting on the normal checklist but remembers to conduct the deferred item on the non-normal checklist. At the pattern altitude of 10,200 ft, the crew fully opens the aft floor valve and cabin altitude rapidly rises from 3,000 to 10,200 ft. This causes severe eardrum discomfort and possible ear injury, and triggers a cabin altitude warning.

Crew C manually sets landing altitude to 6,220 ft before descent and conducts the deferred items but fully opens the aft floor valve at pattern altitude. The consequences are less severe than for Crew B because the cabin altitude only rises from 6,220 to 10,200 ft, but the effects are similar: uncomfortable ear pain for occupants, possible ear injury and a cabin altitude warning.

Crew D manually sets landing altitude before descent, gradually increases cabin altitude from 7,000 to about 9,000 ft, then on final approach below 10,000 ft performs the deferred checklist item to open the aft floor valve. This action safely maintains comfortable cabin altitude, and there is no cabin altitude warning.

"For these crews, the decisions in the circles [Figure 3] were almost the same but the result varied due to the difference in their executive abilities," Zhou said. "Crew D's executive ability covered the decision making required. Executive ability of Crew A, Crew B and Crew C could not. So only Crew D was safe; Crew A, Crew B and Crew C were unsafe."

Regardless of executive ability, however, altering one variable would mask any difference in performance among these crews. "Suppose the destination is Shanghai, airport elevation 9 ft, instead of Kunming," Zhou said. "Both pattern altitude and the cabin pressure then would be 3,000 ft, and even if all crews continued to the destination, the threats discussed for Kunming would have been much smaller, so all would have the same safe outcome."

BY RICK DARBY

Part 135 Sightseeing Flight Accident Rates Improve

Air medical flights had lower rates than other categories.

The numbers of fatal accidents and fatalities in U.S. Federal Aviation Regulations (FARs) Part 135 revenue flights increased in 2008 compared with 2007, according to data published by the Air Charter Safety Foundation (ACSF).[1,2] A year-to-year increase was also found in Part 135 non-revenue flights.

The ACSF analyzed accident and incident data obtained from the U.S. National Transportation Safety Board (NTSB) and flight activity data obtained from the U.S. Federal Aviation Administration (FAA). The organization says that the study is "a critical step toward identifying trends in Part 135–related accidents" but was "limited in its analysis due to limitations on the data currently collected by the NTSB and FAA."

For example, the report says, no accident rates could be determined for cargo versus passenger flights because the FAA does not make

FARs Part 135 Accident Rates, 2004–2007

Accidents/100,000 Hours	2004	2005	2006	2007
Air medical	1.69	0.50	0.57	0.98
Cargo/passenger	2.09	1.86	1.42	1.54
Sightseeing	2.23	2.56	2.37	1.18
Other/unknown			N/A	N/A
Total	**2.04**	**1.70**	**1.39**	**1.54**

FARs = U.S. Federal Aviation Regulations

Note: Cargo and passenger flights are combined because the U.S. Federal Aviation Administration does not distinguish between them in compiling flight hours for Part 135 operations. Activity data for 2008 is not yet available.

Source: Air Charter Safety Foundation

Table 1

that distinction in recording flight hours of Part 135 operators. Therefore, cargo and passenger flights were grouped together in calculating accident rates (Table 1).

Although U.S. helicopter emergency medical services flights during 2009 were the subject of comprehensive risk-reduction initiatives by government and industry, the ACSF found that in every year from 2004 through 2007, revenue air medical flights — not necessarily emergency or helicopter operations — had lower accident rates than the other categories.[3] In 2007, for example, this category had 0.98 accidents per 100,000 hours. That was 36 percent lower than the combined cargo/passenger category, and 17 percent lower than for sightseeing flights.

Sightseeing flights had the highest accident rate of any category throughout 2004–2006 but showed a significant improvement in 2007. The 2007 rate, 1.18 accidents per 100,000 flight hours, was about half the 2006 rate of 2.37.

The rates for non-revenue flights were not determined, and all other data compared only numbers of accidents and fatalities.

More fatal revenue flight accidents occurred in 2008 than in any year since 2004, and the number of fatalities was highest in the five-year period (Table 2). Total accidents, however, were down 8 percent in 2008 from the previous year as well as from the average for the previous four years. One-third of the total accidents in 2008 were fatal.

Cargo and passenger revenue flight accident numbers were tallied separately (Table 3). The 21 cargo flight accidents in 2008 compared with an average annual of 23 in the four previous years. For passenger flights, the 26 accidents in 2008 matched the average in the previous four-year period. Sightseeing flights in 2008 had fewer accidents than in any year going back to 2004.

The percentages of oil rig–related flight accidents among total passenger aircraft accidents varied widely, from a high of 30 percent in 2004 to a low of 8 percent in 2008. On average for the five-year period, transportation to and from

FARs Part 135 Revenue Flight Fatal Accidents, 2004–2008

	2004	2005	2006	2007	2008
Fatal accidents	23	11	10	14	19
Non-fatal accidents	43	54	42	48	38
Total accidents	66	65	52	62	57
Fatalities	64	18	16	43	66

FARs = U.S. Federal Aviation Regulations

Source: Air Charter Safety Foundation

Table 2

FARs Part 135 Revenue Flight Accidents, by Purpose of Flight, 2004–2008

	2004	2005	2006	2007	2008
Air medical	8	3	4	9	6
Cargo	26	25	16	24	21
Passenger	27	28	23	24	26
Sightseeing	5	9	7	6	4
Other/unknown	0	0	2	1	1
Total	**66**	**65**	**52**	**64**	**58**

FARs = U.S. Federal Aviation Regulations

Note: One air medical accident in 2008 involved two aircraft. Therefore, although the total number of accidents in 2008 is 57, this and the following data reflect 58 aircraft and flights.

Two separate cargo-related accidents in 2007 involved two aircraft. Therefore, although the total number of accidents in 2007 is 62, this and the following data reflect 64 aircraft and flights.

Source: Air Charter Safety Foundation

Table 3

FARs Part 135 Revenue Flight Accidents, by Flight Conditions, 2004–2008

	2004	2005	2006	2007	2008
VMC	36	49	36	41	37
IMC	11	3	3	5	5
IMC/VMC	1	1	2	1	1
NVMC	10	8	7	12	9
NIMC	8	4	4	4	4
Unknown	0	0	0	1	2
Total	**66**	**65**	**52**	**64**	**58**

FARs = U.S. Federal Aviation Regulations; VMC = visual meteorological conditions; IMC = instrument meteorological conditions; IMC/VMC = mixed conditions; NVMC = night VMC; NIMC = night IMC

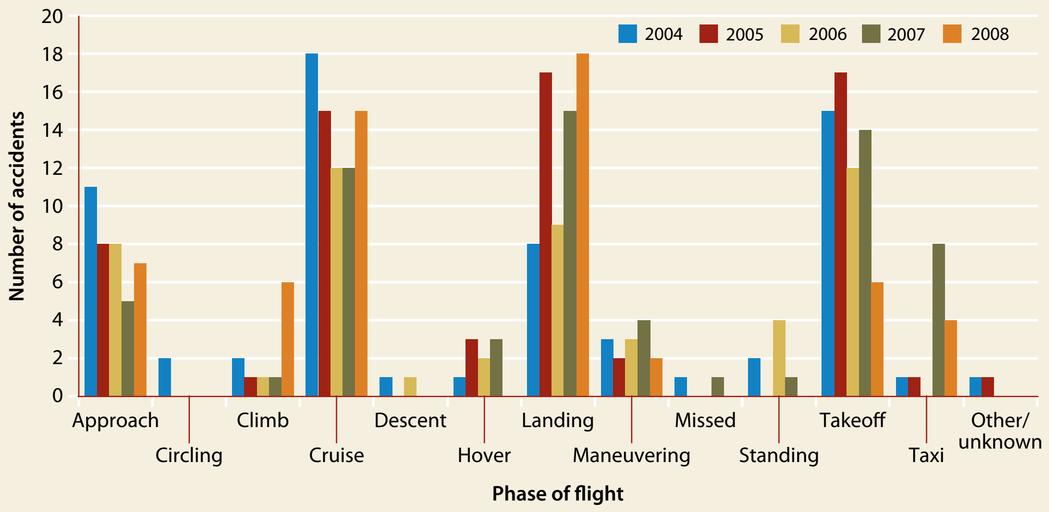
Source: Air Charter Safety Foundation

Table 4

oil rigs represented 18 percent of revenue flight accidents.

In every year of the study period, the majority of accidents in revenue flights occurred in visual meteorological conditions (VMC; Table 4, p. 49). Accidents in instrument meteorological conditions — as a percentage of all accidents where the flight conditions were reported — ranged from 5 percent in 2005 to 17 percent in 2004.

FARs Part 135 Revenue Flight Accidents, by Phase of Flight, 2004–2008

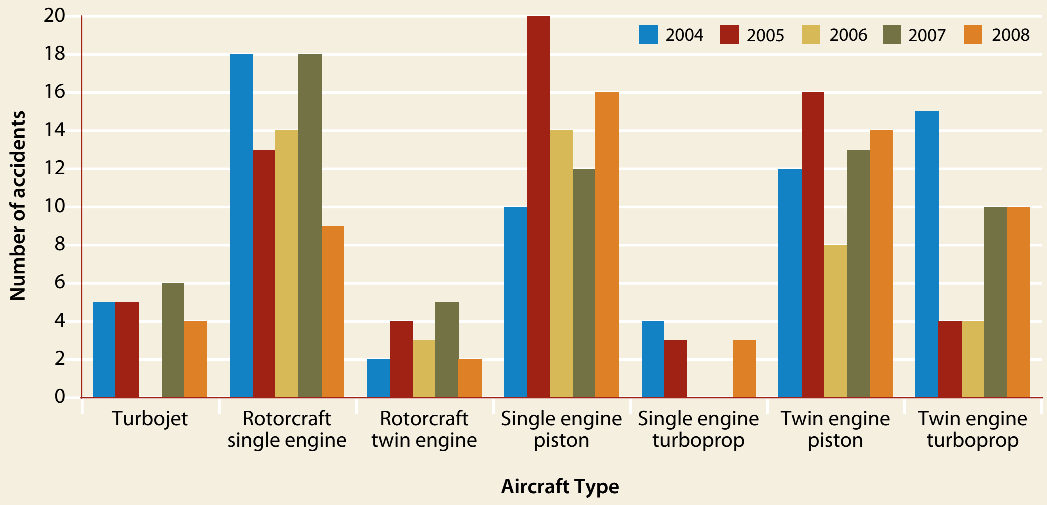


FARs = U.S. Federal Aviation Regulations

Source: Air Charter Safety Foundation

Figure 1

FARs Part 135 Revenue Flight Accidents, by Aircraft Type, 2004–2008



FARs = U.S. Federal Aviation Regulations

Source: Air Charter Safety Foundation

Figure 2

Takeoff, cruise and landing were the most common phases of flight reported in revenue flight accidents throughout the study period (Figure 1). Accidents in these phases totaled 64, 72 and 67, respectively. The number of takeoff accidents, which had averaged 15 from 2004 through 2007, dropped to six in 2008.

The report includes the distribution of revenue flight accidents by aircraft type (Figure 2). There was good news about helicopter accidents. Nine accidents in 2008 involved single-engine helicopters, compared with an average of 16 for the four prior years in the study period. The two accidents involving twin-engine helicopters were an improvement over the annual average of four in the four previous years.

The report also includes data for non-revenue flights flown by Part 135 certificate holders under FARs Part 91. Those include positioning, maintenance ferrying, instructional flights and miscellaneous others.

Jacqueline Rosser, ACSF executive director, told *ASW*, "Basically, we wanted to capture the 'lost' accidents. There are many accidents that occur while deadheading/positioning, but because those are not labeled as Part 135 operations by NTSB, they become lost in the general aviation accident data, when really those flights were the responsibility of the [Part 135] certificate holder. Until now, the number of Part 135 certificate holder–controlled and Part 91–flown accidents was an unknown. Identifying those events allows us to help operators better understand the risks for those flights and, hopefully, we can mitigate those risks."

Fatal non-revenue accidents increased to four in 2008 from two in 2007, but the 2008 number was lower than the average of eight in the four previous years (Table 5). Total non-revenue accidents, tabulated at 19 for 2008, were also higher than the previous year and lower than the annualized 26 in 2004 through 2007.

The number of fatalities increased in 2008 to 11, compared with five in 2007. The previous four-year average was 14. Fatal accidents represented 34 of 123, or 28 percent, of all non-revenue flight accidents during the five years studied.

Air medical operations contributed the largest number of non-revenue accidents during the study period, 44 (Table 6). Non-revenue passenger flight accidents, which numbered 14 in 2004 and 15 the following year, were reduced to two in 2007 and three in 2008.

Among non-revenue flights during the study period, 76, or 62 percent, occurred in VMC.

FARs Part 135 Non-Revenue Flight Fatal Accidents and Fatalities, 2004–2008

	2004	2005	2006	2007	2008
Fatal accidents	13	9	6	2	4
Non-fatal accidents	25	22	18	9	15
Total accidents	38	31	24	11	19
Fatalities	24	15	11	5	11

FARs = U.S. Federal Aviation Regulations

Source: Air Charter Safety Foundation

Table 5

FARs Part 135 Non-Revenue Flight Accidents, by Purpose of Flight, 2004–2008

	2004	2005	2006	2007	2008
Air medical	13	9	11	4	7
Cargo	2	2	3	1	0
Passenger	14	15	4	2	3
Sightseeing	2	0	0	0	0
Other/unknown	7	5	6	4	9
Total	**38**	**31**	**24**	**11**	**19**

FARs = U.S. Federal Aviation Regulations

Source: Air Charter Safety Foundation

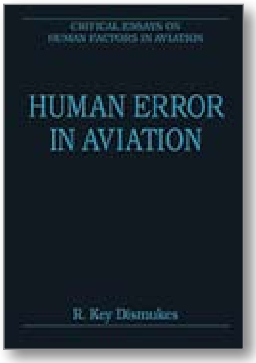
Table 6

Notes

1. FARs Part 135 is titled *Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft*.
2. Air Charter Safety Foundation. "Part 135 Accident/Incident Review, 2004–2008." Released Dec. 10, 2009. Free to members; nonmembers can order a copy for $25 from Jacqueline Rosser, 888.723.3135 (U.S.).
3. Air medical flights "are typically conducted in airplanes and are frequently not emergency- or trauma-related flights. Helicopter emergency medical services operations could be of an emergency nature or might be hospital or medical facility transfers."
4. Other than rates available in 2004–2007, the annual numbers give only a general idea of the significance of changes for safety because of the lack of information about risk exposure, such as flight hours or departures in a given period. Small numbers particularly may reflect random variation. Numbers have been rounded off to the nearest whole number, including when they involve a fraction of exactly 0.5.

Both Sides Now

Studying skilled performance is one way of understanding human error.



BOOKS

Ambiguity and the Need for Human Decisions

Human Error in Aviation

Dismukes, R. Key (editor). Farnham, Surrey, England and Burlington, Vermont, U.S. Ashgate, 2009. 604 pp. Figures, tables, references, index.

“Skilled human performance is the product of the most complicated and sophisticated information-processing system known in the universe: the human brain,” says Dismukes in his introduction to this anthology of articles from scientific and academic sources. “The essays reprinted in this book provide a cross-section of operational challenges, research accomplishments and issues that remain to be addressed. …

“Both correct performance and errors must be understood in the context of the experience, training and goals of the individual; characteristics of the tasks performed; human-machine interfaces; events — routine and unanticipated; interactions with other humans in the system; and organizational aspects. Those aspects include the organization’s explicit and implicit goals, reward structures, policies and procedures. Explicit and implicit aspects sometimes diverge; for example, the norms for how tasks are actually performed on the line may not be consistent with formal guidance.”

Although pilots make errors from time to time, he says, it is often a mistake to design the pilot further out of the system by adding another layer of automation. “Some of the most crucial tasks pilots perform cannot be handled by computers,” he says. “Most of the time, humans — but not computers — are able to make reasonable decisions in novel situations; when available information is incomplete, ambiguous or conflicting; and when value judgments are required.”

As an example of the latter situation, Dismukes presents a scenario in which a passenger is having a heart attack while the aircraft is on approach to an airport with deteriorating weather. Can a computer balance the need to get medical help for the passenger as quickly as possible with trying to land where the weather conditions might pose a high risk?

He believes that studying the skilled performance and errors of aviation personnel other than pilots has not received enough attention, compared with studies of pilots’ performance, possibly because there is a bias in accident investigations to focus on the person who performed the final actions before the accident. “Equipment failures leading to accidents can often be traced to inadequate maintenance, so we should be equally concerned with mechanics’ errors, which, like pilot errors, should be considered manifestations of weaknesses and flaws in the overall system,” he says. “Similarly, we should be concerned with the skilled performance and errors of air traffic controllers, dispatchers, instructors, managers, equipment designers and all others in the aviation system whose work affects safety and production."

Although Dismukes was able to find worthwhile essays on particular dimensions of performance and on factors that affect the quality of performance in those dimensions, he was disappointed at how few essays he reviewed for possible inclusion in the book were published in peer-reviewed journals and provided a "thoughtful, critical overview of a domain of skilled performance in aviation."

He suggests two reasons why more research is not being conducted on skilled performance and human error. The first is that it is hard to design controlled, laboratory experiments in this field. Cognitive processing and behavior are relatively easy to study, he says, but it is a different story when scientists try to design replicable experiments concerned with flying aircraft. These involve "multiple, dynamically shifting tasks, incomplete and ambiguous information and competing goals."

The second reason, he believes, is lack of funding. "A handful of full-mission flight simulator facilities dedicated to research on aircrew performance exist around the world," he says. "However, the cost of such facilities runs into the tens of millions of dollars, and running enough experimental subjects (pilots) through a simulation to answer a given research question requires a very long and expensive study. … Fortunately, some research questions can be answered using lower fidelity simulators that are much cheaper."

The book is divided into four sections, each beginning with a brief introduction to set the stage for its essays. The first section is devoted to conceptual frameworks for thinking about skilled performance and error; the next offers selections that address specific aspects of performance such as workload, automation management, situation awareness, risk assessment and crew resource management (CRM).

The next section comprises essays about factors affecting performance, such as fatigue, stress, age, experience and organizational influences. The fourth section broadens the scope to include maintenance and air traffic control.

"Crews as Groups: Their Formation and Their Leadership," by Robert Ginnett, is one example of the type of material in the book. In CRM, he says, a group — not individuals — is the basic unit, which does not come naturally in an individualistic culture where personal achievement is stressed. He examines how a group most effectively becomes a coherent team.

"Groups are something more than merely a collection of the individuals comprising them," he says. "Some groups do remarkably well with no particularly outstanding individuals. Other groups, made up almost exclusively of high-performing individuals, do not do at all well as a team."

The optimal crew, he says, is not an "all-star team" but people who can integrate their experiences and strengths, particularly when the unexpected arises. "In many accidents in today's complex systems and environment, it is common to find that some aspect of the environment or situation created ambiguity which, by definition, eliminates a structured solution," he says. "After all, if you do not know what the problem is, it is unlikely that you know what the solution is! But if you can get two or three independent critical thinkers involved, you will have a better chance of ruling out individual biases and will be on the road to a more effective solution."

The optimal crew, is not an 'all-star team' but people who can integrate their experiences and strengths, particularly when the unexpected arises.

One key to a well-functioning crew is the quality of the leader. In the cockpit, that is the captain. Ginnett quotes from an earlier study of his when he interviewed subordinate pilots and asked, "Are all the captains you fly with pretty much the same?"

One response was, "Oh, no. Some guys are just the greatest in the world to fly with. … When you fly with them, you feel like you want to do everything you can to work together to get the job done. Some other guys are just the opposite. You just can't stand to work with them.

That doesn't mean you'll do anything that's unsafe, but you won't go out of your way to keep him out of trouble either."

Ginnett discusses some of the characteristics of captains who, prior to observation in a study, were assessed by check pilots as being especially skilled at creating highly effective teams. He calls them HI-E captains.

"Contrary to expectations, the HI-E captains hardly discussed tasks at all," Ginnett says. "Even when tasks were mentioned — closing the cabin door, retracting the aft air stairs or keeping the cockpit door open prior to pushback — they were more about boundary issues than about the tasks themselves."

Boundary issues are essentially a question of who is included in the group. "The HI-E captains … worked to create a larger vision of the relevant work group — one that exceeded the bounds of the aircraft," Ginnett says. "They took pains to include, at least psychologically, gate personnel, maintenance and air traffic controllers as part of the group trying to help them — not as an outside hostile group trying to thwart their objectives."

The HI-E captain can communicate standards and expectations both through formal briefings and by modeling the desired norms.

The Zeus-like authoritarian captain is supposed to be a thing of the past. Instead, the HI-E captain can communicate standards and expectations both through formal briefings and by modeling the desired norms. "For example, a captain may quite subtly transmit the importance of exchanging information as the group goes about its work by merely taking the time to exchange information (two-way communication) in the time allotted for the crew briefing. The norm that 'communication is important' is expressed in the series of exchanges including (1) I need to talk to you; (2) I listen to you; (3) I need you to talk to me; or even (4) I expect you to talk to me."

The captain's expression of authority can be visualized as a continuum, with "laissez-faire" at one end and "autocratic" at the other. Ginnett found that the HI-E captains did not settle somewhere around the mid-point; they shifted one way or another as circumstances or their intentions changed. At no time, however, did they move all the way to the laissez-faire pole.

Ginnett says that the HI-E captains used three methods to build an effective leader-team relationship.

The first was establishing their competence. They demonstrated the legitimacy of their authority by means such as logical organization of their briefing, using the language of aviation precisely and showing comfort in the group setting.

Second was disavowing perfection. The HI-E captains made it clear that the other crewmembers were expected to take responsibility for the work of the group. One said, "I just want you guys to understand that they assign the [cockpit] seats in this airplane based on seniority. So anything you can see or do that will help out, I'd sure appreciate it."

The third behavior was engaging the crew. Instead of giving a completely standardized briefing that might as well have been a recording, they were interactive. "By dealing in real time with the people who were filling the roles, they conveyed important normative information about themselves and the value of the individuals who made up this particular group," Ginnett says.

— Rick Darby

WEB SITES

Boeing Firefighting Aid

Boeing Commercial Airplanes, Airport Technology, <www.boeing.com/commercial/airports/rescue_fire.htm>

To benefit airports, airlines, and fire and rescue departments, Boeing has made airport rescue and firefighting (ARFF) information about its Boeing, McDonnell Douglas and Douglas aircraft models available via the Internet. Boeing's instruction sheets and diagrams for each aircraft type highlight precise locations of flammable materials and equipment, techniques to gain emergency rescue access, locations of batteries and flight deck control switches, and interior and exterior aircraft sections made of composite materials.

Instruction sheets include detailed information on fuel tank capacity and hydraulic reservoirs, operation of switches and controls, floor height from ground, methods for dealing with hot brakes and wheel fires, ways to determine aircraft surface integrity, and other critical information.

The 2009 edition of "Aircraft Rescue and Fire Fighting Information" is available in English only as a single manual or as individual instruction sheets by aircraft type. A 1999 edition of the manual is available in Russian. All materials may be read online, printed or downloaded at no cost. Instruction sheets in large formats for training purposes may be requested from an address provided on the site.

Boeing's responses to inquiries from airport operators and airport and community fire departments about airport emergency planning have been compiled into additional instructional documents. Examples of information covered include "Aircraft Recovery Planning at Airports" with lists of recommended equipment and "Tire Safety" diagrams showing hot-brake and damaged-tire safety areas. "Firefighting Practices for New Gen Composite Structures" describes fire behavior of composite materials. Use of foam on runways for aircraft experiencing unsafe landing gear issues is discussed in "Runway Foaming Requirements." Some materials cite compliance, regulations and guidelines from the U.S. Federal Aviation Administration and the International Civil Aviation Organization.

For commercial airports that might encounter transient military flights or host military air shows, Boeing identifies contact information within the U.S. Department of Defense.

— Patricia Setze

Law Group Offers Safety News

Nolan Law Group, <www.nolan-law.com>

Nolan Law Group's core practice area is representing clients in legal cases involving aviation accidents. Blogs, white papers, accident alerts, news and case reports are some of the aviation resources available on the company's Web site.

Researchers will find two blogs by aviation writer David Evans and others. The first, "Aviation Safety Journal," contains articles on accident events and related regulations and news. The blog maintains a chronological list of general and commercial aircraft accidents and incidents. Entries contain essential information; some include photos.

The second blog, "Helicopter Accident Digest," is similar in design. Like "Aviation Safety Journal," there is a chronological list of accidents and incidents. Recent discussions cover news, operational and safety issues, regulatory oversight, the investigation process, and litigation procedures.

There is also a list of Internet links to support organizations and government and consumer agencies.

Three videos from *NASA Pilots Guide to In-Flight Icing* — "How Icing Occurs," "How Icing Affects Flying Performance" and "How Icing Forms on Unprotected Areas" — may be viewed free online.

— Patricia Setze

Control Anomaly Catches Crew Unaware

The Citation pilots did not know what went wrong or how to deal with it.

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

High Airspeed Intensified the Problem

Cessna Citation 550. Destroyed. Six fatalities.

The flight crew's "lack of coordination" and "mismanagement of an abnormal flight control situation" were the probable causes of the crash of a Citation II into Lake Michigan on June 4, 2007, said the U.S. National Transportation Safety Board (NTSB) in its final report on the accident.

The board was not able to determine conclusively what caused the flight control problem, however.

The pilots had flown a medical transplant team from Ypsilanti, Michigan, U.S., to Milwaukee to harvest an organ. After about four hours on the ground, the Citation departed from Milwaukee's General Mitchell International Airport at 1557 local time for the return flight to Ypsilanti.

The captain, 59, had about 14,000 flight hours, including 12,000 hours in a variety of transport category airplanes, with 300 hours in the Citation 500/550 series. He was the charter company's chief pilot and check airman.

The first officer, 65, had about 9,200 flight hours, including 420 hours in type, and held a Citation 500/550 type rating. He was a businessman who flew part-time for the charter company.

Marginal visual meteorological conditions (VMC) prevailed when the airplane lifted off from Runway 01L. The departure clearance called for a climb on runway heading to 2,000 ft, followed by a right turn to 050 degrees. Soon after starting the turn, the captain asked the first officer, "Why am I fighting the controls here?"

The first officer replied, "How's your trim set? Is that the way you want it?"

The captain said, "It wants to turn hard left. … Something is wrong with the trim … the rudder trim. … Something is wrong with our rudders, and I don't know what."

He told the first officer to inform air traffic control (ATC) that they were returning to land at Mitchell. Shortly thereafter, the sound of a grunt was recorded by the cockpit voice recorder (CVR), and the captain said, "She's rolling on me. Help me. Help me."

"I am," the first officer said.

The captain asked the first officer to pull the autopilot circuit breakers. The first officer — who was known to have deficient systems knowledge, according to the report — asked where they were located.

The captain did not answer the first officer's question. He declared an emergency, telling ATC that he had a control problem. "I don't know what's wrong," he said.

He told the first officer, "You hold it, I'm going to try to pull circuit breakers." He then said, "We're not … holding it."

"I'm pulling," the first officer said. Five seconds later, at 1600:45, the CVR recording ended.

The Citation was in a 42-degree nose-down attitude and in a 115-degree left bank when it struck the water at about 243 kt. The fragmented wreckage was recovered by divers.

Investigators determined that the control problem might have been related either to inadvertent engagement of the autopilot or to an electric pitch trim anomaly. "Without an FDR [flight data recorder] or image recorder on board, it was not possible to determine the exact cause of the initiating event or the pilots' actions during the accident sequence," the report said.

Noting that the autopilot and yaw damper push buttons are identical and close together on the center pedestal, the report said that if the autopilot had inadvertently been engaged by the first officer when he attempted to select the yaw damper on initial climb, the autopilot would have tried to maintain the climb pitch attitude and the runway heading when the captain leveled off at 2,000 ft and initiated the right turn to the assigned heading.

If the initiating event was a nose-down pitch trim runaway, the pilots would have had to place as much as 140 lb (64 kg) of back pressure on their control columns to counter it. "Although the airplane would have been controllable … it would have required a significant physical effort by both pilots working together to keep the airplane upright," the report said.

When investigators explored these scenarios in a Citation flight simulator, the participating pilots were able to recover only after reducing power and airspeed to reduce the control forces.

"Regardless of the initiating event, if the [accident] pilots had simply maintained a reduced airspeed while they responded to the situation, the aerodynamic forces on the airplane would not have increased significantly," the report concluded. "At reduced airspeeds, the pilots should have been able to maintain control of the airplane long enough to either successfully troubleshoot and resolve the problem or return safely to the airport."

The report also said that the pilots' actions in response to the control problem were not coordinated. CVR data indicates that the first officer adjusted the trim settings without consulting the captain.

Moreover, the report said, "The first officer's trim inputs aggravated, rather than ameliorated, the situation." For example, a performance study indicated that after the first officer said, "How's that? Any better?" about a minute before impact, the airplane banked steeply and the CVR recorded the sound of the captain grunting.

The report said the accident illustrates that when pilots encounter abnormal flight control forces, "they should prioritize airplane control (airspeed, attitude and configuration) before attempting to identify and eliminate the cause of the flight control problem."

Among recommendations based on the findings of the investigation, NTSB called on the U.S. Federal Aviation Administration to require on-demand operators and fractional ownership operators to provide their pilots with recurrent upset recovery training (*ASW*, 11/09, p. 22).

'At reduced airspeeds, the pilots should have been able to maintain control.'

Speed Brakes Neglected on Go-Around

Boeing 757-200. No damage. No injuries.

The 757 was inbound with 78 passengers and eight crewmembers from Innsbruck, Austria, to London Gatwick Airport, where surface winds the morning of Dec. 13, 2008, were from the southeast at 14 kt, gusting to 26 kt.

"Runway 08R was in use, and aircraft were being radar-vectored to intercept the ILS [instrument landing system] from the south," said the U.K. Air Accidents Investigation Branch (AAIB) report. "The wind at 2,000 ft was 50 kt from the south."

Groundspeed was 190 kt and the aircraft was high as it neared the final approach course, so the commander, who was flying with the autopilot and the autothrottles engaged, deployed the speed brakes.

The autopilot localizer mode was armed too late to capture the localizer from the south, so the commander disengaged the autoflight systems and hand-flew the aircraft onto the final approach course. He then re-engaged the autopilot but not the autothrottles.

The landing gear was extended — and the speed brakes were still deployed — when the crew selected the flap 20 setting. Shortly thereafter, the stick shaker activated and the autopilot automatically disengaged.

"The commander immediately lowered the aircraft's nose and increased engine thrust," the report said. "The airspeed increased and the stick shaker stopped, but the crew decided that the best [course] of action was to go around."

The stick shaker activated and the autopilot automatically disengaged.

The aircraft was descending through 1,000 ft when the go-around was initiated. The commander selected the takeoff/go-around mode, but neither pilot checked to ensure that the speed brakes were retracted, as required for a go-around.

The commander became confused and disoriented because the aircraft's attitude and performance did not appear normal, the report said. Moreover, the flight director pitch bars had inexplicably disappeared from the primary flight displays. The commander transferred control to the copilot, who appeared to have better situational awareness, and subsequently noticed that the speed brakes were deployed. He retracted them, and the crew completed the go-around and a second approach to a landing without further incident.

The report noted that the 757 training manual recommends that the pilot flying "keep his hand on the speed brake lever whenever the speed brakes are used in flight; this will preclude leaving the speed brake extended."

Tires Burst Under Heavy Braking

Raytheon 390 Premier I. Substantial damage. One minor injury.

The aircraft encountered continuous turbulence during a charter flight from Jodhpur, India, to Udaipur the morning of March 19, 2008. Surface winds at the destination were from 230 degrees at 10 kt. During a visual approach to Runway 26, the "FLAP FAIL" annunciator illuminated, and the pilots were unable to extend the flaps.

"Subsequently, the pilots carried out the checklist for a flap-less landing," said the report by India's Directorate General of Civil Aviation (DGAC). "However, the pilot approached with a higher speed." The airspeed recommended by the checklist is reference landing speed (V_{REF}) plus 20 kt, or 135 kt at the aircraft's landing weight. Airspeed on short final approach, however, was 149 kt.

"At about 20 to 30 ft above the ground, the pilot stated [that the aircraft] experienced a sudden downdraft [and then] touched down heavily on the runway," the report said. "The touchdown was on the centerline, just before the touchdown zone."

The crew applied heavy wheel braking but did not extend the spoilers. Both main landing gear tires burst, and the aircraft veered off the right side of the 7,500-ft (2,286-m) runway about 2,200 ft (671 m) from the approach threshold and struck the airport boundary wall. The copilot sustained minor injuries; the pilot and five passengers were not hurt.

The report did not provide information on the likely causes of the flap-extension system failure.

Ninety-Tonne Takeoff Error

Airbus A330-243. No damage. No injuries.

While preparing for a flight from Montego Bay, Jamaica, to an undisclosed location in the United Kingdom the night of Oct. 28, 2008, the A330 flight crew was unable to locate the aircraft's performance manual, which had been improperly stowed among navigation charts, the AAIB report said.

The commander used a mobile telephone to call the airline's dispatch office in the United Kingdom and to request takeoff performance data calculations.

According to airline procedure, such calculations must be derived independently by both flight crewmembers working with different dispatchers. The pilots provide information including the aircraft's takeoff weight, airport weather conditions and runway data. The dispatchers enter the information into an Airbus computer system, which calculates takeoff speeds (V_1, V_R and V_2), permitted takeoff thrust reduction and the "green dot speed" — that is, the target airspeed to be used if the takeoff is continued after an engine failure. The pilots then compare and cross-check the data received from the dispatchers.

The report noted that pilots of Airbus aircraft typically perform a "gross error check" by comparing the green dot speed calculated by the manufacturer's computer system with the value independently calculated by the on-board flight management guidance system (FMGS).

However, the incident pilots were not given a green dot speed; for unknown reasons, the computer function that enables this calculation had been disabled at the airline's dispatch office.

Moreover, although two dispatchers were on duty, only one was in the dispatch office when the commander called. "Only he processed the data," the report said. "He did, however, speak with both pilots and confirmed the input data and performance data with each."

Nevertheless, a substantial discrepancy went unnoticed: The A330's load sheet showed a takeoff weight of 210,183 kg (463,369 lb), but the performance calculations were based on an erroneous takeoff weight of 120,800 kg (266,316 lb). Investigators were unable to determine how the mistake was made, in part because the telephone conversations between the pilots and the dispatcher were not recorded, and the CVR data subsequently were overwritten.

The calculations provided to the pilots included 114 kt for both V_1 and V_R (the correct figures were 136 kt and 140 kt, respectively) and an FMGS data entry — an artificial outside air temperature — that resulted in a reduced takeoff thrust setting that was lower than the correct setting for the autothrottle system.

Although the takeoff speeds and the thrust setting were lower than normal, "the crew were unable to explain why they did not recognize that the figures they used were outside the expected range," the report said.

There were 318 passengers and 13 crewmembers aboard the A330 when the pilots began the takeoff from Sangster International Airport's 2,663-m (8,737-ft) Runway 07 at 2326 local time.

"The aircraft appeared to accelerate normally, and the copilot made the standard calls as the aircraft passed through 100 kt and then V_1/V_R," the report said. "The commander was surprised by how close the calls had followed on from each other. … He pulled back on his sidestick and pitched the aircraft to about 10 degrees nose-up but stated that the aircraft 'did not feel right' and instinctively selected TOGA [takeoff/go-around] power.

"The aircraft then became airborne and climbed away. … By 50 ft radio altitude, the aircraft had covered an estimated distance of approximately 2,500 m [8,202 ft] since the start of the takeoff roll."

The flight continued to the destination without further incident.

Citing the findings of the investigation of this incident and those of other incidents and accidents involving erroneous takeoff performance calculations (*ASW*, 10/06, p. 16, and *ASW*, 9/08, p. 28), the AAIB recommended that the European Aviation Safety Agency develop specifications for takeoff performance monitoring systems and require installation of the systems aboard transport category aircraft.

Deicing Fluid Fouls Cabin

Boeing 737-800. No damage. No injuries.

The flight crew had not configured the 737 for deicing before ground crewmembers began deicing operations after the airplane was pushed back from the gate at Seattle-Tacoma International Airport the morning of Dec. 24, 2008. The auxiliary power unit was operating and the engine bleed air valves were open, allowing deicing fluid to enter the air supply lines for the cabin and cockpit, the NTSB report said.

The cabin crew reported fumes in the cabin, and the flight crew saw a "gray cloud" in the cockpit, the report said. After telling the ground crew to discontinue deicing operations, the flight crew completed the smoke removal checklist, started the engines and taxied the 737 back to the gate, where the 135 passengers and six crewmembers disembarked via the airbridge.

"The captain reported that he did not clear the ground deicing crew to start their deicing operations," the report said. "The driver of the primary deicing vehicle reported that he informed the flight crew of the fluid types, freeze points and concentrations. He added that there was a lot of 'radio chatter' and the bucket operator began deicing operations 'after we received no objections' from the flight crew."

The flight crew saw a 'gray cloud' in the cockpit.

Tow Bar Snaps During Pushback

British Aerospace RJ85. Substantial damage. No injuries.

All four engines were operating at idle power while the aircraft was pushed back from the stand at Dublin (Ireland) Airport the evening of March 2, 2009. The tug driver stopped the pushback on a taxiway and then began to pull the aircraft forward.

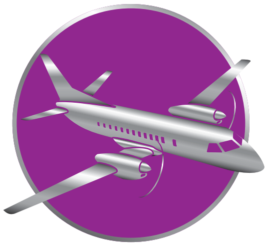
"This pull forward was not in a straight line but in an arc," said the report by Ireland's Air Accident Investigation Unit. "This was carried out on his [the tug driver's] own initiative with the probable intention of a minor realignment of the aircraft nosewheel back onto the taxi line."

The tug driver perceived that the aircraft, which weighed 34,300 kg (75,618 lb), was pushing the tug on the wet taxiway, which had a slight downhill slope. "He braked, but the aircraft continued forward," the report said. "The tug jackknifed, and the tow bar broke (the shear pins did not shear). The aircraft continued forward under its own inertia and struck the tug."

The 48 passengers and five crewmembers disembarked through the aft cabin door. Examination of the aircraft revealed substantial damage to the fuselage skin, frames and substructure on the lower right side of the nose.

The report noted that the tug, which weighed 5,750 kg (12,676 lb), had markings indicating that it was to be used "for pushback only."

Among postaccident revisions to the airline's ground-handling procedures was a requirement that only one engine can be started at the stand and that the other engines can be started only after the pushback operation is completed and the aircraft's brakes are set.



TURBOPROPS

Icing Suspected in Approach Stall

Gulfstream Commander 690C. Destroyed. Three fatalities.

Moderate icing conditions were forecast along the business airplane's route of flight from Denver to Wray, Colorado, U.S., the morning of Jan. 15, 2009. Wray Municipal Airport is uncontrolled and has no weather-reporting facilities. While en route, the pilot received from ATC the current weather conditions at the two closest weather-reporting stations.

Akron, Colorado, which is 52 nm (96 km) west of Wray, had 4 mi (6 km) visibility in mist and a 100-ft overcast ceiling. Imperial, Kansas, 42 nm (78 km) northeast, had 3 mi (4,800 m) visibility in light snow and a 1,600-ft overcast.

The pilot requested and received clearance from ATC to conduct the global positioning system (GPS) area navigation approach to Runway 17 at Wray.

Several witnesses saw the Commander emerge from low clouds north-northeast of the airport. "Shortly thereafter, the airplane pitched down to a near-vertical attitude and began to rotate," the NTSB report said. "The airplane impacted the ground nose-first, and a fire erupted."

Investigators determined that the airplane was 560 lb (254 kg) over gross weight and that the center of gravity was at or just forward of the forward limit.

NTSB determined that the probable cause of the accident was an aerodynamic stall resulting from "the pilot's failure to maintain aircraft control during the approach" and that icing conditions were a contributing factor.

Near the time of the accident, a Beech King Air pilot reported that, despite frequent operation of the deicing boots, his airplane had accumulated a significant amount of ice while flying in the area. "In a follow-up telephone conversation with the pilot, he characterized the ice that day as 'sticky' and hard to get rid of," the report said.

Control Lost in Low Visibility

Beech King Air C90. Destroyed. Two fatalities.

Loss of control during a sudden maneuver to avoid an obstruction likely caused the King Air to strike terrain during a visual approach in low visibility the morning of Oct. 29, 2008, said the report by India's DGAC.

The aircraft was operated by the Punjab state government. The pilots were conducting a short positioning flight from Chandigarh to Ludhiana. The report said that neither pilot had previously flown to Ludhiana or had proper endorsement to fly the King Air. The pilot-in-command, who was in the right seat during the flight, had not received required familiarization training; and there was no record to verify the copilot's claim of 50 flight hours in type.

Visibility was 1,500 m (less than 1 mi) in haze and smoke, and the flight crew was given a special visual flight rules clearance to the airport, which had no instrument approach procedure. "They were estimating their position based on GPS," the report said.

The crew spotted Ludhiana's Runway 12 too late to land during the first visual approach and initiated a go-around. However, instead of complying with procedure requiring an initial climb to 1,000 ft above ground level (AGL), they leveled at about 300 ft AGL and then descended while circling to the right of the runway in an apparent effort to maintain visual contact with the runway.

The report said that the aircraft was at about 100 ft AGL when the crew likely saw an unmarked tower ahead and lost control while trying to avoid it. The King Air was banked steeply left when it struck terrain and burned.

PISTON AIRPLANES

Disorientation Leads to Control Loss

Beech 58 Baron. Substantial damage. One fatality.

Night VMC prevailed when the pilot departed from Cleveland's Burke Lakefront Airport for a positioning flight on Jan. 16, 2008. After taking off to the southwest, the pilot initiated a right climbing turn over Lake Erie.

"The moon and city associated with the airport were south of his flight path," the NTSB report said. "The maneuvering of the aircraft and lack of outside visual references soon after takeoff made the situation conducive to spatial disorientation."

The airport traffic controller saw the Baron descend during the right turn and strike the water. Examination of the aircraft revealed no pre-impact anomalies and verified that both engines were producing high power when the crash occurred.

Investigators found that the 68-year-old pilot had been using a potentially sedating muscle relaxant for back pain. "He had heart disease identified during the autopsy that may have increased his risk of sudden cardiac death," the report said. "However, the investigation could not conclusively identify that the pilot was impaired."

NTSB concluded that spatial disorientation was the probable cause of the accident.

Turbulence Triggers Breakup

Rockwell Aero Commander 500S. Destroyed. Two fatalities.

Night instrument meteorological conditions prevailed for the business flight from Essendon to Shepparton, both in Victoria, Australia, on July 31, 2007. ATC radar and radio contact with the aircraft were lost when it was about 25 nm (46 km) north-northwest of Essendon at 7,000 ft over the Great Dividing Range.

"The wreckage was found in the area of the last radar position, and both occupants had been fatally injured," said the report by the Australian Transport Safety Bureau. "At the time, special weather reports for severe turbulence and severe mountain waves were current for that area." Local residents said that surface wind velocity was 50 kt.

Investigators calculated that the Commander's true airspeed was about 165 kt when radio and radar contact were lost; the aircraft's weight-adjusted maneuvering speed was about 131 kt. "Flight through an area of severe turbulence at speeds at or above the aircraft's maneuvering speed increases the risk of aircraft structural failure," the report said.

Examination of the wreckage indicated that the Commander likely broke up while it was in level cruise flight. "The breakup most likely resulted from an encounter with localized and intense turbulence or from an elevator control input, or from a combination of both," the report said.

Leak Prevents Gear Extension

Cessna 421C. Substantial damage. No injuries.

At the conclusion of a business flight the night of Oct. 29, 2008, the pilot received no indication that the left main landing gear was down and locked on approach to Falcon Field in Mesa, Arizona, U.S. He made several unsuccessful attempts to extend the gear using the normal procedure.

"The pilot attempted to extend the gear using the emergency procedure, and he was similarly unsuccessful," said the NTSB report.

The pilot landed the airplane with the left main gear partially extended. The 421 veered off the runway and slid to a stop. "Belly skin was punctured, and several ribs were bent upward," the report said. None of the five people aboard the airplane was injured.

Examination of the 421 revealed that an aluminum hydraulic line had ruptured beneath a clamp, allowing hydraulic fluid to leak. The report noted that the airplane had 4,113 airframe hours.

HELICOPTERS

Short Causes Engine Deceleration

Eurocopter EC 130B4. Substantial damage. No injuries.

Soon after slowing the helicopter to 30 kt to give his air tour passengers a view of waterfalls, the pilot heard the main rotor low speed warning horn and saw instrument indications confirming that main rotor speed was decreasing.

"He entered into an autorotation to make a forced landing and tried to regain engine torque and rotor speed but was unsuccessful, and the low rotor horn sounded again," the NTSB report said. "The helicopter came down in trees, with the main rotor blades contacting the treetops."

None of the six people aboard the helicopter was hurt in the accident, which occurred in Lahaina, Hawaii, U.S., the morning of Jan. 5, 2006.

Initial examination of the helicopter revealed damaged insulation and electrical shorts in the wiring harness for the digital engine control unit and the ancillary control unit. "Further examination and testing revealed the insulation breakdown was a result of wire damage due to a tight bend in the harness," the report said.

The wiring harness was longer than necessary and had been bent tightly to facilitate its installation during the manufacture of the helicopter, the report said. The helicopter — the first EC 130B4 delivered to a customer — had been in service more than 4,800 hours.

The helicopter had received a lightning strike in August 2004, but "no evidence of lightning strike damage was found in any of the wiring" during the investigation of the air tour accident, the report said.

Tarpaulin Fouls Main Rotors

Aerospatiale SA 315B. Substantial damage. No injuries.

The helicopter was carrying construction materials for a television relay antenna to a temporary helibase in Obonai, Japan, the afternoon of Oct. 23, 2008. The pilot said that during initial approach, he saw a pile of folded blue tarpaulins about 4 m (13 ft) from the helipad and, before continuing the approach, visually confirmed that timber had been placed on the tarpaulins to secure them.

The report by the Japan Transport Safety Board said that the timber placed on the tarpaulins was not heavy enough to secure them properly.

As the pilot brought the helicopter to a hover slightly above the helipad, several tarpaulins were blown into the air by its downwash, and one tarpaulin was "sucked into its rotor disc," the report said. The pilot felt the helicopter begin to vibrate and yaw left as it touched down. He shut down the engine and applied the rotor brake.

None of the three people aboard the helicopter was hurt. Examination of the aircraft revealed that one of the three main rotor blades was damaged, some tail boom truss tubes were broken, the tail boom and tail rotor drive shaft were bent, and the left shock strut was broken.

Control Lost in Clouds

Robinson R44. Substantial damage. Two serious injuries.

The commercial pilot and his flight instructor discontinued an instrument training flight because of turbulence the night of Jan. 8, 2009. The commercial pilot was flying the R44 back to Bountiful, Utah, U.S., under visual flight rules when the helicopter entered clouds.

The pilot became spatially disoriented and lost control of the helicopter. "The flight instructor took the controls and attempted to regain control but was unable to do so before the helicopter impacted the ground," said the NTSB report.

Preliminary Reports, October–November 2009

<table>
<tr><th>Date</th><th>Location</th><th>Aircraft Type</th><th>Aircraft Damage</th><th>Injuries</th></tr>
<tr><td>Oct. 1</td><td>Lacco Yavero, Peru</td><td>Aerospatiale AS 350B3</td><td>destroyed</td><td>3 fatal</td></tr>
<tr><td colspan="5">The helicopter crashed in the jungle during a survey flight.</td></tr>
<tr><td>Oct. 6</td><td>Aurora, Texas, U.S.</td><td>Beech King Air B100</td><td>destroyed</td><td>4 serious</td></tr>
<tr><td colspan="5">The King Air crashed in a field after both engines lost power.</td></tr>
<tr><td>Oct. 15</td><td>San José de Ocoa, Dominican Republic</td><td>Eurocopter EC 120B</td><td>destroyed</td><td>3 fatal</td></tr>
<tr><td colspan="5">The helicopter was being flown in heavy rain when it crashed into a mountain.</td></tr>
<tr><td>Oct. 16</td><td>Kangerlussuaq, Greenland</td><td>Piaggio P180 Avanti</td><td>substantial</td><td>1 serious</td></tr>
<tr><td colspan="5">The pilot made a forced landing on an ice sheet following fuel exhaustion during a ferry flight from Keflavik, Iceland.</td></tr>
<tr><td>Oct. 16.</td><td>Weert, Netherlands</td><td>Pilatus PC-12NG</td><td>destroyed</td><td>2 fatal</td></tr>
<tr><td colspan="5">Witnesses saw smoke coming from the engine on takeoff from Budel Airport. The PC-12 then descended and crashed in a field.</td></tr>
<tr><td>Oct. 17</td><td>Manila, Philippines</td><td>Douglas DC-3C</td><td>destroyed</td><td>4 fatal</td></tr>
<tr><td colspan="5">The DC-3 struck an abandoned warehouse soon after the pilot reported engine problems during takeoff for a cargo flight.</td></tr>
<tr><td>Oct. 21</td><td>Sharjah, United Arab Emirates</td><td>Boeing 707-300C</td><td>destroyed</td><td>6 fatal</td></tr>
<tr><td colspan="5">Witnesses saw the freighter enter a steep right bank after takeoff and descend into an open field.</td></tr>
<tr><td>Oct. 22</td><td>Bonaire, Netherlands Antilles</td><td>Britten-Norman Islander</td><td>destroyed</td><td>1 fatal, 9 none</td></tr>
<tr><td colspan="5">The pilot was not able to exit the airplane after ditching it following an engine failure on approach. The passengers were rescued by boaters.</td></tr>
<tr><td>Oct. 26</td><td>Minsk, Belarus</td><td>Raytheon Hawker 800</td><td>destroyed</td><td>3 fatal</td></tr>
<tr><td colspan="5">The Hawker crashed in a wooded area during the crew’s second night approach with 2,000 m (1 1/4 mi) visibility and a 200-ft ceiling. The airport’s instrument approach systems reportedly were not in service.</td></tr>
<tr><td>Oct. 26</td><td>Benavides, Texas, U.S.</td><td>Beech King Air B100</td><td>destroyed</td><td>4 fatal</td></tr>
<tr><td colspan="5">Radio and radar contact were lost soon after the pilot reported difficulty maintaining control in severe turbulence at 25,000 ft. The wreckage later was found in a rural area.</td></tr>
<tr><td>Nov. 1</td><td>Mirnyj, Russia</td><td>Ilyushin 76M</td><td>destroyed</td><td>11 fatal</td></tr>
<tr><td colspan="5">The aircraft crashed shortly after taking off for a positioning flight to Irkutsk.</td></tr>
<tr><td>Nov. 2</td><td>Mulia, Indonesia</td><td>Antonov An-28</td><td>destroyed</td><td>4 fatal</td></tr>
<tr><td colspan="5">The An-28 crashed into a mountain while descending during a police-supply flight.</td></tr>
<tr><td>Nov. 5</td><td>Fort Pierce, Florida, U.S.</td><td>Grumman Albatross</td><td>substantial</td><td>1 minor, 2 none</td></tr>
<tr><td colspan="5">The airplane struck terrain while returning to the airport after the left engine failed on takeoff.</td></tr>
<tr><td>Nov. 6</td><td>Cat Lake, Ontario, Canada</td><td>Cessna 310R</td><td>destroyed</td><td>3 fatal</td></tr>
<tr><td colspan="5">The 310 struck terrain during a night charter flight.</td></tr>
<tr><td>Nov. 9</td><td>Nairobi, Kenya</td><td>Beech 1900D</td><td>destroyed</td><td>2 fatal</td></tr>
<tr><td colspan="5">The airplane struck the perimeter fence and crashed while returning to the airport after the crew reported a problem on departure for a cargo flight.</td></tr>
<tr><td>Nov. 9</td><td>Greer, South Carolina, U.S.</td><td>Beech King Air B200</td><td>substantial</td><td>3 serious</td></tr>
<tr><td colspan="5">The King Air struck terrain on approach after both engines flamed out due to fuel exhaustion during a post-maintenance test flight.</td></tr>
<tr><td>Nov. 12</td><td>Kigali, Rwanda</td><td>Canadair CRJ100ER</td><td>destroyed</td><td>NA</td></tr>
<tr><td colspan="5">After returning to the airport due to a problem on takeoff, one or both engines accelerated at the stand, and the airplane struck the terminal building. One of the 10 passengers was killed; another passenger and both pilots were injured.</td></tr>
<tr><td>Nov. 14</td><td>Doyle, California, U.S.</td><td>Aerospatiale AS 350BA</td><td>destroyed</td><td>3 fatal</td></tr>
<tr><td colspan="5">Night visual meteorological conditions prevailed when the emergency medical services (EMS) helicopter struck terrain while returning to its base after transporting a medical patient to Reno, Nevada.</td></tr>
<tr><td>Nov. 19</td><td>Norfolk Island, Australia</td><td>Israel Industries 1124A</td><td>destroyed</td><td>6 none</td></tr>
<tr><td colspan="5">After fuel ran low during three unsuccessful approaches in adverse weather, the EMS flight crew ditched the Westwind in the ocean.</td></tr>
<tr><td>Nov. 28</td><td>Shanghai, China</td><td>McDonnell Douglas MD-11F</td><td>destroyed</td><td>3 fatal, 4 NA</td></tr>
<tr><td colspan="5">The tail struck the runway shortly before the freighter stalled and crashed on takeoff.</td></tr>
<tr><td>Nov. 29</td><td>Lyall Harbour, British Columbia, Canada</td><td>de Havilland Beaver</td><td>destroyed</td><td>6 fatal, 2 NA</td></tr>
<tr><td colspan="5">The floatplane crashed while taking off in adverse weather conditions for a scheduled flight to Vancouver.</td></tr>
</table>

NA = not available

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

Smoke, Fire and Fumes Events in the United States, September–October 2009

<table>
<tr><th>Date</th><th>Flight Phase</th><th>Airport</th><th>Classification</th><th>Sub-Classification</th><th>Aircraft Model</th><th>Operator</th></tr>
<tr><td>Sept. 9</td><td>Cruise</td><td>Atlanta, Georgia (ATL)</td><td>Unscheduled landing</td><td>Smoke in cockpit</td><td>Embraer EMB-145XR</td><td>Continental Express Airlines</td></tr>
<tr><td colspan="7">"The crew reported an electrical burning odor in the cockpit and forward cabin during cruise, with a bleed 2 overheat warning on the EICAS. The aircraft was landed at ATL without incident."</td></tr>
<tr><td>Sept. 13</td><td>Descent</td><td>Dallas/Fort Worth, Texas (DFW)</td><td>Emergency landing, return to airport</td><td>Smoke in cabin</td><td>Canadair CL-600</td><td>American Eagle Airlines</td></tr>
<tr><td colspan="7">In icing conditions at 20,000 ft, the crew reported receiving an ant-icing message. The crew was descending the airplane to 11,000 ft when a bleed duct warning came on. The crew then ran an emergency checklist for the bleed duct warning. The first officer reported a noxious odor with fumes in the cabin. The crew declared an emergency and elected to return to DFW.</td></tr>
<tr><td>Sept. 23</td><td>Cruise</td><td>Cincinnati/Northern Kentucky (CVG)</td><td>Return to airport, unscheduled landing</td><td>Sparking windshield</td><td>Canadair CL-600</td><td>Sky West Airlines</td></tr>
<tr><td colspan="7">En route at Flight Level 350, the crew noticed windshield sparking. They turned off windshield heat. A couple of seconds later the outer ply of the windshield shattered. They consulted the quick reference handbook and landed normally at CVG.</td></tr>
<tr><td>Sept. 24</td><td>Takeoff</td><td>NA</td><td>Aborted takeoff</td><td>Smoke in cockpit, smoke in cabin</td><td>Embraer EMB-145</td><td>American Eagle Airlines</td></tr>
<tr><td colspan="7">During the takeoff at about 40 kt, the crew reported grayish-white smoke in the cockpit that increased rapidly. The crew elected to abort the takeoff. Smoke removal procedures were applied with the auxiliary power unit and packs, and the smoke cleared to 84 percent. A flight attendant confirmed smoke in the cabin but not in the lavatory.</td></tr>
<tr><td>Oct. 1</td><td>Climb</td><td>Dallas/Fort Worth, Texas (DFW)</td><td>Return to airport</td><td>Smoke in cockpit, smoke in cabin</td><td>McDonnell Douglas DC-9</td><td>American Airlines</td></tr>
<tr><td colspan="7">Approaching Flight Level 180, the crew started smelling fumes in the cockpit and flight attendants reported a burning odor getting stronger at the back of the cabin. The flight crew turned off the recirculation fan and returned to DFW.</td></tr>
<tr><td>Oct. 1</td><td>Takeoff</td><td>Port Columbus, Ohio (CMH)</td><td>Emergency landing, return to airport</td><td>Smoke in cabin</td><td>Cessna 500</td><td>Corporate</td></tr>
<tr><td colspan="7">Just after rotation, the cabin filled with smoke with an oily odor. The crew deployed passenger oxygen masks and conducted an emergency return to the airport.</td></tr>
<tr><td>Oct. 3</td><td>Takeoff</td><td>White Plains, New York (HPN)</td><td>Continued to destination</td><td>Smoke in cockpit</td><td>Embraer EMB-190</td><td>JetBlue Airways</td></tr>
<tr><td colspan="7">On takeoff from Orlando, Florida (MCO), there was a "pack 1 fail" EICAS message, an odor of smoke and a rumbling noise with the pack on. The crew consulted the quick reference handbook and the odor and noise ceased. The flight was continued to its destination.</td></tr>
<tr><td>Oct. 6</td><td>Climb</td><td>Sitka, Alaska (KSIT)</td><td>Return to airport, unscheduled landing</td><td>Smoke in cockpit, smoke in cabin</td><td>Boeing 737</td><td>Alaska Airlines</td></tr>
<tr><td colspan="7">On takeoff, the crew smelled smoke on the flight deck. Within two seconds, a flight attendant reported a smell of smoke throughout the cabin. The crew diverted back to the origination airport and accomplished the quick reference handbook "Smoke/Fumes or Fire in Flight Deck or Passenger Cabin" checklist.</td></tr>
<tr><td>Oct. 9</td><td>Descent</td><td>NA</td><td>Emergency landing, return to airport</td><td>Smoke in cabin</td><td>Boeing 767</td><td>Delta Air Lines</td></tr>
<tr><td colspan="7">A strong electrical burning odor was noticed at the top of descent, but it dissipated in five minutes. The odor returned and an emergency was declared. The crew found the left recirculation fan circuit breaker tripped and reset the circuit breaker.</td></tr>
<tr><td>Oct. 13</td><td>Climb</td><td>NA</td><td>Emergency landing, diversion</td><td>Smoke in cockpit</td><td>Boeing 767</td><td>Delta Air Lines</td></tr>
<tr><td colspan="7">On climbout, the crew observed a right automatic direction finder flag and fumes in the cockpit. The first officer's horizontal situation indicator also lost color and flickered. The crew also received a "cabin auto inop 1 and 2" message.</td></tr>
<tr><td>Oct. 15</td><td>Cruise</td><td>NA</td><td>Unscheduled landing</td><td>Smoke in cockpit, smoke alert</td><td>Boeing 777</td><td>United Air Lines</td></tr>
<tr><td colspan="7">Smoke was noted in the cockpit, and smoke alarms activated at Flight Level 320.</td></tr>
<tr><td>Oct. 23</td><td>Descent</td><td>NA</td><td>Diversion, unscheduled landing</td><td>Smoke in cockpit, smoke in cabin</td><td>Embraer EMB-145</td><td>Continental Express Airlines</td></tr>
<tr><td colspan="7">The crew reported a strong odor of smoke on the flight deck and in the cabin as soon as descent was started at Flight Level 250. The odor was described as acrid, like electrical smoke. The aircraft was landed without incident.</td></tr>
</table>

NA = not available

Source: Safety Operating Systems

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— DAVE BARGER, CHIEF EXECUTIVE OFFICER

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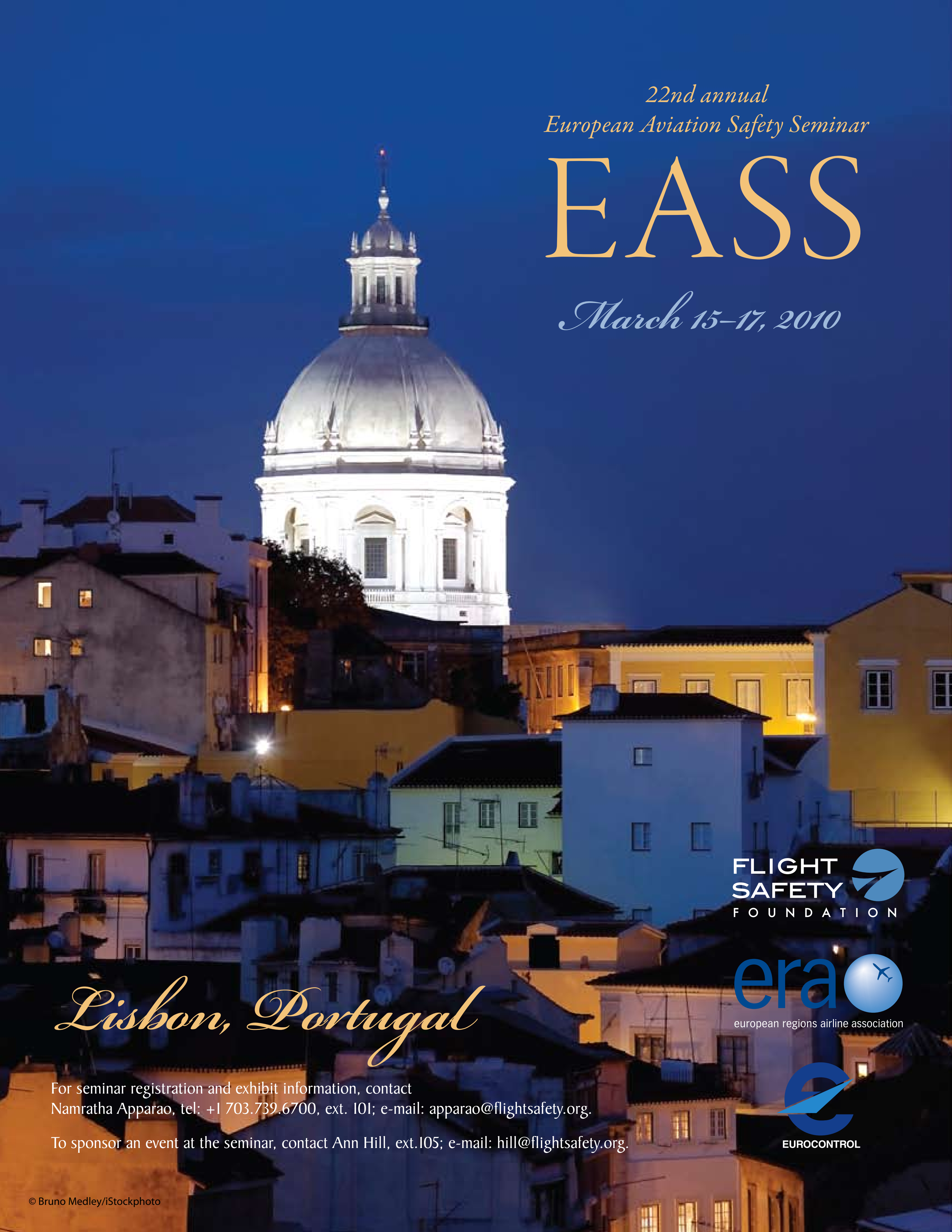
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