AeroSafety WORLD

EYES CAN SEE CLEARLY
SURGERY ACCEPTED, RISKS REMAIN

GROUND ACCIDENT PREVENTION
Losses of $10 billion in small bits

NTSB ACADEMY
Investigator scholars

CAUSAL FACTORS
Icing claims one more

WIND SHEAR STRATEGIES
Need quicker info distribution

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

MAY 2007

GROWTH Pains

The outlook for growth in the aviation sector is extraordinary. The manufacturers' forecasts vary a bit, but there seems to be a broad consensus that the airline fleet will at least double over the next 20 years. Boeing expects the fleet size in the Asia-Pacific region to triple in 20 years. The Middle East fleet is expected to grow at an annual rate of 7 percent, which means that it will double in just 10 years. Growth is projected everywhere.

This is very exciting, but the challenge for safety professionals will be to make sure this growth does not outpace the availability of qualified pilots and mechanics around the world.

The leading edge of this global challenge will be faced in Asia. The Centre for Asia Pacific Aviation estimates that by 2010, India will have about 225 domestic aircraft, which could lead to a shortage of about 1,500 to 2,000 pilots and more than 1,000 mechanics. Pilot shortages are already affecting the global marketplace. China is recruiting pilots from as far away as Brazil, and hiring in the Middle East has impacted the pilot pools in Africa, Indonesia and elsewhere.

This is an important problem; but for many of us in Europe and the United States, it is a tough one to relate to. I grew up in a time and place where three moon landings and X-ray vision couldn't guarantee you a job flying a turboprop. It was a world where airline captains had a lifestyle that made doctors and lawyers jealous. Intellectually, I know that era is long gone; but that history makes it difficult to acknowledge today's reality.

Today, it is not unusual for a pilot from the developing world to drift from region to region on a series of wet-lease agreements and contracts just to make a marginal living. It should not be a surprise that there is no army of new pilots begging to follow in their footsteps.

Recruiting mechanics is also difficult. Smart youngsters can make a good living managing computer networks in Beijing or writing software in Bangalore, India. There just isn't much motivation to learn how to troubleshoot airplanes on a deserted ramp in the middle of the night.

We are a capable and creative industry that has learned a lot about safety in the last 20 years. We know how to deal with safety threats; we do it every day. The difference is that the growing shortage of skilled personnel is a threat that none of us can address alone. It is time for us to work together to address the problem. The only question is whether we face the problem honestly now or wait for the accidents to occur.

We have tools in place now, like flight operational quality assurance (FOQA), that could provide an early warning when expansion of an airline exceeds the capability of its people. We must look at the tools we have in our hands and consider how to apply them to this fundamental problem.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

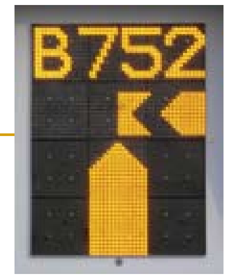
contents

May2007 Vol 2 Issue 5

12

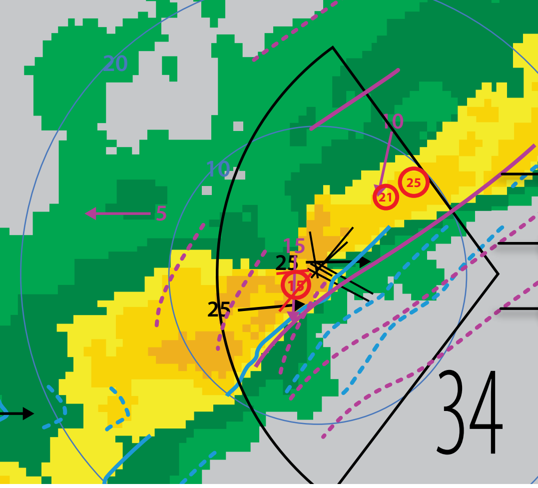
20

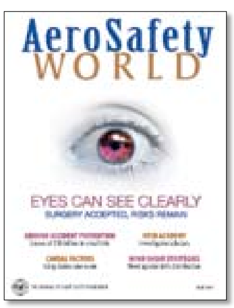
28



features

departments





About the Cover
Eye correction surgery is a mainstream therapy, but some risks remain.
© David Raboin/iStockphoto

We Encourage Reprints (For permissions, go to <www.flightsafety.org/asw_home.html>)

Share Your Knowledge

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

The publications staff reserves the right to edit all submissions for publication. Copyright must be transferred to the Foundation for a contribution to be published, and payment is made to the author upon publication.

Subscriptions: Subscribe to *AeroSafety World* and become an individual member of Flight Safety Foundation. One year subscription for 12 issues includes postage and handling — US$350. Special Introductory Rate — $280. Single issues are available for $30 for members, $45 for nonmembers. For more information, please contact the membership department, Flight Safety Foundation, 601 Madison Street, Suite 300, Alexandria, VA 22314-1756 USA, +1 703.739.6700 or membership@flightsafety.org.

AeroSafetyWORLD
telephone: +1 703.739.6700

William R. Voss, publisher,
FSF president and CEO
voss@flightsafety.org, ext. 108

J.A. Donoghue, editor-in-chief,
FSF director of publications
donoghue@flightsafety.org, ext. 116

Mark Lacagnina, senior editor
lacagnina@flightsafety.org, ext. 114

Wayne Rosenkrans, senior editor
rosenkrans@flightsafety.org, ext. 115

Linda Werfelman, senior editor
werfelman@flightsafety.org, ext. 122

Rick Darby, associate editor
darby@flightsafety.org, ext. 113

Karen K. Ehrlich, web and print production coordinator
ehrlich@flightsafety.org, ext. 117

Ann L. Mullikin, production designer
mullikin@flightsafety.org, ext. 120

Susan D. Reed, production specialist
reed@flightsafety.org, ext. 123

Patricia Setze, librarian
setze@flightsafety.org, ext. 103

FLIGHT SAFETY FOUNDATION
SINCE 1947

Serving Aviation Safety Interests for More Than 50 Years

Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 1,000 member organizations in 142 countries.

Member**Guide**

Flight Safety Foundation
601 Madison Street, Suite 300, Alexandria, VA, 22314-1756 USA
tel: +1 703.739.6700 fax: +1 703.739.6708

www.flightsafety.org

Member enrollment — ext. 105
Ann Hill, director, membership and development — hill@flightsafety.org

Seminar registration — ext. 101
Namratha Apparao, membership services coordinator — apparao@flightsafety.org

Seminar/*AeroSafety World* sponsorships — ext. 105
Ann Hill, director, membership and development — hill@flightsafety.org

Exhibitor opportunities — ext. 105
Ann Hill, director, membership and development — hill@flightsafety.org

***AeroSafety World* orders** — ext. 101
Membership Department — membership@flightsafety.org

Technical product orders — ext. 101
Namratha Apparao, membership services coordinator — apparao@flightsafety.org

Library services/seminar proceedings — ext. 103
Patricia Setze, librarian — setze@flightsafety.org

Web Site — ext. 117
Karen Ehrlich, web and print production coordinator — ehrlich@flightsafety.org

SPREAD THE Word

AeroSafety World reminds me in a weird way of the Soviet Union's doomsday machine that was about to be activated in the classic Stanley Kubrick movie, *Dr. Strangelove*. "The whole point of the doomsday machine is lost," the eponymous Dr. Strangelove rails at the Soviet ambassador, "if you keep it a secret! Why didn't you tell the world?"

AeroSafety World is, we hope, more of a positive force than the movie's doomsday machine, but like the machine in the movie, not enough people know about it, even though the more widespread the knowledge the better off the world might be.

The beneficial impact of *ASW* so far has been restricted by a distribution system that is a legacy of the seven specialist FSF publications that preceded it. That is about to change.

Late last year, we moved the downloadable digital version of *ASW* to the Flight Safety Foundation home page, doing away with password protection so that search engines such as Google or Yahoo can find the journal and its stories. The result has been a dramatic rise in the number of people downloading the issue each month, now nearly double the number that get the printed magazine.

The Foundation offers subscriptions to the digital version. Every month, subscribers receive an e-mail with a link to download the new issue when it is available. However, we were not satisfied with the subscription management facility we were using, and so did not actively seek to enlarge that subscription base. We didn't even advertise that it was free.

However, now that a new, more robust facility has been installed, it is time to invite our readers to get their own digital subscriptions. We also invite you to send that link to friends and others who might also benefit from *ASW's* range of safety coverage. Go to www.flightsafety.org. The link to the subscription page is on our home page.

We have had requests for digital subscriptions for groups of people. If anyone still wants to do this, and can send out the link over an internal company communication system to avoid anti-spam filters, we can assist in this effort.

We also will be asking our industry safety partners, especially associations, to send their members our invitation to subscribe to the digital *ASW*.

The subscription process is quick and non-invasive, requiring just name, e-mail address, company and position. The Foundation will protect the privacy of our members and *ASW* readers, but we want to build a powerful case for advertisers to buy space in *ASW* by showing the number of executives, managers, pilots and such who subscribe. The more revenue the Foundation can bring in that way, the better-financed it will be to do its job of promoting safety.

Ultimately, we will be making it easier to buy the printed version of *ASW*, moving to broaden that circulation, as well. Our goal is to make certain that everyone with an aviation safety responsibility — and that's nearly everyone connected with the industry — knows what *ASW* is and how to get it.

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

Disputing Composites' Role in Accident

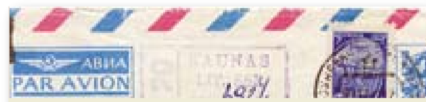
Just wanted to comment on "The Composite Evolution" [*ASW*, 3/07, p. 17].

While I thought you tried to write in a balanced way about changes composites are bringing to the 21st century, the "Composites in Accidents" sidebar about the Nov. 12, 2001, fatal accident involving an American Airlines Airbus A300 totally missed the mark. Adding in brackets "[which was made with composite materials]" after the U.S. National Transportation Safety Board's words "the in-flight separation of the vertical stabilizer" showed your own editorial bias. I've pasted the probable cause findings from the NTSB report here:

> *The National Transportation Safety Board determines the probable cause(s) of this accident as follows.*
>
> *… the in-flight separation of the vertical stabilizer as a result of the loads beyond ultimate design that were created by the first officer's unnecessary and excessive rudder pedal inputs. Contributing to these rudder pedal inputs … .*

The U.S. Federal Aviation Administration requires all materials used in commercial jet transports to meet or exceed structural load criteria, be they aluminum alloy, composites or cardboard. The Airbus tragedy resulted from excessive loads beyond the design capability of the structure. It was not a result of the structure's material properties.

Liz Verdier
Boeing Commercial Airplanes



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

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

JUNE 3–5 ➤ 3rd Annual International Airfield Operations Area Expo & Conference. Airport Business. Milwaukee. Carmen Seeber, <carmen.seeber@cygnuspub.com>, <www.aoaexpo.com>, 800.547.7377, ext. 1622, +1 920.563.6388, ext. 1622.

JUNE 3–5 ➤ Annual General Meeting and World Air Transport Summit. International Air Transport Association. Vancouver, Canada. By invitation only. <www.iata.org/events/agm/2007>.

JUNE 4–5 ➤ Wide Area Multilateration (WAM) Workshop. Eurocontrol. Brussels. Gaëlle Evrard, <gaelle.evrard@eurocontrol.int>, <www.eurocontrol.int/eatm/public/event/070604_05_wam_worksh.html>, +32 2 729 36 75.

JUNE 4–7 ➤ SimTecT 2007: Simulation Conference and Exhibition. Simulation Industry Association of Australia. Brisbane. <simtect2007@consec.com.au>, <www.siaa.asn.au/simtect/2007/2007.htm>, +61 2 6251 0675.

JUNE 5–6 ➤ 5th Annual Regional Airline Industry Flight Technology Conference. Regional Airline Association. Washington, D.C. <www.raa.org>, +1 202.367.1170.

JUNE 5–7 ➤ 2007 EU/US International Aviation Safety Conference. European Aviation Safety Agency and the U.S. Federal Aviation Administration. Prague, Czech Republic. <www.easa.europa.eu/webshop>.

JUNE 6–7 ➤ 13th Annual Asia Pacific Airline Engineering & Maintenance Conference. Aviation Industry Conferences. Bangkok, Thailand. <ruthm@aviation-industry.com>, <www.aviationindustrygroup.com>, +44 (0)207 931 7072.

JUNE 8–10 ➤ 2007 Regional Air Safety Seminar. Australian and New Zealand Societies of Air Safety Investigators. Wellington, New Zealand. Peter Williams, <p.williams@taic.org.nz>, +64 4 473 3112.

JUNE 10–13 ➤ 79th Annual AAAE Conference and Exposition. American Association of Airport Executives. Washington. <AAAEmeetings@aaae.org>, <www.aaae.org>, +1 703.824.0500.

JUNE 12–14 ➤ 2007 Flightscape Users Conference. Flightscape. Ottawa. Christine Fernandes, <christine.fernandes@flightscape.com>, <www.flightscape.com/about/conferences.php>, +1 613.225.0070, ext. 231.

JUNE 18–24 ➤ 47th International Paris Air Show. Le Bourget, Paris. <exposants@salon-du-bourget.fr>, <www.paris-air-show.com/en/index.php>.

JUNE 25–26 ➤ NBAA Flight Operations Manual Workshop. National Business Aviation Association. San Diego. Jan Kelliebrew, <jkelliebrew@nbaa.org>, <web.nbaa.org/public/cs/fomw/200706/index.php>, +1 202.783.9283.

JUNE 29–30 ➤ 12th Annual Flight Attendants Conference. National Business Aviation Association. San Diego. Dina Green, <dgreen@nbaa.org>, <web.nbaa.org/public/cs>, +1 202.783.9357.

JULY 9–12 ➤ CBAA 46th Annual Convention, Trade Show and Static Display. Canadian Business Aviation Association. Calgary, Alberta. Janet Maslin, <jmaslin@cbaa.ca>, <www.cbaa.ca/portal/convention>, +1 613.236.5611, ext. 225.

AUG. 8–10 ➤ Wildlife Hazard Management Workshop. Embry-Riddle Aeronautical University, Center for Professional Education. Seattle-Tacoma International Airport, Seattle. Billy Floreal, <florealb@erau.edu>, <www.erau.edu/ec/soctapd/seminar_progs.html>, +1 386.947.5227.

AUG. 9–11 ➤ Latin American Business Aviation Conference & Exhibition (LABACE2007). National Business Aviation Association and the Associação Brasileira de Aviação Geral. São Paulo, Brazil. Dan Hubbard, <dhubbard@nbaa.org>, <www.labace.aero>, +1 202.783.9360.

AUG. 27–30 ➤ 38th International Seminar: International Cooperation: From Investigation Site to ICAO. International Society of Air Safety Investigators. Singapore. <www.isasi.org>.

SEPT. 3–6 ➤ Asian Aerospace 2007. Reed Exhibitions. Hong Kong, China. Clive Richardson, <clive.richardson@reedexpo.com.hk>, <www.asianaerospace.com/index.html>, +852 2824 0330.

SEPT. 10–13 ➤ Bird Strike 2007 Conference. Bird Strike Committee Canada, Bird Strike Committee USA. Kingston, Ontario, Canada. Carol Liber, <events@theplanner.net>, <www.birdstrikecanada.com/2007conf.htm>, +1 604.276.7471.

SEPT. 16–20 ➤ International Congress. International Academy of Aviation and Space Medicine. Vienna, Austria. <www.iaasm.org/English/Congresses.cfm>.

SEPT. 17–19 ➤ Air Medical Transport Conference. Association of Air Medical Services. Tampa, Florida, U.S. Natasha Ross, <nross@aams.org>, <www.aams.org>, +1 703.836.8732.

SEPT. 25–27 ➤ NBAA2007: Helping Businesses Take Flight. National Business Aviation Association. Atlanta. Donna Raphael, <draphael@nbaa.org>, <web.nbaa.org/public/cs/amc/2007>, +1 202.478.7760.

SEPT. 26–27 ➤ 7th Annual CIS, Central & Eastern European Airline Engineering and Maintenance Conference. Aviation Industry Group. Prague, Czech Republic. Ruth Martin, <ruthm@aviation-industry.com>, <www.aviationindustrygroup.com/index.cfm?pg=247&archive=false&offset=1>, +44 (0)207 932 5587.

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

OCT. 17–18 ➤ MRO Asia. Aviation Week Conferences & Exhibition. Shanghai, China. <www.aviationnow.com/conferences/masmain.htm>.

NOV. 7–8 ➤ MRO Europe. Aviation Week Conferences & Exhibitions. Milan, Italy. <www.aviationnow.com/conferences/meumain.htm>.

NOV. 28–30 ➤ 4th Annual International Aviation Safety Forum. U.S. Federal Aviation Administration, Air Transport Association and the International Air Transport Association. Dulles International Airport, Chantilly, Virginia. <www.faa.gov/news/conferences_events/2007safetyforum>.

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

If you have a safety-related conference, seminar or meeting, we'll list it. Get the information to us early — we'll keep it on the calendar until the issue dated the month before the event. Send listings to Rick Darby at Flight Safety Foundation, 601 Madison St., Suite 300, Alexandria, VA 22314-1756 USA, or <darby@flightsafety.org>.

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

Safety News

Takeoff Performance Monitoring System Sought

The Transportation Safety Board of Canada (TSB) says it will work with Transport Canada (TC) on preliminary research to determine whether a takeoff performance monitoring system could be designed to give flight crews "an accurate and timely indication of inadequate takeoff performance."

TC suggested the research in response to a TSB safety recommendation calling for installation of such equipment in transport category aircraft.

© Sven De-Bevere/aviation-images.com

In the response, TC said its representatives were "not aware of any certified system that is available at this time to meet this recommendation" but that "it is conceivable that such a system could be designed by current technology."

The TSB recommendation followed investigation of an Oct. 14, 2004, accident in which an MK Airlines Boeing 747-200SF crashed on takeoff from Halifax, Nova Scotia; all seven crewmembers were killed and the airplane was destroyed. The TSB said that the accident was a result of the crew's unintentional use of an incorrect aircraft weight to calculate takeoff speeds and thrust settings. The takeoff speed and thrust setting were "significantly lower than those required to become safely airborne," and the crew did not recognize the problem until the airplane had passed the point where they could safely reject the takeoff, TSB said (*ASW*, 10/06, p. 18).

'Back of Clock'

Flight crews on single-sector overnight transcontinental flights from western Australia to the east were unlikely to be significantly affected by related sleep patterns and fatigue, a report by the Australian Transport Safety Bureau (ATSB) says.

However, when the transcontinental flight was followed by an additional sector on the east coast, the report said, "there is evidence of reduced prior sleep, impaired neurobehavioral performance and high levels of subjective fatigue."

The report discussed a study of "typical transcontinental back-of-clock route pairings" — usually from Perth in the west to Melbourne, Sydney or Brisbane in the east. During the 14-day study, 37 participating crewmembers were required to wear an activity-monitor wristwatch; maintain sleep and duty diaries in which they recorded their "time of sleep, subjective alertness and time of duty"; and complete a five-minute "reaction time task" during cruise on each sector and three times on non-flight days.

When crews conducted a transcontinental flight, plus an additional east coast sector, they averaged less than 5.5 hours of sleep during the 48 hours before the final landing, and most categorized their condition as "extremely tired" or "completely exhausted," the report said.

The report said that fatigue risk management systems (FRMS) are being developed to provide organizations and their personnel with tools to manage fatigue by identifying behavioral symptoms of fatigue — not only by complying with flight and duty time regulations.


© Rolffimages/Dreamstime

Emergency Action on 737 Spoilers

The spoilers on certain Boeing 737-800s must be inspected after every landing and rejected takeoff to determine that they are in the correct position, the U.S. Federal Aviation Administration (FAA) said in an emergency airworthiness directive (AD). If a spoiler is found in the "UP" position while the speed brake handle is down, maintenance personnel must be notified.

The AD was issued in mid-March, as a result of reports of seven flight spoiler actuator jams on 737-800 short field performance (SFP) airplanes. Two of the jams, involving in-service airplanes, were discovered during routine maintenance walk-arounds; they probably occurred during auto speed brake extension on the previous landing, the FAA said. The five other reports occurred during testing of the spoiler systems by Boeing before the airplanes were delivered. Two additional jams occurred during bench testing after Boeing began investigating the reports.

The FAA said that the in-service failures resulted in the spoilers remaining extended after the speed brake handle was moved to the "DOWN" position after landing.

"This condition, if not corrected, could result in a spoiler actuator hardover, which could cause the spoiler surface to jam in the fully extended position," the FAA said. "Two or more hardover failures of the spoiler surfaces in the up direction on the same wing, if undetected prior to take-off, can cause significant roll and consequent loss of control of the airplane."

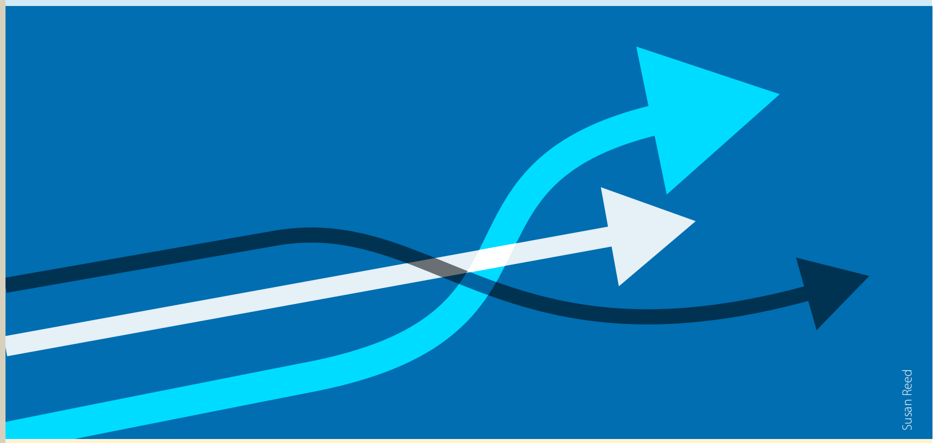
Endorsing Offset Procedures

The International Federation of Air Line Pilots' Associations (IFALPA) is urging wider use of strategic lateral offset procedures, which allow pilots to fly parallel to and slightly to the right of airway centerlines, to reduce midair collision risks (*ASW,* 3/07, p. 40).

During a meeting in Dubrovnik, Croatia, IFALPA called on all member nations of the International Civil Aviation Organization (ICAO) to "urgently implement" offset procedures "in all appropriate airspace."

"The Federation has argued for more than 20 years, since the advent of highly accurate navigation systems, that [offset procedures] are vital to reduce the risk of midair collisions and firmly believes that a globally standardized [procedure] is the most effective measure to mitigate the risk of these types of midair collisions," IFALPA said.

After the implementation of reduced vertical separation minimum (RVSM) procedures over the North Atlantic in 1997, offset procedures were approved for use on some routes to help alleviate wake turbulence and reduce the possibility of a collision in the event of a vertical error in navigation.



Susan Reed

Obstacles to a 'Single Sky'

European transportation officials "still have some way to go" in implementing the Single European Sky (SES) initiative, but a recent report indicates that reorganization of air traffic management was a positive step, European Commission Vice President Jacques Barrot says.

The report, prepared by the independent Eurocontrol Performance Review Commission at the request of the European Commission, said that the initiative has improved cooperation between member states and air navigation service providers and led to some improvements in efficiency and the reporting of safety incidents.

EUROCONTROL

Nevertheless, the report said that potential weaknesses of the SES include "a risk that SES requirements will over-regulate, creating burdens without compensating benefits." In addition, there is "no guarantee that the SES in its current form will produce tangible performance improvements in respect of efficiency and thus address effectively the key current issues in [air traffic management]," the report said.

Bird Flu Guidelines

Guidelines have been developed for airports and airlines in the event of an outbreak of avian influenza — commonly known as bird flu — or other communicable diseases, the International Civil Aviation Organization (ICAO) says (see *Human Factors & Aviation Medicine*, November–December 2005).

"A preparedness plan for aviation is required since air travel may increase the rate at which a disease spreads, thereby decreasing the time available for preparing interventions," ICAO said in the preface to the guidelines, developed along with the International Air Transport Association and the Airports Council International, as well as the United Nations World Health Organization and the U.S. Centers for Disease Control and Prevention. The aviation-specific guidelines accompany general preparedness guidelines directed toward national governments worldwide.

© Robert Balazik/Dreamstime

The aviation guidelines say, among other things, that airports should develop plans for operating with "greatly reduced staff numbers" and that airlines should establish a system by which cabin crewmembers can detect travelers suspected of having a communicable disease.

In addition, a new provision for ICAO Annex 9, *Facilitation,* calls for introduction of a "passenger locator card" to be used by public health officials to trace passengers who might have been infected with a serious communicable disease.

In Other News …

Capt. Carlos Limón, an Airbus A320 pilot for Mexicana Airlines and a member of the Flight Safety Foundation International Advisory Committee, has been elected president of the International Federation of Air Line Pilots' Associations. … The **U.S. National Transportation Safety Board (NTSB)**, which has investigated 130,000

© Marcus Legien/Fotolia

aviation accidents since its creation in April 1967, plus thousands of accidents in other modes of transportation, has marked its 40th anniversary. In those 40 years, the NTSB issued 12,600 safety recommendations, about 82 percent of which were accepted. … The **Port Authority of New York and New Jersey** has authorized the design and construction of engineered materials arresting systems (EMAS) at three of its airports — Kennedy International Airport in New York, Newark (New Jersey) Liberty International and Teterboro (New Jersey) Airport. EMAS arrestor beds are built from aerated cement blocks designed to stop an airplane quickly and safely if it overruns a runway (*ASW*, 8/06, p. 13).

© Port Authority of New York and New Jersey

Engineered materials arresting system

Clarification: Erik Eliel of Radar Training International (*ASW*, 04/07, p. 46) has been invited to make a 50-minute presentation at the 11th Safety Standdown.

Compiled and edited by Linda Werfelman.

Better Sight for Flight

Although laser eye surgery is growing in popularity, some aeromedical specialists warn that — for pilots — it may carry risks.

BY LINDA WERFELMAN

Increasing numbers of pilots are choosing surgery over eyeglasses or contact lenses to correct some vision problems.

As medical personnel have gained experience with refractive surgery — so named because its goal is to correct refractive errors, another name for defects such as nearsightedness, farsightedness and astigmatism that interfere with the eye's proper focusing and therefore cause a reduction in visual acuity — and as new surgical procedures have been developed, acceptance of the procedures has increased among aeromedical authorities.

Nevertheless, these procedures are not without risks, including loss of pilot medical certification.

"These technologies advance so fast, typically to fill a public need, but they don't always fill a pilot's need," said Dr. William A. Monaco, a specialist in aviation optometry (see "Consider This…").

With normal vision, light enters the cornea, the transparent dome at the front of the eye. The cornea bends — or refracts — the light, which then passes through the pupil to the lens, which focuses the light on the retina, the eye's innermost lining. The retina converts the light into electrical signals, which travel along the optic nerve to the brain, where the image is interpreted (Figure 1, page 14).

In nearsightedness — also called myopia — the cornea bulges out, increasing the distance light must travel from the cornea to the retina; as a result, light rays focus in front of the retina instead of on it, and this makes distant objects appear blurred. In farsightedness — also called hyperopia — near vision is blurred because the cornea is not curved enough or the eyeball is too short from front to back and, as a result, light rays focus behind the retina. In astigmatism, the shape of the cornea is irregular; as a result, light rays focus at more than one point, and blurred vision results.

For years, refractive surgery was performed to correct only nearsightedness, but new techniques are being used today to correct farsightedness and astigmatism. Surgery also is available to correct presbyopia, an age-related difficulty in focusing on near objects that begins to affect people in their 40s and 50s.

Blades and Lasers

Some eye specialists trace the concept of refractive surgery to attempts in the mid-1800s to flatten the bulge in the cornea by applying a spring-mounted mallet through a closed eyelid.[1] Most, however, say that the first refractive surgeries were performed in the 1930s and '40s by researchers in Japan who made incisions in the cornea to flatten it and correct nearsightedness. In the 1960s, a Soviet physician refined the process — known as radial keratotomy (RK) — which involved use of surgical blades and a standardized formula for vision correction; this was the first type of refractive surgery to be widely performed.

Today, RK is rarely used. In its place, new types of surgical procedures have been developed, many of which are performed with a high-energy laser light known as an excimer laser, which disrupts and vaporizes the molecules in the surface of the cornea. Like RK, these procedures reshape the cornea so that light focuses properly on the retina.

The first procedure performed with the excimer laser was photoreactive keratectomy (PRK), in which the outer layer of the cornea is removed and the curved part of the cornea is reshaped by the laser. When PRK was introduced in the late 1980s, it was used only to correct

Consider This …

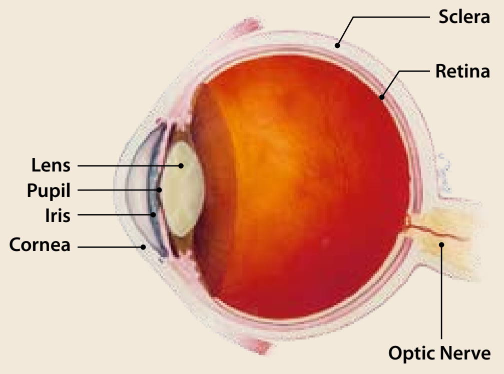
Pilots considering refractive surgery should think carefully about several factors, including:[1]

- For some patients, complications are unavoidable and may be permanent;
- Some aviation employers prohibit certain refractive procedures;
- Medical insurance usually does not pay for refractive surgery;
- People with "refractive instability" — a change in a contact lens or eyeglasses prescription in the previous year — usually are not good candidates for refractive procedures. Neither are people who have experienced some eye diseases, eye injuries or previous eye surgeries;
- People with dry eyes may find the condition aggravated by refractive surgery, and the procedures may place those with an eyelid inflammation called blepharitis at increased risk of infection or inflammation of the cornea;
- People with large pupils could be at increased risk of post-operative side effects such as glare, double vision and the appearance of halos around lights; and,
- People with unusually thin corneas may face increased risks of blindness.

Note

1. U.S. Food and Drug Administration. *LASIK Eye Surgery: When Is LASIK Not For Me?* <www.fda.gov/cdrh/LASIK/when.htm>.

The Eye



Source: U.S. National Eye Institute, National Institutes of Health

Figure 1

The most common procedure in use today is laser-assisted *in situ* keratomileusis (LASIK), which combines the excimer laser and a knife blade called a microkeratome.

low-to-moderate nearsightedness; later, treatments were developed for higher levels of nearsightedness, as well as farsightedness and astigmatism.

The most common procedure in use today is laser-assisted *in situ* keratomileusis (LASIK), which combines the excimer laser and a knife blade called a microkeratome. An eye surgeon uses a microkeratome to cut a flap in the outer layers of the cornea and an excimer laser to remove underlying corneal tissue; the flap is then replaced. The procedure originally was used on very nearsighted patients, but recent advances have allowed for its use to also treat those with farsightedness, astigmatism and lower levels of nearsightedness.

A report by the U.S. Federal Aviation Administration (FAA) Civil Aerospace Medical Institute said that, in comparison with patients who underwent PRK, LASIK patients "experienced less pain, stabilized faster, had less regression, did not require extended use of topical steroids and had fewer complications and side effects."[2]

Nevertheless, LASIK also "requires a greater surgical skill and therefore does have a greater risk of surgical complications," the report said.

A number of related LASIK procedures have been developed in recent years, including IntraLase, which eliminates the need for surgical blades, and wavefront — or custom — LASIK, in which the surgeon is guided by three-dimensional measurements of how the eye processes images.

According to 2003 data, 15 million LASIK procedures had been performed worldwide, about half of them in the United States, where they continue at a rate of about 1 million a year.[3]

A procedure similar to LASIK is laser-assisted subepithelial keratectomy (LASEK), in which an eye surgeon cuts a flap not in the cornea but in its protective covering, or epithelium, before removing corneal tissue and replacing the flap. Because LASEK requires the removal of less of the cornea, it sometimes is recommended instead of LASIK for people with thin corneas.[4]

These procedures — LASIK, LASEK and PRK — vary somewhat when they are used to treat farsightedness and astigmatism. For farsightedness, the procedure involves removal of tissue in a way that steepens the dome of the cornea. For astigmatism, the surface of the cornea is smoothed out.

Other relatively new techniques for correcting refractive errors include implants of phakic intraocular lenses (IOLs), placed into the eye, near the eye's lens, to correct nearsightedness or farsightedness. Manufacturers say that the advantages of IOLs, in comparison with laser surgery, include less risk of side effects such as glare or the appearance of "halos" around lights; in addition, in case of problems with an IOL, it can be removed. Risks include the possibility of damage to the eye's lens and an increase in intraocular pressure (pressure within the eye), which can be remedied with medication or surgery.[5]

Farsightedness and astigmatism — but not nearsightedness — also have been treated with conductive keratoplasty (CK), in which a thin probe is used to release radio-frequency energy to reshape the cornea.[6]

Another procedure, originally performed on patients with cataracts, is refractive lens exchange, also called clear lens extraction; it replaces the eye's natural lens with an artificial one. Risks are similar to those experienced by patients undergoing cataract surgery and include slightly increased chances of a detached retina.[7]

Corneal implants — clear, partial-ring-shaped pieces of the same kind of plastic used in IOLs — can be surgically implanted in the cornea to flatten it and thereby improve vision for people with nearsightedness. Side effects may include eye irritation, abnormal growth of blood vessels and glare. The implants can be removed if patients are not satisfied with the results.[8]

Monovision

In the past, eye specialists believed that presbyopia could not be corrected by surgery, but in recent years, techniques have been developed to treat presbyopia by using LASIK, LASEK, PRK or CK. The treatments are designed to produce monovision — a condition in which one eye is corrected for optimal distant vision and the other eye is corrected for optimal near vision. Because some people have difficulty adjusting to this correction, specialists typically recommend that they be fitted with monovision contact lenses for a time before deciding to undergo refractive surgery.[9]

After a pilot undergoes a monovision procedure, he or she needs time to adjust to the change in perceived visual cues involving depth perception, said Dr. Anthony Evans, chief of the International Civil Aviation Organization (ICAO) Aviation Medicine Section.

In addition, the FAA, which recently modified its policies to allow pilots to undergo monovision refractive surgery, said in an informational brochure for pilots that those who have blurred vision and difficulty performing visual tasks in low-light conditions, such as night driving, typically are not good candidates for monovision procedures.[10]

Other procedures also are available, including implantation of multifocal IOLs or corneal inlays and a procedure called anterior ciliary sclerotomy, in which incisions are made in the sclera — the white part of the eye — to create more room for the ciliary muscles, which help the eyes focus. One relatively new theory about presbyopia is that it begins when the eye's lens grows into the space used by the ciliary muscles, preventing muscle contraction that would help the lens change its shape and focus.[11]

'Rarely Any Reason'

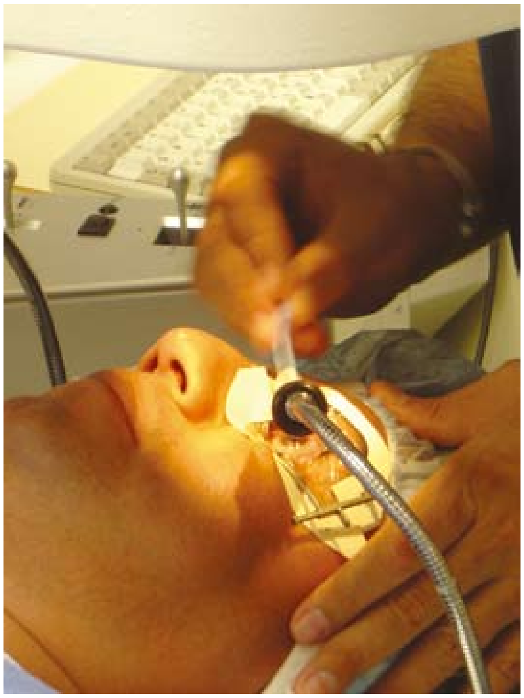
ICAO, noting the considerable experience worldwide with refractive surgery, the infrequent complications and the success rates for some procedures of more than 95 percent, allows all of the surgical procedures and says that a pilot who has undergone any of them can be considered fit for flight duties "as long as there has been a good recovery," Evans said.

A draft version of the "refractive surgery" section of the upcoming edition of ICAO's *Manual of Civil Aviation Medicine* says, "Applicants who have had refractive surgery and are being considered for medical certification or recertification should meet the following criteria: The surgery is uncomplicated; vision is stable; there is no corneal haze and no complaints of glare, halos or 'ghosting'; the [applicant] meets the visual requirements of Annex 1 [*Personnel Licensing*] and the assessment must be based on measurements made by a qualified vision care specialist; [and] there should be follow-up examinations by a qualified vision care specialist six months after return."[12]

Some civil aviation authorities have stricter rules. For example, European requirements do not allow for medical certification of pilots whose uncorrected vision was very poor before they underwent the procedure.

The ICAO draft says that, despite the increasing use of refractive surgery, "there is … rarely any reason for an applicant to submit to refractive surgery in order to meet the visual requirement, and it is important that applicants understand this."

In addition, the draft says, "Individuals contemplating refractive surgery must



© D.J. Modena/Dreamstime

be made aware of the risks involved and should be told that having the surgery might result in a delay in return to duties as aircrew or air traffic controller or, if complications occur, in the permanent loss of medical certification."

Monaco agreed, and said that when pilots consult him about the advisability of refractive surgery, he urges them to consider all possible outcomes.

"By regulation, these procedures are all acceptable for pilots, but they're not appropriate for every pilot," he said. "A small percentage of LASIK patients have had complications, very severe complications. … I would want my patients to know what the downsides are before they consider having surgery, and … if there are less invasive ways of dealing with a [pilot's vision] problem, that's what I'd recommend."

The FAA said that pilots considering LASIK should know that, although "the majority of patients do experience dramatic improvement in vision after laser refractive surgery, there is no guarantee that perfect [uncorrected visual acuity] will be the final outcome. …

"While the risk of serious vision-threatening complications after having LASIK is low (less than 1 percent), some complications could have a significant impact on visual performance in a cockpit environment."[13]

Those complications include an extended healing period of three months or longer; a one in 50 chance of experiencing glare, halos or other distortions of light at night; a one in 100 chance of over-correction or under-correction of vision, or a degradation of best visual acuity; and a one in 100 chance of a dislocated corneal flap or other related problem, the FAA said.

Overall, Evans said, aeromedical specialists have become increasingly comfortable with the concept of refractive surgery.

"Refractive surgery is more acceptable now than 10 years ago because RK is no longer the treatment of choice, and there were significant problems with it," he said, "and the aviation medicine community — and the medical community in general — has gained more experience of individuals that have had very successful refractive surgery." ●

Notes

1. LASIK of Sacramento. *What Is Refractive Surgery?* <www.eyeinfo.com/lasikwhatisrefsurg.html>.
2. Nakagawara, Van B.; Wood, Kathryn J.; Montgomery, Ron W. *New Refractive Surgery Procedures and Their Implications for Aviation Safety*, DOT/FAA/AM-06/9. April 2006.
3. Ibid.
4. Mayo Clinic. *LASIK Eye Surgery: Alternative to Corrective Lenses.* <www.mayoclinic.com/health/lasik-eye-surgery/EY00002>.
5. STAAR Surgical Co. *Potential Risks of Refractive Surgery*. <www.visianinfo.com/html/safety-icl.html>.
6. Cleveland Eye Clinic. *Patient Information: CK.* <www.clevelandeyeclinic.com/ck.cfm>.
7. AllAboutVision. *Refractive Lens Exchange (Clear Lens Extraction)*. <www.allaboutvision.com/vision-surgery/refractive-lens-exchange.htm>.
8. AllAboutVision. *Intacs Corneal Inserts or Implants: A Proven Treatment for Keratoconus*. <www.allaboutvision.com/conditions/inserts.htm>.
9. Mayo Clinic. *Presbyopia*. <www.mayoclinic.com/health/presbyopia/DS00589>.
10. Nakagawara, Van B.; Wood, Kathryn J.; Montgomery, Ron W. *Information for Pilots Considering Laser Eye Surgery*, U.S. Federal Aviation Administration (FAA) Pilot Safety Brochures. <www.faa.gov/pilots/safety/pilotsafetybrochures>.
11. An older theory is that presbyopia is a result of the age-related loss of elasticity of the lens.
12. International Civil Aviation Organization (ICAO). "Refractive Surgery," an excerpt from an unpublished draft of ophthalmology guidelines to be included in an upcoming revision of the ICAO *Manual of Civil Aviation Medicine*. March 2007.
13. Nakagawara; Wood; Montgomery. *Information for Pilots Considering Laser Eye Surgery.*

Further Reading From FSF Publications

Mohler, Stanley R. "Early Diagnosis Is Key to Correcting Age-Related Vision Problems Among Pilots." *Human Factors & Aviation Medicine* Volume 47 (September–October 2000).

Wide-Angle Safety

"Times of change" are bringing specialists together to create safety systems that transcend companies, industry segments and regions.

BY RICK DARBY | FROM AMSTERDAM

"Times of change" generated by changing technology and increasing traffic — as well as perennial issues such as human factors — have produced a major difference in today's aviation safety strategies. This was the message of many presentations at the 19th annual European Aviation Safety Seminar (EASS) in Amsterdam, Netherlands, March 12–14.

Localized and isolated efforts, such as those within a single department of an organization or limited to a particular industry segment, are being replaced by across-the-organization, regional and worldwide cooperative ventures. Flight Safety Foundation (FSF) is a catalyst for these wide-angle plans. Several speakers at EASS described such "big picture" initiatives.

William R. Voss, FSF president and CEO, offered an overview of new and continuing FSF programs through which multiple aspects of the aviation industry, based around the globe, can benefit.

In discussing the Foundation's corporate flight operational quality assurance (C-FOQA) program, Voss said, "This is something we've been working at for a long time, but it's now finally moving out of development to more of a sustained mode. We've gone from a few pilots and airplanes in the program to a point where we may have quite a few within the next few months. So all the hard work is bearing fruit in this area. We're making a special issue out of reaching out to European business aviation as well, because we'd like to increase the offerings we can provide European business aviation."

Approach and landing accident reduction (ALAR), which has been an FSF priority for more than a decade, is still a big issue, Voss said: "It makes us wonder how we can reach everyone we need to. We've done an enormous amount of work over the years. There are 33,000 [*ALAR Tool Kit*] CDs out there. Jim Burin [FSF director of technical programs] has circled the world a few times over; he's now given 24 seminars. One hundred to 200 people were in each of those seminars, so you see how many people have attended."

Recently, the Foundation has given impetus to industry efforts to counter the problem of in-flight smoke, fire and fumes (SFF). "The guidelines we've had out there are having an effect," Voss said. "They're being incorporated in checklists and operations. That's what we want — we're not here just to put material on shelves. On average, there's one smoke diversion every day in North America. We recognized this as a problem back in January 2005, and we had materials published by June 2005. Our materials contained a checklist that was adapted for use by crews dealing with SFF, and of course the last step in that template is to remove the smoke and fumes. As an industry, we haven't done enough to make sure that pilot vision is maintained during such events. The International Federation of Air Line Pilots' Associations has taken the position that if a pilot cannot see the instruments, he or she is incapacitated, and it's a reasonable position. There's a need for immediate industry support to facilitate continued flight deck vision in otherwise blinding smoke."

Among several other FSF activities Voss discussed, activism against criminalization of accident investigations is

An Airport Safety Management System

AeroSafety World asked Gerhard Gruber, manager, airport operations, Vienna (Austria) International Airport, for a few additional comments after his EASS presentation "SMS at Airports — A Big Step in the Right Direction!"

ASW: When you describe the activities and functions required by a safety management system (SMS), it seems like many of these things would have been done before an SMS was required.

Gruber: Many of its modules already existed. SMS is an organized way to bring it together and harmonize the different systems.

ASW: So the SMS is designed to make the activities more coherent, and help everybody to understand better what's going on and their part in it?

Gruber: Yes. We already had an incident reporting system, we had statistics, we collected evidence of occurrences on the airside. One of the really new items is the distribution of information. For instance, before that, we did not have the Web-based capability to bring all the information to all the airside users. So that was one big step forward.

ASW: You said in your presentation that airline flight operations and air traffic control (ATC) must be included in the airport SMS. Does the airport's role require coordination with the others? Are there ever conflicts between the players?

Gruber: There are no conflicts, but there is room for improvement — exchange of information, especially. A good example is the local runway safety team. This is one of the fields where we do have a group with all parties involved and excellent communication. But we do not have an organized reporting system from airlines to the airport. For example, we have no idea if there is some confusion about the taxiway signage system among some pilots. Maybe they report it to their fleet chief or safety manager, but there is no obligation for them to send us the reports.

ASW: The SMS handbook is a printed book. How do you keep it up to date?

Gruber: It's a living document, updated continuously and reflects the complete SMS organization, including processes. The relevant parts are on our Web page and may be downloaded by every airside user.

ASW: Who is on the safety committee that the SMS includes? What sort of job functions do they have, other than their work on the committee?

Gruber: Middle managers [of the airport] and group managers of the different organizations, for instance, handling companies.

ASW: One function of the safety committee you mentioned is accident and incident investigation. Does that overlap with the civil aviation authority's investigations?

Gruber: There is a clear division of responsibilities. Aircraft accidents are investigated by the government in accordance with ICAO [International Civil Aviation Organization] Annex 13. All other incidents and accidents are investigated by the airport. These are mainly ramp accidents like collisions between ground vehicles and damage to aircraft.

Regine Piller

We have about 260 occurrences on airside per year. The safety committee reviews them all with a view to changing procedures. The airport itself is in a position to issue certain kinds of regulations. For example, if we feel that in one part of the airport the speed has to be reduced for the vehicles, we can impose a restriction. Speed restrictions are controlled with fixed and mobile laser measurement systems.

ASW: Who monitors compliance with an airport's SMS?

Gruber: The safety manager is responsible. He works closely with the manager, airport operations. The SMS is part of the aerodrome certification, and therefore is supervised by the Ministry of Transport, which is the responsible authority for the whole airport.

ASW: Are you happy that the SMS has been instituted?

Gruber: Of course. It has enhanced the safety awareness of all airside people and we all will benefit from the increase in safety.

— RD

prominent. "We've made big progress in the past few months," Voss said. "We put out a resolution that's had a lot of media coverage and had impact worldwide. We built the broadest possible coalition, making the point that this wasn't simply about pilots or controllers being thrown in prison after an accident. We can't give the impression that we're trying to put our industry above justice. We simply have to restore the notion of justice that includes consideration of people who can still be saved by incident and accident reporting systems that need to be protected from contamination by law enforcement systems."

Runway safety, Voss said, is a great example of the need for working across domains. "You can't just look at what's going on in the cockpit. You have to look at the materials pilots use that come from manufacturers, whether the information on runway friction was transmitted by air traffic control [ATC], whether that information was correct when it came from the airport."

In their presentation on preventing runway incursions at Schiphol Airport, Amsterdam, Dick van Eck and Hans Houtman, both in the Expert Incident Investigation and ATM [air traffic management] Training department of ATC Netherlands, noted that the traffic at Schiphol — with six runways, a huge network of taxiways and as many as 100 aircraft movements an hour — needed a coordinated airport-wide safety action plan, in addition to its compliance with the 2001 European Action Plan for the Prevention of Runway Incursions. Schiphol's own action plan included coordination among regulators, airport authorities, ATC and airlines; creation of a local runway safety team; low-visibility procedures; and a campaign to detect "hot spots" on the airport surface that present special opportunities for error.

Systemwide, there are still opportunities for improvement, van Eck said. Citing an article in the January 2007 *ICAO Journal* that said a good practice adopted in some states is a policy preventing aircraft from crossing illuminated stop bars, van Eck added, "Something is definitely wrong here. … In 2007, crossing of illuminated stop bars is apparently a daily practice. It seems that the missing link is lack of training. If the current generation of pilots and controllers were properly trained, we would certainly be steps ahead."

Safety management systems — another innovation that seeks systematic rather than narrowly targeted improvement — were also discussed by several speakers. Gerhard Gruber, manager, airport operations, Vienna (Austria) International Airport, described how safety management systems can be instituted at airports. (See sidebar.)

Other presentations at the EASS looked at the accident record for the preceding year, presented by David Learmount, operations and safety editor, *Flight International*; aviation insurance, discussed by Göran Forsberg, general manager, Inter Hannover Scandinavian Branch; a new "approach" to helicopter offshore approaches, presented by Bjoern Boe, senior inspector, flight operation, Civil Aviation Authority Norway; and an analysis of weight-and-balance safety-related occurrences from Gerard van Es, senior consultant, safety and flight operations, National Aerospace Laboratory (NLR)–Netherlands Air Transport Safety Institute.

Of course, human factors always play a role in safety discussions. The subject has been studied for years and improvements made. Yet nothing can be taken for granted.

Daniel W. Knecht, accident investigator for the Swiss Aircraft Accident Investigation Bureau, offered an account of the investigation of a puzzling accident involving a Saab 340B after takeoff from Zurich Airport on Jan. 10, 2000. It was a scheduled passenger flight with the commander flying the airplane. Seven passengers were aboard.

Contrary to instructions from ATC to turn left, the pilot flying turned the aircraft right as it climbed. The pilot lost control and the aircraft struck terrain, killing everyone aboard. Painstaking reconstruction and examination determined that the airplane had been airworthy and there had been no significant mechanical malfunction.

Among the human factors that came to light in the investigation were the following: Both pilots had trained in a simulator that, unlike the Saab 340, had no flight management system; the commander, a citizen of the Republic of Moldova, had trained in Moldova and was a contract pilot, separated from his family, socially isolated and in difficult financial circumstances; and he was taking a self-prescribed benzodiazepine drug, Phenazepam, for insomnia. "Most probably, this accident was due to spatial disorientation of the pilot flying, [who] took the aircraft into a spiral dive," Knecht said.

The first officer, a citizen of the Slovak Republic, also was separated from his family. An earlier pilot evaluation determined that he had a tendency to delay intervention when called for and a latent weakness in decision making and establishing priorities.

Another finding was that both pilots came from a background of flying Eastern-built aircraft, whose avionics designers had a different philosophy of attitude-indicator display. Western-built aircraft show the attitude as an "inside out" view, as seen from the pilot's seat. Eastern-built aircraft show the attitude from "outside in," as though the pilot were standing in front of the aircraft looking toward it. Knecht said, "Under stress, the pilot flying resorted to a reaction pattern he had learned earlier, on the older [Eastern] type of instrumentation.

"Different cultures have individual strengths and weaknesses, and that's not a problem at all, but a transfer between different cultures may cause problems if we don't know these differences. So if we know those problems, we can solve them. This intercultural exchange can be an enrichment for the whole community."●

DEFUSING the Ramp

Progress report on FSF efforts to stem the toll of ground accidents.

BY MARK LACAGNINA

© Aircraftfire/Airliners.net

© Rogério Carvalho/Airliners.net

Airport ramps, or aprons, are busy and dangerous places, confined areas in which aircraft, vehicles and people are in constant motion in all types of weather. Turnover among personnel typically is high, training can be spotty, and standard operating procedures may be nonexistent or ignored. Often, the focus on schedule overshadows concerns about safety.

Ramp accidents happen more frequently than most people in the aviation industry realize, and the toll is astonishing.

Five years ago, Flight Safety Foundation (FSF) was asked by a member, an airline organization, for help in improving ramp safety. "A lot of people were being injured, and damage was being done to their airplanes on the ramp," said Robert H. Vandel, FSF executive vice president. "So, we set out to see what we could do to eliminate the problem."

The Foundation launched the Ground Accident Prevention (GAP) program under the chairmanship of Vandel and Earl F. Weener, Ph.D., a Foundation Fellow. The focus of the program was defined as "accidents and incidents that occur on airport ramps and adjacent taxiways, and during movement of aircraft into and out of hangars, and that directly affect airport operations and/or result in injuries or damage to aircraft, facilities or ground-support equipment."

Weener recalls that, when the program was initiated, there were various perceptions

© Marcel Drescher/Airliners.net

© Jan Einar Fardal/Airliners.net

This page: an A330 struck by a catering truck (left); a fuel truck driven into the nose of a military Falcon 20. Opposite page: an MD-82's right wing severed by a construction truck (top); a catering vehicle with stabilizers not deployed toppled onto the wing and nacelle of an A340 (bottom).

of the problem. "Most airlines had an incomplete picture of the problem because the costs were 'hidden,'" he said. "The costs of repairing airplanes damaged on the ramp were hidden in the costs of maintenance, the costs of flight diversions and cancellations were recorded in other categories, and so on. Some airlines were tracking the data, so at some level they did know about the problem — but not at a high-enough level to effect the needed changes. Very few had a true picture of what was happening on their ramps."

Multibillion-Dollar Problem

No one knew the magnitude of the problem until a rough estimate of US$5 billion a year emerged from brainstorming sessions that preceded the launch of the GAP program. The estimate was derived by extrapolation from data provided by an airline and represented the direct costs of repairing aircraft damaged on the ramp and an estimate of the indirect costs of schedule disruptions, out-of-service aircraft and associated costs. It included $4 billion for the airline industry worldwide and $1 billion for corporate aircraft operators.

Only a fraction of the losses are covered by insurance. One airline told the Foundation that of the 274 accidents that occurred during ramp operations, only one resulted in direct costs that exceeded the deductible limit of its insurance coverage. The average cost of the ramp accidents was $250,000. The airline's deductible limits were typical of the industry: $1 million for a widebody airplane, $750,000 for a new narrowbody airplane and $500,000 for an older narrowbody.

Vandel said that the $5 billion cost estimate helped focus attention on the problem. "The monetary losses were being accepted as a cost of doing business and really were not seen as stemming from a safety problem on the ramp," he said.

The initial estimate, however, did not include the indirect costs of personnel injury on the ramp. As the team refined the cost model, they found that the combined direct and indirect costs for medical treatment and related factors doubled the initial estimate.

GAP program activities, including collection and analysis of data and the development of the industry's first ramp-accident cost model, enabled the Foundation to refine its estimate and to include indirect costs of ramp accidents. The current estimate is that ramp accidents are costing major airlines worldwide at least $10 billion a year. "This is a staggering sum, yet the estimate is conservative," Vandel said. "It applies to about 90 percent of the world's airlines. We do not have the data yet to refine the estimate

The current estimate is that ramp accidents are costing major airlines worldwide at least $10 billion a year.

for corporate aircraft operators or to develop an estimate for regional airlines."

Cost Model

The GAP cost model (Figure 1) is among several e-tools now available free of charge on the Foundation's Web site.[1] The cost model provides users — air carriers and airports, for example — with estimates of their annual costs related to ramp accidents and incidents.

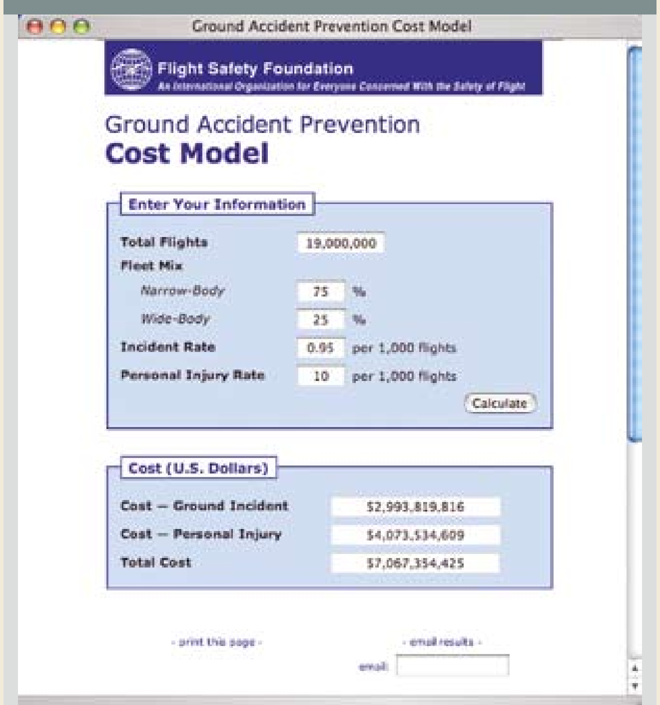
Cost-model calculations are based on the user's input of total annual flights, the percentage of narrowbody and widebody airplanes in its fleet or operation, and the accident/incident and injury rates per 1,000 flights. The user can print the calculated estimates or transfer them by e-mail.

"The calculations are automatic and remain on the user's personal computer," Weener said. "No information is transferred to the FSF Web site." The calculations are based on actual data collected by the GAP team.

Development of a standardized system for collecting and analyzing data was one of the most important tasks identified during the first meetings of the GAP program steering team. The results are data-collection and analysis tools that include a computer spreadsheet with drop-down menus for ease of use.[2]

Since 2005, the Foundation has been collecting data under legal confidentiality agreements with aircraft operators, ground-service providers and others involved in ramp operations worldwide. Efforts to secure data sources continue.

Ground Accident Cost Model



Source: Flight Safety Foundation

Figure 1

Initial Indications

Using activity data developed by the International Air Transport Association (IATA), the Foundation estimates that 27,000 ramp accidents and incidents — one per 1,000 departures — occur worldwide every year, and about 243,000 people are injured. The injury rate is 9 per 1,000 departures.

Initial analyses of GAP data collected to date indicate that contact between airplanes and ground-service equipment — baggage loaders, airbridges, catering vehicles, fuel trucks, etc. — accounts for more than 80 percent of ramp accidents/incidents.

Figure 2 shows where airplanes are being damaged by ground-service equipment. The initial indication is that damage most frequently is done to cargo doors, the fuselage and wing-mounted engines.

Ramp accidents/incidents involving contact between airplanes is a distant second, at slightly more than 10 percent, followed by contact between ground-service equipment, equipment and facilities, and airplanes and facilities.

Vandel said that the GAP team believes that as more data are collected, they will show a greater frequency of ramp accidents and incidents involving contact between ground-service equipment, and between ground-service equipment and facilities.

"The GAP team already is seeing human factors, particularly noncompliance with standard operating procedures, emerging as a dominant factor in ramp accidents and incidents," Weener said. "Malfunction and inadequate design of ground-service equipment, weather conditions and faulty communication are other, lesser, factors indicated by the data in hand."

Vandel and Weener stress that the Foundation continues to solicit robust sources of data on ramp accidents/incidents and injuries. "Unfortunately, it is not like the Foundation's CFIT/ALAR [controlled flight into terrain/approach and landing accident reduction] projects, where we were able to gather data on virtually all the accidents and incidents," Weener said. "The GAP data on hand, although not inclusive, can readily be used for troubleshooting, to point out targets of opportunity. We need more data to really focus on this problem and understand what is going on so that we can address mitigation and intervention actions more accurately."

Tools on Line

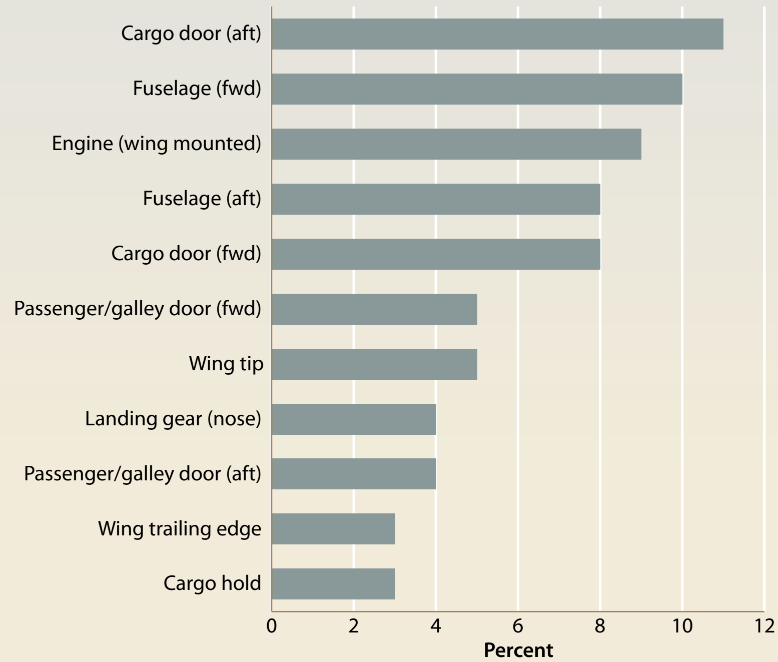
In addition to the cost model, GAP e-tools available at press time included three instructional videos, leadership tip sheets and links to articles from FSF publications related to ramp operations and safety. Several other GAP e-tools are in the works.

The videos show best practices for the safe operation of tow vehicles, for towing corporate aircraft and for general ramp safety. Each video runs approximately 12 minutes.

There are five leadership tip sheets, each a one-page briefing designed to be presented to senior managers to heighten their awareness of the ramp safety problem and its effect on the organization's operations and economic performance. "We recognized at the beginning that one of our most difficult tasks would be 'selling' ramp safety to top executives and getting them to buy into it," Vandel said. "Our cost estimates have attracted a lot of attention. The tip sheets are intended to help top executives lead their organization's efforts to improve ramp safety."

The first tip sheet includes a series of questions that senior managers should ask their staff about what is being done to prevent ramp accidents. "The important concept here is that you show interest in ramp safety," the tip sheet says. "A few simple questions posed by senior management can go a long way in preventing ground accidents."

Aircraft Damage Location



fwd = forward

Source: Flight Safety Foundation

Figure 2

The other tip sheets discuss the development of a company safety policy; the importance of including ramp operations in the company's safety management system (SMS); roles and responsibilities of senior managers, line managers and employees in an effective SMS; and the development and use of ramp safety performance metrics.

Among GAP e-tools that were being finalized at press time was *Ramp Operational Safety Procedures*, a manual template for ramp supervisors. The template, presented in Microsoft Word format to facilitate customization by the user, includes industry best practices and guidelines for a wide range of ramp procedures. "Some airlines do not have written standard operating procedures," Vandel said. "This will provide the basis for establishing them."

Other e-tools in the works included an inventory of ramp best practices; ramp-operations-oriented safety tactics and tools, such as threat and error management, safety audits, incentive and recognition programs, training plans and materials, and the Boeing ramp error decision aid.

"We are also trying to identify and encourage technical solutions to the ramp safety problem and make people aware of them," Vandel said. "This is something that we'll be doing with our Web site." For example, he cited an automated airbridge that uses infrared sensors to prevent damage to the aircraft during deployment, advanced docking visual guidance systems (see "Graceful Arrivals," p. 42) and vacuum devices that help workers avoid injury while picking up and sorting baggage.

Program in Transition

Plans are underway for the transition of the GAP program to its third phase, which will focus on implementation. The first phase involved the sharing of experience and knowledge by industry specialists assembled as the GAP steering team and five working groups — Awareness and Industry Relations, Data Collection and Analysis, Education and Training, Facilities, Equipment and Operations, and Management and Leadership Practices — to identify the safety issues and interventions that would build on work already done by organizations including the Airports Council International, Australasian Aviation Ground Safety Council, European Regions Airline Association, IATA, International Civil Aviation Organization, National Air Transportation Association, National Business Aviation Association, Regional Airline Association and several others.

In the second phase, the GAP team's work moved from experience-driven to data-driven. The cost model was developed and data analyses refined the program's focus and work on the e-tools. "We saw the issues and how disparate they are," Weener said. "We knew that we could effect change if we explored the data and got a good understanding of the problem."

In the third phase, which will begin this year, the name of the program might be changed to the Ground Incident Risks Management Program, with emphasis on continued data collection and expansion of data sources, database refinement, preparation and distribution of data-analysis reports, and management and refreshment of e-tool materials.

"The successful implementation of the final products will depend on the involvement of everyone concerned with ramp safety," Vandel said. "We expect to see measurable safety improvements. We have a problem. By working together, we can solve this problem." ●

An A320 was being pushed back from the gate when its tail struck the right wing of a 777.

© Weimeng/Airliners.net

Notes

1. Flight Safety Foundation (FSF), Technical Initiatives, Ground Accident Prevention <http://flightsafety.org/gap_home.html>.

2. The FSF Ground Accident Data Collection Tool is available free of charge on compact disc. Contact Millicent Wheeler, FSF technical programs specialist, at +1 703.739.6700 extension 109, <wheeler@flightsafety.org>.

Industry Leadership in Modernizing Safety Standards

BY DONALD SPRUSTON

International safety standards for general aviation have become woefully outdated. The general aviation industry's realization of this global problem generated action to find a solution.

The global benchmark for aviation safety regulation is the standards and recommended practices (SARPs) of the International Civil Aviation Organization (ICAO), the United Nations specialized agency responsible for the policies and standards for international civil aviation. The SARPs applicable to international operation of general aviation airplanes are found in Part II of *Annex 6 to the Convention on International Civil Aviation — Operation of Aircraft*.

This part was initially developed in the 1960s, when the shape of the industry was much different than today's modern high-technology sector. The '60s saw few international general aviation operations, and these were largely cross-border flights with small twin-engine aircraft, as well as a few intercontinental operations in converted airline aircraft. Today, there are more than 360,000 general aviation aircraft worldwide, including more than 25,000 turbine business aviation aircraft, many capable of intercontinental flight.

The problem is that international safety rules have not kept pace with industry advancements. What happens when the top of the world's rule-making hierarchy is inadequate? Experience shows that when there is a vacuum, someone will fill it. This is happening within the global regulatory environment, as regulators in a number of countries are seeing the deficiencies in the international standards and are acting alone to develop new rules for business aviation operations.

Business aviation has witnessed incredible growth over the past 20 to 30 years. Although the immense growth has not been in the public eye, it has certainly gained the attention of regulators. The consequence is consideration of new regulations for business aviation without benefit of a common definition of the industry and without recognition of its excellent safety record, which is equivalent to that of the large legacy air carriers.

The general aviation industry is very concerned about inherent safety deficiencies that exist whenever rules and operational procedures are different between countries. The solution proposed by the industry is to modernize the international standards and

The general aviation industry is very concerned about inherent safety deficiencies that exist when rules are different between countries.

to encourage ICAO member states to apply the new benchmark in developing rules, thus fostering harmonized regulations for general aviation worldwide. The International Business Aviation Council (IBAC) and its member associations formed an industry task force to address the issue, with willing assistance from the International Aircraft Owners and Pilots Association (IAOPA). A comprehensive proposal was developed to modernize Part II of Annex 6.

The industry task force applied the following principles to guide development of the proposal:

- Recognition of the excellent safety record of business aviation and the codes of practice used by the industry;
- Application of performance-based rules;
- Application of scalability of provisions per the philosophies applied in the initial Part II of Annex 6; and,
- Standardization of the structural presentation with other annexes.

Following the development of a draft proposal, IBAC and IAOPA consulted their organizations to test the concept. When these industry sectors were satisfied, the proposal was submitted to ICAO, which accepted it with considerable enthusiasm. A thorough review was conducted by the ICAO Secretariat and the Air Navigation Commission (ANC). Some adjustments were proposed by the ANC, and ICAO currently is seeking comments by its member states.

Fundamental to the design of the proposed new annex is separation of provisions for the different sectors of general aviation. The first section includes definitions and basic applicability information. The second section applies to basic general aviation operations. The third section will contain provisions applicable to turbojet aircraft and those over 5,700 kg (12,500 lb). A fourth section may be added at a later date subsequent to an ICAO policy decision on fractional ownership operations.

Requirements for basic general aviation would substantially be the same as the existing provisions, although modernized in line with current terminology.

The third section would introduce a significant change in the annex, as it would add new provisions for the rapidly growing business aviation sector. The objective is to stem the current move by states to make different regulations that will add to the continuing problem of global variances. The proposed new requirements recognize today's more sophisticated aircraft, their size and their performance and long-range capabilities. The most significant addition is a requirement for a safety management system (SMS) established in accordance with industry standards. The SMS requirement and reference to industry standards recognize the need for a program suited to the dimensions of business operators. Proven industry standards for SMS demonstrate the value and the scalability for both one-aircraft and multi-aircraft flight departments. Other new requirements in the updated annex include an operations manual and organizational standards.

Standards for fractional ownership operations, not included in the initial rendering from ICAO, would be added later. It is intended that these requirements be similar to those of U.S. Federal Aviation Regulations Part 91, Subpart K, and those proposed by the European Civil Aviation Conference (ECAC). These requirements would supplement those of business aviation and basic general aviation.

ICAO has requested member states to comment on the proposal by this summer. The new annex would likely take effect late in 2008, although some provisions such as the SMS might have effective dates further down the road.

In conclusion, the main motivator behind the industry-proposed amendment is to promote rule harmonization worldwide; the standards also would introduce many valuable additional safety benefits. ●

Donald Spruston is director general of the International Business Aviation Council.

Saw You in Amsterdam; See You in Seoul

European Aviation Safety Seminar

On March 12–14, 225 people happened to find themselves in the same meeting hall at the Grand Hotel Krasnapolsky in Amsterdam. Actually, it was no coincidence. The delegates made their way to Amsterdam from their home bases in 39 countries to attend the 19th annual European Aviation Safety Seminar (EASS), whose theme was "Staying Safe in Times of Change" (see report, page 17).

Heart and Seoul

As a Flight Safety Foundation member, one of your benefits is a US$200 discount on all FSF seminar registrations. Take advantage of the savings and join us for the 60th annual International Air Safety Seminar in Seoul, Korea, October 1–4, 2007. Hosted by Korean Airlines, the seminar will feature topics such as crew resource management (CRM) issues, risk management in maintenance, future air traffic management systems, regional safety efforts and many others.

If you would like to learn more about supporting aviation safety by becoming a member of Flight Safety Foundation, please contact Ann Hill, director, membership and development, at hill@flightsafety.org or +1.703.739.6700, ext. 105.

Global Aviation Information Network (GAIN)

The Global Aviation Information Network (GAIN) originally was proposed by the U.S. Federal Aviation Administration (FAA) to learn about the potential individual links in an accident chain by bringing together diverse groups to collect and share information. With FAA support for GAIN ending in 2007, Flight Safety Foundation decided to continue to furnish the wide range of fine products developed by GAIN, which are available for download at no charge in PDF format at <www.flightsafety.org/gain_home.html>.

Member News

Patricia Andrews, manager of aviation services at ExxonMobil Corp., was elected the new chairwoman of the Flight Safety Foundation Corporate Advisory Committee (CAC).

Flight Safety Foundation Governor Emeritus Gloria Heath was inducted into the National Lacrosse Hall of Fame. Also a member of the Women's Aviation International Hall of Fame, Heath was a founding member of Flight Safety Foundation.

CAE SimuFlite celebrated 60 years of business in the field of fight simulation and training this past March.

Flight Safety Foundation–Taiwan recently appointed a new chairman, Te-Ho Wang. ●

— Ann Hill, director, membership and development, Flight Safety Foundation

THIN *but* DEADLY

Another hard lesson that even a little ice can be dangerous.

BY MARK LACAGNINA

© Chris Sorensen Photography

Noncompliance with procedures for the use of a Citation's deice boots led to an ice-induced stall.

On the morning of Feb. 16, 2005, two Cessna Model 560 Citation Vs operated by the same company and being flown only minutes apart encountered icing conditions on approach to Pueblo (Colorado, U.S.) Memorial Airport. One airplane crashed about 4 nm (7 km) from the runway, killing the two pilots and six passengers; the other airplane was landed safely.

The difference, according to the U.S. National Transportation Safety Board (NTSB), was that the flight crew of the accident airplane did not cycle their deice boots during the approach and did not increase their approach speed, as required in icing conditions. The result was an ice-induced stall and an upset from which the pilots were unable to recover. The crew of the other airplane cycled their deice boots several times and maintained a higher-than-normal approach speed.

In its final report, NTSB said that the probable cause of the accident was "the flight crew's failure to effectively monitor and maintain airspeed and comply with procedures for deice boot activation on the approach." The board said that a contributing factor was the failure of the U.S. Federal Aviation Administration (FAA) "to establish adequate certification requirements for flight into icing conditions, which led to the inadequate stall warning margin provided by the airplane's stall warning system."

Cross-Country Trip

The Citations were owned by Circuit City Stores and operated by Martinair. "Martinair has provided pilots and maintenance support for Circuit City Stores airplanes through a management services agreement since 1993," the report said. "At the time of the accident, Martinair managed 15 aircraft, operated 11 aircraft and had 33 full- and part-time pilots and eight aircraft mechanics. Martinair's chief pilot stated that, although Circuit City Stores flights fell under [the general operating and flight rules of U.S. Federal Aviation Regulations Part 91], company pilots generally adhered to Part 135 [on-demand] operating rules for these flights and used the same checklists and standard operating procedures used for Part 135 flights."

On the day of the accident, the Citations were scheduled to fly employees of Circuit City Stores from Richmond, Virginia, to Santa Ana, California, with en route fuel stops in Columbia, Missouri, and Pueblo.

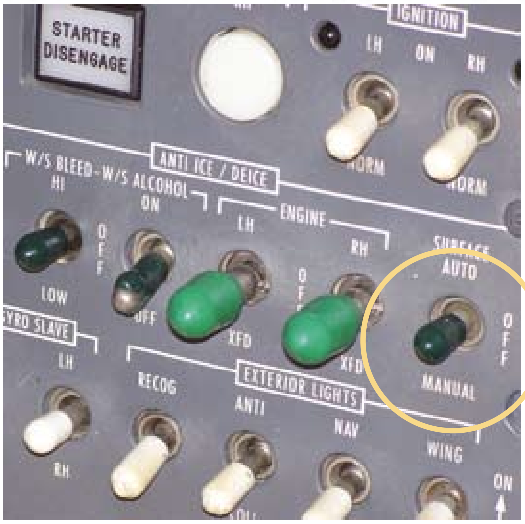
The captain of the accident airplane, 53, had 8,577 flight hours, including 2,735 flight hours in type and 1,500 flight hours as a Citation pilot-in-command (PIC). He held type ratings for 500-series Citations, the Beech King Air 300 and 1900, and the Dassault Falcon 10. He was hired by Martinair in February 2002.

The first officer, 42, held a Citation 500 type rating and had 2,614 flight hours, including 1,397 flight hours in type and 322 flight hours as a Citation PIC. He was hired by Martinair in November 2004.

The accident airplane departed from Richmond at 0600 local time — 0400 Pueblo time — and arrived in Columbia about an hour and a half later. After about 30 minutes on the ground, the airplane continued the trip to Pueblo.

Before beginning the descent from cruise altitude at about 0840 Pueblo time, the crew received automatic terminal information system (ATIS) information indicating that weather conditions at the airport included surface winds from 060 degrees at 6 kt, 10 mi (16 km) visibility, an overcast ceiling at 1,400 ft and a

Supercooled large droplets typically splash and freeze relatively slowly on contact with an aircraft.



Christine Lacagnina

When the surface-deice switch in the Citation V is selected to 'AUTO,' the boots cycle once; in 'MANUAL,' all the boots inflate and remain inflated until the switch is released.

surface temperature of minus 3 degrees C (27 degrees F).

The ATIS information indicated that Runway 08L was being used for landings. Accordingly, the crew briefed the instrument landing system (ILS) approach to that runway.

The airplane was descending in instrument meteorological conditions (IMC) at 0851 when the crew began discussing icing conditions. The captain said, "I'm going to heat them up." The report said that this statement likely referred to activation of the engine anti-ice system, which heats the engine inlets and the inboard wing leading edges. The captain also activated the windshield-heating system.

With deice boots of modern design on the airplane, pilots do not need to worry about the phenomenon of 'ice bridging.'

© Chris Sorensen Photography

The Citation V is certified for flight in icing conditions that are not severe. Engine bleed air is used to heat the engine inlets, inboard wing leading edges and the windshield. Deice boots are installed on the outboard wing leading edges and the horizontal stabilizer. Electric heating elements protect the pitot tubes, static ports and angle-of-attack (AOA) vanes.

'Real Thin Line'

The report said that analysis of cockpit voice recorder (CVR) data and meteorological data indicated that the airplane was in mixed icing conditions for about 5 1/2 minutes while descending from 21,000 ft to 14,000 ft.

At 0854, the captain asked the first officer if he saw any ice on the wing. "It's building a little bit right on the leading edge," the first officer said. "It's not the real white ice like we had yesterday. It's more … grayish. There's a real thin line back there."

The airplane was descending through 18,000 ft at 0858 when the captain said, "Doesn't look like we picked up any more [ice]."

The first officer said "nope" and suggested that the captain activate the deice boots. Noting that the surface temperature was minus 3 degrees C, he said, "It ain't going to melt much on the ground."

After the deice boots were cycled, both pilots commented about residual ice that remained on the boots. "Might have gotten rid of a little, but not much," the captain said. "Little sticky ice today," the first officer said. The flight crew did not activate the deice boots again during the descent and approach.

The report noted that the spring-loaded surface-deice switch in the Citation V has two positions: "MANUAL" and "AUTO." When the switch is held in the "MANUAL" position, all of the deice boots inflate simultaneously and remain inflated until the switch is released. Selection of "AUTO" initiates an 18-second cycle in which the various deice boots are inflated and deflated in a specific sequence. After the cycle is completed, the boots remain deflated until the surface-deice switch is selected to "AUTO" again.

Ice Bridging Fallacy

During postaccident interviews, instructors at CAE SimuFlite, Martinair's training provider, told investigators that they teach pilots to activate deice boots after 1/4 to 1/2 in (6 to 13 mm) of ice has accumulated on them. The report said that the SimuFlite *Cessna Citation V Technical Manual* states, "Early activation of the boots may result in ice bridging on the wing, rendering the boots ineffective."

"Ice bridging is a phenomenon in which ice in the shape of an inflated deice boot forms after the boot is cycled," the report said. "Ice bridging had been known to occur on older deice boot designs that used larger tubes and lower pressures, resulting in slower inflation and deflation rates."

However, research has shown that ice bridging is not a risk for modern turbine airplanes equipped with segmented, high-pressure deice boots that inflate and deflate quickly, the report said.

In Advisory Circular 25.1419-1A, issued in May 2004, the FAA says that pilots should not wait for a specific amount of ice to accumulate before activating deice boots. "Although the ice may not shed completely with one cycle of the boots, this residual ice will usually be removed during subsequent boot cycles and does not act as a foundation for a bridge of ice to form," the FAA said.

The report said that concern about ice bridging is no reason for pilots of modern airplanes to delay activation of deice boots. "Activating the deice boots as soon as an airplane enters icing conditions provides the greatest safety measure," the report said.

Airspeed Factor Omitted

While conducting the "Approach" checklist at 0859, the first officer said that the landing reference speed, VREF, was 96 kt. An approach-airspeed adjustment required by company standard operating procedures (SOPs) had not been applied.

"In accordance with company guidance, if any amount of residual ice — that is, ice that remains on the deice surface after the deice boots have been cycled — is present, VREF should be increased by 8 kt, which would have resulted in a VREF of 104 kt instead of the 96 kt reported by the first officer," the report said.

At 0905, the approach controller told the crew to fly a heading of 240 degrees. The controller said that the heading was a vector to the final approach course for the ILS approach to Runway 26R.

The first officer, who had prepared for the ILS approach to Runway 08L, told the captain, "He did a change on us here." He then retuned the navigation receivers and set the instruments for the ILS approach to Runway 26R.

"During postaccident interviews, the controller stated that he was often asked by corporate

Cessna Citation V

Cessna Aircraft Co.

The Cessna Model 560 Citation V is a derivative of the Model S550 Citation S/II, with a fuselage stretched 2.0 ft (0.6 m) and higher-performance Pratt & Whitney JT15D-5A engines, each producing 2,900 lb (1,315 kg) thrust. Deliveries began in 1989.

The Citation V can accommodate two pilots and eight passengers. Maximum takeoff weight is 15,900 lb (7,212 kg). Maximum landing weight is 15,200 lb (6,895 kg). Maximum rates of climb are 3,650 fpm with both engines operating and 1,180 fpm with one engine operating. Maximum operating speeds are 292 kt below and 0.76 Mach above 29,000 ft. Maximum operating altitude is 45,000 ft.

The Citation V was replaced in 1994 by the Citation Ultra, which has increased performance, a higher payload, a digital autopilot and electronic flight instrument systems. The current version of the Model 560 is the Citation Encore, introduced in 2000 with more powerful engines, a longer wing with improved stall characteristics and other improvements.

Source: *Jane's All the World's Aircraft* pilots to use the runway opposite that being advertised on ATIS [i.e., reciprocal runway] and that, as a service, he would provide the closest runway as a matter of course as long as the winds allowed it," the report said.

SLD Conditions

At 0908, while discussing the location of a regional airplane that was holding at 9,000 ft to reduce its fuel load for landing, the first officer told the approach controller that the Citation had entered IMC at 9,400 ft. A few minutes later, the controller told the crew to fly a heading of 290 degrees to intercept the localizer at 7,000 ft and cleared them for the approach.

A study of meteorological data by the National Center for Atmospheric Research (NCAR) found that the airplane likely encountered supercooled large droplet (SLD) conditions while descending from 9,400 ft to 6,100 ft, where the upset occurred. An SLD is a water droplet that remains liquid at a temperature below freezing until it strikes or is struck by something solid; it then freezes relatively slowly.

"SLD conditions can cause [thin, rough] ice accretions that are more aerodynamically detrimental than those that were considered during the initial certification of many existing airplanes for flight in icing conditions," the report said.

The NCAR study found that, during the 4 1/2 minutes the Citation was in the SLD conditions, 1 to 4 mm (0.04 to 0.16 in) of additional ice likely accumulated along the wing leading edges.

At 0909, the first officer said, "You got a little different ice on there now. It's clear." The captain said, "Yeah, and open up those valves all the way." The report said that the captain likely was referring to the windshield anti-ice bleed air valves. The windshield bleed-air switch has two positions: "LOW" and "HIGH."

At 0910, the first officer said, "OK, ignition is on with the anti-ice, now it's on for sure. Glideslope is alive." He then conducted a partial briefing of the approach: "It's two hundred decision height and three-quarters of a mile."

Soon after the captain announced that he was extending the landing gear at 0911, the approach controller cleared the crew to land and told them to remain on his radio frequency.

Boots Neglected

At 0911, the captain said, "Speed brakes coming back out again." The first officer said, "OK, there's your glideslope intercept." The captain told the first officer to extend full flaps. The first officer replied, "Full selected and indicated … and you are plus twenty-five." The captain replied, "Slowing."

The crew did not activate the deice boots, as required by company SOPs and recommended by the SimuFlite technical manual. "When reconfiguring for approach and landing … with any ice accretion visible on the wing leading edge, regardless of thickness, activate the surface deice system," the manual says. "Continue to monitor the wing leading edge for any reaccumulation."

At 0912:08, the first officer said, "Slowing, sinking seven. Captured the localizer and the glideslope. I've got some ground, but stay on the gauges." He then briefed the missed approach procedure.

At 0912:37, three seconds before the upset occurred, the first officer suggested that the captain activate the deice boots and told him that airspeed was at V_{REF}.

The report said that the airplane was descending through 6,100 ft, about 1,500 ft above ground level, at 0912:40 when the upset occurred — "a large roll to the left concurrent with a rapid decrease in pitch." The cockpit voice recorder recorded a tone consistent with activation of the autopilot-disconnect warning horn and a terrain awareness and warning system (TAWS) "BANK ANGLE" warning; the bank angle was about 50 degrees. The CVR stopped recording at 0912:55.

The Citation struck terrain at an elevation of about 4,600 ft. The airplane was destroyed by the impact and post-accident fire.

No Warning

The report said that the flight crew received no warning of the impending stall, which occurred well above the expected stall speed in icing conditions.

Based on input from the AOA system, the stick shaker in a Citation V activates when airspeed is about 7 percent above the speed at which the airplane, with uncontaminated wings, will stall. The report said that during flight tests of 560-series Citations in 1996, following three icing-related accidents, the FAA found that stall speeds increased 3–5 kt in icing conditions. In 1999, Cessna modified the stall warning system with an ice mode that causes the stick shaker to activate 5 kt above the clean-wing stall speed. The ice mode is armed when the engine anti-ice system is selected.

The accident airplane was equipped with the ice mode. The airplane flight manual (AFM) indicated that, at the airplane's landing weight and with full flaps, its stall speeds should have been 76 kt with uncontaminated wings and 81 kt with ice on the wings; stick shaker activation would occur at 86 kt.

Analysis of TAWS data indicated that airspeed was about 90 kt when the stall occurred. The report said that the flight crew should have been maintaining an airspeed of 114 kt at this point. In addition to the 8-kt adjustment of V_{REF} for icing conditions, company SOPs and the AFM say that an additional 10 kt should be maintained until the airplane is over the runway threshold.

Impact and fire damage to components of the AOA and stall warning systems precluded postaccident tests. The captain of the other Citation, which the report called the "sister ship," had flown the accident airplane the previous day and had found no problems with the systems. "Furthermore, no discrepancies were noted during the last scheduled maintenance inspection of the stall warning system," the report said.

Sister Ship

The sister ship was about 19 nm (35 km) behind the accident airplane on arrival at Pueblo. The flight crew of the sister ship told investigators that their airplane accumulated rime ice during descent.

"The first officer estimated that the ice was less than 1/2-in thick and stated that the deice boots effectively shed the ice," the report said. "He stated that there was no ice on the heated inboard wing leading edge or on the top of the wing. The captain stated that they kept the airspeed up on the approach because of the icing conditions."

The report said that performance calculations indicate that the sister ship's airspeed was more than 160 kt as it descended through 6,200 ft and that 120 kt was maintained until the airplane was about 200 ft above airport elevation, 4,726 ft.

"The sister ship landed on Runway 08L about 0926 without incident," the report said. "A review of the sister ship's CVR revealed that the pilots conducted several procedures to minimize any icing problems, including cycling the wing deice boots five times, turning the windshield heat to the 'HIGH' position, using only approach flaps until close to the ground, and keeping the engine power and speed as high as possible until clear of the clouds and landing was assured."

Slow Pace

In response to previous NTSB recommendations, the FAA formed the Ice Protection Harmonization Working Group in 1997 to review the icing-certification standards and operational guidance.

Among changes proposed by the group are a requirement that manufacturers demonstrate during transport airplane icing certification either that the airplane can be operated safely in SLD conditions or that a means is provided for the crew to detect and safely exit the conditions, and a requirement for guidance stating that deice systems should be activated as soon as icing conditions are encountered.

In the accident report, NTSB said that the working group is addressing some of the issues that were raised in previous recommendations. However, NTSB said that work is proceeding at "an unacceptably slow pace" and that "the FAA has taken no action to issue a final rule adopting the regulatory changes proposed by [the working group]."

Calls for Action

Based on the findings of the accident investigation, NTSB made the following new recommendations to the FAA:

- "Require that operational training in the Cessna 560 airplane emphasize the [AFM] requirements that pilots increase the airspeed and operate the deice boots during approaches when ice is present on the wings. (A-07-12);
- "Require that all pilot training programs be modified to contain modules that teach and emphasize monitoring skills and workload management, and include opportunities to practice and demonstrate proficiency in these areas. (A-07-13);
- "Require manufacturers and operators of pneumatic-deice-boot-equipped airplanes to revise the guidance contained in their manuals and training programs to emphasize that leading edge deice boots should be activated as soon as the airplane enters icing conditions. (A-07-14) … ;
- "Require that all pneumatic-deice-boot-equipped airplanes certified to fly in known icing conditions have a mode incorporated in the deice boot system that will automatically continue to cycle the deice boots once the system has been activated. (A-07-15);
- "When the revised icing certification standards (recommended in Safety Recommendations A-96-54 and A-98-92) and criteria are complete, review the icing certification of pneumatic-deice-boot-equipped airplanes that are currently certificated for operation in icing conditions and perform additional testing and take action as required to ensure that these airplanes fulfill the requirements of the revised icing certification standards. (A-07-16) … ; [and,]
- "Require modification of the Cessna 560 airplane's stall warning system to provide a stall warning margin that takes into account the size, type and distribution of ice, including thin, rough ice on or aft of the protected surfaces. (A-07-17)."

At press time, FAA responses to these recommendations had not been published.●

This article is based on U.S. National Transportation Safety Board Accident Report NTSB/AAR-07/02, "Crash During Approach to Landing, Circuit City Stores, Inc., Cessna Citation 560, N500AT, Pueblo, Colorado, February 16, 2005." The 86-page report contains appendixes.

Real-Time defenses

BY WAYNE ROSENKRANS

Integrating data from terminal Doppler weather radar and anemometer-based wind shear alerting systems during the past 10 years has further reduced, but not eliminated, wind shear encounters by large commercial jets below 1,600 ft (500 m) as a cause of accidents. Taking the next big advance in risk reduction will require blending the technology already in place into standard operating procedures (SOPs) for airline flight crews and dispatchers and into air traffic control (ATC) procedures, says Chris Glaeser, vice president safety and security for Alaska Airlines.[1]


© Patrick Lutz/airliners.net

Wind shear avoidance can reach the next level if airlines and ATC update their procedures to match current detection capabilities.

Combined with on-board wind shear detection equipment, the variety of ground-based enhancements helps flight crews to avoid encounters with abrupt changes in wind speed and/or direction that cause airspeed to increase or decrease by more than 15 kt, and may include updrafts and downdrafts that cause vertical speed changes greater than 500 fpm.

Such severe low-level wind shear primarily is associated with convective clouds and thunderstorms, gust fronts, downbursts and microbursts.

Glaeser has based his call for better integration on a three-year review of international guidance, wind shear detection upgrades by the U.S. Federal Aviation Administration (FAA) and best practices obtained from eight major U.S. airlines, reflecting the FAA's 1987 *Wind Shear Training Aid* and its adaptation to current guidance by the International Civil Aviation Organization (ICAO).[2]

"Estimates of U.S. wind shear encounters — whether on-board wind shear alerts or much more serious on-board wind shear warnings requiring a full-thrust escape maneuver — range from 150 to 400 per year," Glaeser said. "More study in this area is definitely warranted. Over the past 10 years, wind shear also contributed to a number of U.S. runway excursions that did not result in accidents. These conditions can change rapidly, and benign conditions quickly can become extremely dangerous."[3]

The consensus of the best practices is that, as the best defense, flight crews should avoid operating through areas where low-level wind shear is present or suspected. Whenever multiple indicators point to possible wind shear conditions, flight crews should operate with heightened awareness; contact ATC for additional information, including delays; and request advice from airline dispatchers.

Recent wind shear events in which safe landings were conducted showed that common factors were rapidly changing conditions, microburst-generated wind shear that exceeded aircraft control capabilities and no direct feedback from ATC regarding hazardous conditions, according to Glaeser. Reviewers also analyzed two of the runway excursions, involving a Boeing 737 in 2003 and a McDonnell Douglas DC-9 in 2005.

Ground-Based Upgrades

Ground-based wind shear defenses in the United States include terminal Doppler weather radar systems; integrated terminal weather systems (ITWSs) for a group of major airports that have experienced severe weather conditions;[4] weather-system processors;[5] and enhanced low-level wind shear alert systems (E-LLWAS and others).[6]

"The ITWS is a powerful tool that will make a tremendous difference if integrated into ATC procedures," Glaeser said. Although the ITWS has been a valuable tool for tower controllers, its integration into ATC arrival and departure procedures could be significantly improved, he said. Similar integrated capabilities are being deployed in other places, including Japan and Hong Kong, China. On the other hand, as of June 2005, 16 countries had filed differences with ICAO standards and recommended practices (SARPs) noting that their air traffic controllers do not issue wind shear warnings, typically because their facilities have no ground sensors or insufficient ground sensors; or they issue wind shear warnings only at one airport; or methods of communicating about wind shear vary.

The ground-based information for flight crews primarily comes in the form of an ATC *wind shear alert* in effect for about one minute or a less-urgent *wind shear advisory* in effect for 20 minutes. Controllers issue an alert to any aircraft crew that will penetrate a warning area associated with specific runways at airports equipped with ITWS. This area is a rectangle 0.5-nm (0.9-km) wide and extending 3.0 nm (5.6 km) from the approach end of a specific runway in use to 2.0 nm (3.7 km) from the departure end. This rectangle may encompass more than one runway, and warnings are only issued for specific runways with active wind shear or microburst alerts. Other runways at the same airport may continue operations when authorized by ATC when flight crews take appropriate precautions.

"Since 2000, the National Weather Service and the FAA have upgraded more than 120 airports with runway-specific wind shear alert systems," he said. "Some airports post wind shear advisories whenever gusty winds are present, however, regardless of convective activity. Standardization would reduce false warnings."

Advisories may be received via the airborne communications addressing and reporting system (ACARS) or automatic terminal information service (ATIS), telling flight crews that a wind shear or microburst has occurred within the past 20 minutes. Common to E-LLWAS or other upgraded LLWAS, the weather-system processor and terminal Doppler weather radar in airport control towers is a ribbon display that visually and audibly draws controllers' attention to any automated wind shear alert, showing the effect in terms of airspeed gain/loss and the specific runway(s) affected. Tower controllers are required to communicate these alerts to flight crews by radio. One example of phraseology would be, "Runway 34R arrival, microburst alert, airspeed loss of 35 kt on one-mile [1.9-km] final." Other controllers are not required to issue these alerts, which may reduce significantly the time available for the flight crew to take evasive action, Glaeser said.

"The gust front is a huge hazard to aircraft during takeoff and landing, but is … ignored in ATC procedures, and somewhat unrecognized in industry training programs."

An ITWS display of a gust front and its movement (Figure 1) enables controllers or dispatchers to advise flight crews about the real-time situation. On this display, the runway complex — shown by black lines — is centered, the current position of the gust front is shown as a solid line, and future gust-front positions are shown by dashed lines representing 10 minutes later and 20 minutes later. "Notice how far the gust front is projected to move in only 10 minutes," Glaeser said. "Use of this display should be integrated into ATC procedures, at both approach control and tower facilities, and into operators' dispatch offices. In this case, a 15-minute delay allowed time for all of the hazardous weather to leave the airport area. The gust front is a huge hazard to aircraft during takeoff and landing, but is a very transitory phenomenon ignored in ATC procedures, and somewhat unrecognized in industry training programs."

Airline Best Practices

Several recommendations emerged from comparing the best practices. One is that SOPs should specify that "takeoffs and approaches and landings are not authorized when runway-specific wind shear alerts or microburst alerts have been issued by ATC." Another is that if a takeoff is in progress, and one or more wind shear indications are encountered, the captain immediately should decide either that the takeoff can be completed safely and continue, or reject the takeoff. If wind shear is encountered during approach and landing, a full-thrust wind shear escape/recovery maneuver is mandatory. An immediate go-around or missed approach should be conducted if any degraded aircraft performance is experienced below 1,000 ft above ground level, an airspeed loss greater than 15 kt occurs, ATC issues a wind shear alert or the airborne wind shear warning system activates.

Similar to the ICAO guidance, the eight airlines that use these best practices also manage the risk of encounters with academic training on how to evaluate severe low-level wind shear probability given a set of current conditions. Recommendations from the review were that flight crews especially need to be vigilant for any runway-specific wind shear alert or microburst alert — which normally indicate the highest probability of a wind shear encounter — and to interpret this alert as an unmistakable indication that takeoff or landing cannot be conducted safely.

The following events would indicate a high probability of a wind shear encounter: a runway-specific wind shear alert within the previous 10 minutes — for the flight crew's own aircraft or another aircraft approaching the same runway — even though the alert is no longer active; a severe thunderstorm cell less than 5.0 nm (9.3 km) from the airport and moving toward the airport; a gust front approaching the airport, indicated by rapid changes in wind speed and/or direction; a pilot report (PIREP) of an airspeed loss or gain of more than 15 kt within the previous 10 minutes in a similar or larger aircraft; a wind shear warning from an airborne system (aboard the flight crew's own aircraft or another aircraft); heavy rain showers along the flight path; airborne weather radar returns showing heavy precipitation; reports of blowing dust, roll clouds, wall clouds or cloud rotation approaching the airport;

large changes of autothrust or manual thrust required to maintain airspeed; and/or large changes in pitch required to maintain the glideslope.

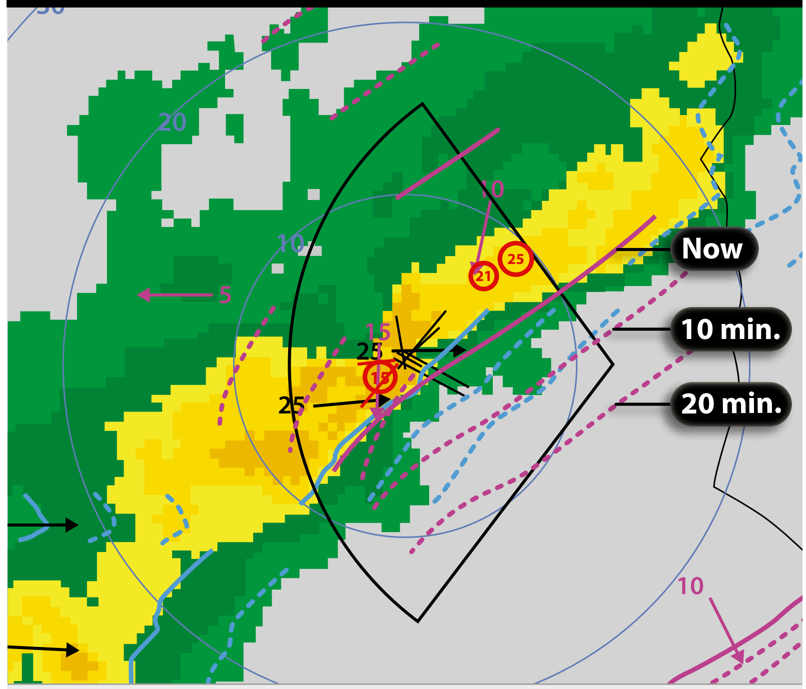
Faced with high-probability events, the flight crew should use caution and consider holding until the weather phenomenon no longer affects the approach/departure path, Glaeser said. The flight crew should divert if the safety of flight is adversely affected by the fuel state or weather. In any event, the pilot monitoring must be vigilant for degradations in either aircraft performance or weather conditions. Crews also should consider each environmental factor as cumulative. "If more than one is observed, the probability of a hazardous weather encounter is increased," Glaeser said. "The flight crew then should consider alternate routings or runways; consider holding or diverting; brief the wind shear escape maneuver; and utilize all wind shear precautions." Review of the two runway excursions, which he called "near accidents," found multiple high-probability events, he said.

Another best practice used by the eight airlines is to present, for periodic review, possible current conditions, wind shear probabilities, departure precautions, approach/landing precautions and appropriate flight crew actions in a flow chart in the quick reference handbook. In either the departure phase or the approach and landing phase, the flow chart's precautions should require specific decisions/actions for thrust setting, runway selection, flap selection, operational considerations, engine ignition and response to wind shear warnings. For example, precautions for takeoff call for using maximum thrust; using the full length of the longest compatible runway that avoids convective activity; soliciting PIREPs; using the maximum takeoff flap setting in accordance with the aircraft flight manual; being prepared to reject the takeoff by watching for signs of stagnated acceleration; and adding a factor to the normally computed rotation airspeed.[7]

Examples of precautions for approach and landing are: do not approach or land on a runway if an ATC wind shear/microburst alert is active; conduct a stabilized approach as a mandatory requirement; do not make aggressive reductions of thrust due to sudden changes in indicated airspeed (IAS) or allow the autothrust system to significantly reduce thrust — instead, the pilot flying should accept increases and expect corresponding rapid drops while gradually correcting IAS; and consider disconnecting autothrust or otherwise minimizing thrust reductions by not allowing autothrust to make inappropriate reductions. "The first precaution is the most important but, unlike the others, requires ATC involvement," Glaeser noted.

More precautions for approach and landing include: wait 10 minutes after the flight crew of a similar or larger aircraft reports a loss of IAS greater than 15 kt; conduct an immediate go-around in response to a loss of IAS greater than 15 kt; select an approach procedure that provides

FAA ITWS Display of Gust Front and Wind Shear



21 Low-level wind shear with predicted change of airplane velocity in knots
Current gust front position
Projected gust front position in minutes
Boundary for wind shear detection by terminal Doppler weather radar and other FAA/NWS sensors

FAA = U.S. Federal Aviation Administration ITWS = Integrated terminal weather system
NWS = National Weather Service

Note: ITWS primarily is a tool for air traffic controllers and airline dispatchers, showing the airport runway complex at the center of the display and the surrounding area to 60 nm (111 km). The FAA's prime contractor is Raytheon Air Traffic Management Systems.

Source: Chris Glaeser

Figure 1

a glideslope when possible; increase the approach speed by up to 15 kt to correspond to any anticipated loss of IAS; be sensitive to large changes in pitch — five degrees — or in vertical speed — 500 fpm — and go around if excessive changes occur; use continuous engine ignition; and go around if any airborne wind shear warnings occur.

One resource that Glaeser highlights is terminal weather information for pilots (TWIP), which enables automated wind shear/microburst advisories and alerts to be uplinked via the ARINC network to ACARS displays. Like digital ATIS text messages, the ACARS message from TWIP for a wind shear advisory will continue for 20 minutes after any wind shear/microburst alert has been issued. "A number of U.S. operators take advantage of this automated service, which is destination-specific," Glaeser said. "To determine if a wind shear/microburst alert is active, however, a flight crew must contact the tower even though a wind shear advisory is in effect."

Each ACARS message (Figure 2) indicates the source of the message, such as ITWS. Only one advisory per airport is current at a time; recurring alerts do not result in multiple advisory messages, and any advisory can be superseded.

"Tremendous recent advances have occurred in U.S. wind shear detection technologies, with good progress in nationwide installation and 100-percent upgrades of LLWAS," Glaeser said. "But ATC and ICAO documents should be updated — and accident risk can be greatly reduced by air carriers' widespread incorporation of these procedures and best practices. The FAA also should adopt the ICAO term 'warning' in place of 'alert' in controller-pilot radio communication as it is much clearer in required flight crew actions." ●

Example of TWIP Message on ACARS

1. DFW
2. *MICROBURST Advisory
   40KT LOSS BEGAN 1816Z
   –STORM AT ARPRT MOD PRECIP
   1NM E HAIL
   MOVG W AT 15KT
   BEGIN 1822Z
3. VALID 1816 TO 1836Z
4. CANCEL NONE-TWIP

ITWS TERMINAL WX INFO

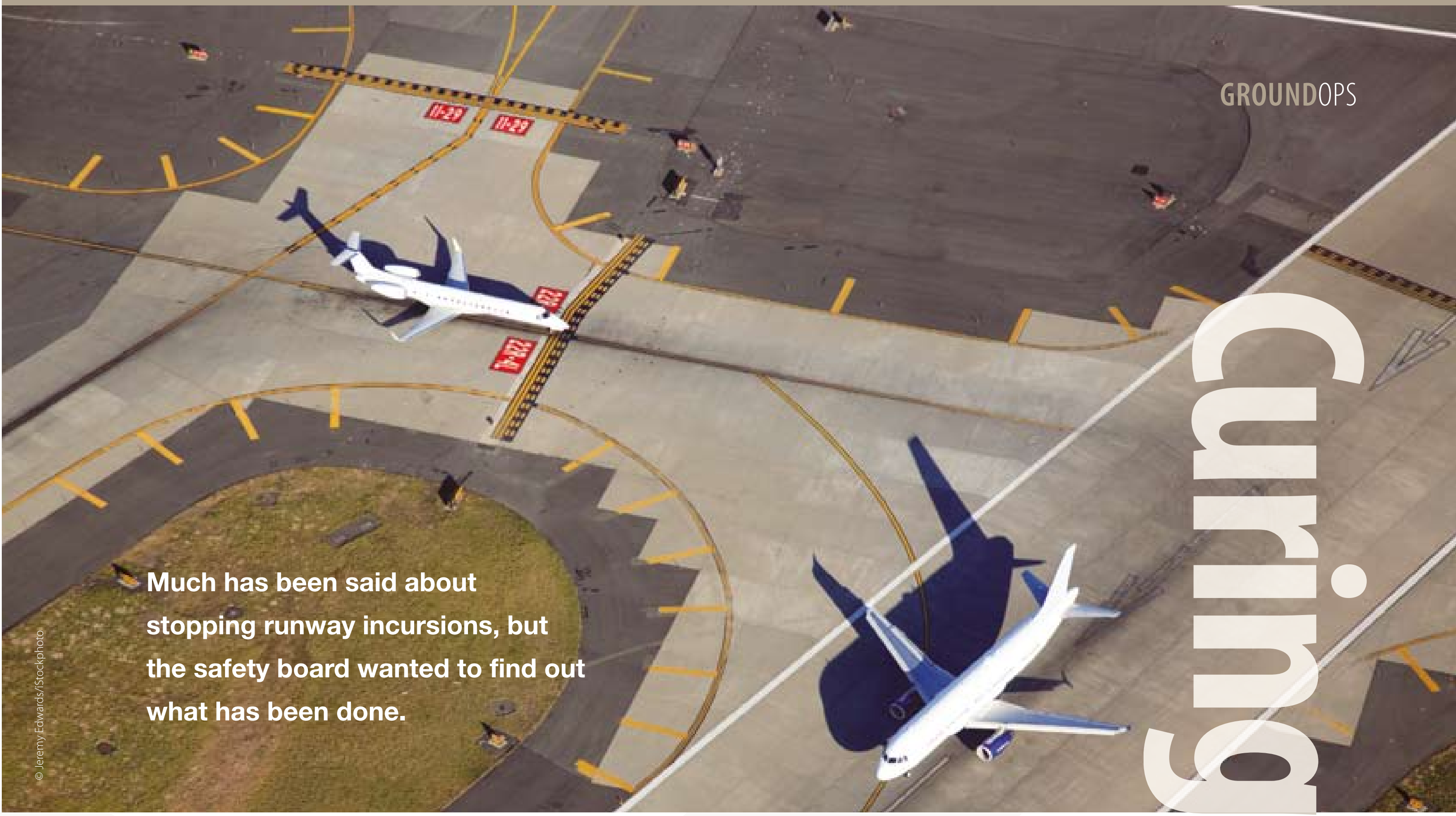
ACARS = Airborne communications addressing and reporting system
DFW = Dallas/Fort Worth International Airport
ITWS = Integrated terminal weather system
TWIP = Terminal weather information for pilots

Source: Chris Glaeser

Figure 2

Notes

1. Glaeser, Chris. "Windshear Risk Reduction: Integrating New Technologies Into Aircrew and ATC Procedures." A presentation to the Flight Safety Foundation International Air Safety Seminar in Paris. Oct. 23–26, 2006.
2. International Civil Aviation Organization. *Annex 3 — Meteorological Service for International Air Navigation.* 2005. Document 9817, *Manual on Low-level Wind Shear.* 2005.
3. Estimates were based on extrapolating deidentified aviation safety action program (ASAP) data — voluntary reports submitted by U.S. airline pilots — after noting that flight operational quality assurance (FOQA) programs show that only 10–15 percent of wind shear events downloaded from aircraft quick-access recorders were reported via ASAP, and that approximately 20 percent of reports were full-thrust escape maneuvers, Glaeser said.
4. Integrated terminal weather service (ITWS) primarily provides automated weather information for use by air traffic controllers and supervisors in airport terminal airspace 60 nm (111 km) around the airport. The system was designed for wide use without meteorological interpretation. ITWS provides information about the current weather and forecasts for 30 minutes through integration of data from sensors such as terminal Doppler weather radar, next-generation weather radar, airport surveillance radar, low-level wind shear alert system (LLWAS), automated weather and surface observing systems, lightning-detection systems, weather models and weather sensors aboard some airliners.
5. The ATC facilities equipped with a weather-system processor have an enhanced weather channel on their ASR-9 traffic surveillance radar, warning controllers and pilots of hazardous wind shear and microburst events near runways; predicting the arrival of gust fronts; and tracking/predicting thunderstorm movement. It is used when facilities do not have terminal Doppler weather radar.
6. As of early 2007, U.S. airports had four LLWAS generations in operation. The most advanced — called *network expansion* — integrates wind speed and wind direction data from as many as 32 anemometers to increase the probability of microburst detection compared with four to six sensors in the legacy *LLWAS-2* generation. The *relocation* generation improved LLWAS-2 performance by relocating or replacing anemometer masts to overcome sensor-shielding or sensor-sheltering. The *sustainment* generation extended the service life of LLWAS at airports that do not have terminal Doppler weather radar or the weather-system processor.
7. According to U.S. Federal Aviation Administration Advisory Circular 00-54, *Pilot Windshear Guide*, to apply the wind shear additive for takeoff, the flight crew essentially calculates the normal takeoff airspeeds for the actual aircraft gross weight and flap setting; sets these speeds with the indicated-airspeed bugs; determines the runway maximum weight capability for the same conditions; determines the takeoff speeds for this maximum weight; and, during takeoff, delays aircraft rotation until the higher speeds — to a maximum additive of 20 kt — are reached. Some operators specify 15 kt, Glaeser said.


© Jeremy Edwards/iStockphoto

Curing Incursions

Much has been said about stopping runway incursions, but the safety board wanted to find out what has been done.

BY J.A. DONOGHUE

Washington, D.C. — While relatively rare, runway incursion accidents can be exceedingly lethal, as was demonstrated 30 years ago in the Canary Islands when two 747s came together on the runway at Tenerife and 583 people died in what remains the world's deadliest aircraft accident. Advances in procedures and technology since that tragic day have reduced the risk of fatal incursions, but, according to industry experts, the big advances needed to achieve a substantial reduction of risk remain uncompleted.

Testifying at the Runway Incursion Forum held by the U.S. National Transportation Safety Board (NTSB) to publicize the progress, or lack of progress, in reducing the risk from incursions, U.S. industry leaders seemed in agreement that sought-after technologies and procedures seem to be nearing reality.

NTSB Chairman Mark V. Rosenker opened the forum by declaring that the U.S. Federal Aviation Administration's Airport Movement Area Safety System (AMASS) — essentially airport surface radar based in the airport control tower — "will not prevent an incursion in all situations. It takes too long for the warning to get to the pilot." The needed solution, proved by simulations, "is something that goes directly to the cockpit."

But short of that technological solution there are other steps that, if taken, provide some risk reduction, speakers said.

Capt. Robert Bragg, first officer of the Pan Am 747 involved in the Tenerife accident, listed the low-tech lessons he took away from that day:

- Anyone can make a mistake, no matter how qualified;
- Communications must be effective and readily understood;
- When in doubt, don't;
- Check, double-check and re-check; and,
- Continue emphasis on crew resource management (CRM).

Speaking to his final point, Bragg said, "Probably today this accident would not have occurred due to the emphasis on CRM, which is fantastic," referring to the fact that the very senior captain flying the KLM 747 that day 30 years ago was questioned by both his first and second officers about his decision to start the fatal takeoff run.

After discussing subjects as varied as runway stop lights, distinctive airport surface markings and systems that sense aircraft on runways and blink approach lights to warn landing aircraft, most of the speakers eventually turned to in-cockpit information and warning systems.

Capt. Mitchell Serber, chairman of the Air Line Pilots Association airport ground environment group, summed it up: "Most of the CAST [Commercial Aviation Safety Team] 2002 recommendations are not yet implemented." Among those CAST items still not available, Serber listed moving-map displays of the airport surface with own-ship position, adding traffic to the display, runway occupancy advisories, graphical/text display of taxi and clearance limits and, for the tower, Airport Surface Detection Equipment-X, which, the Federal Aviation Administration (FAA) said, is only installed at nine airports, while 26 more await the system to upgrade existing AMASS installations.

Given that the original CAST report said, "The Runway Incursion JSIT [Joint Safety Analysis Team] determined that the moving-map display systems were the most powerful intervention for runway incursion prevention," members of the forum were encouraged when Jeffrey Loague, from the FAA office of runway safety, said that FAA recently approved a quicker certification process for a Class II electronic flight bag with an airport moving-map and own-ship position. With the publication of certification standards for the moving-map display due by the end of April, Loague estimated that products could be available "as early as this summer."

While own-ship position can be derived from Global Positioning System data compared to an airport surface chart, the addition of automatic dependent surveillance-broadcast (ADS-B) data from other aircraft would allow the depiction of surrounding surface and nearby airborne traffic on the same display, speakers said. With FAA's recent formal adoption of ADS-B as its navigation system for the future, some vendors are itching to obtain approval for the technology in the near term.

ACSS, which has been participating in a UPS ADS-B development program at the airline's hub in Louisville, Kentucky, is pushing hard to gain such an approval for its moving-map system.

Some uncertainty was expressed about moving maps. Mont Smith, director, safety,

This chart details the aircraft types involved in all U.S. incursions and the most hazardous incursions, listed as category A&B.

Runway Incursions, a Comparison of Commercial Involvement

Fiscal Year	Total Runway Incursions (RIs)	Total Number of A&B RIs	Percent of All RIs Involving at Least One Commercial Aircraft	Percent of RIs Involving Both Commercial and General Aviation Aircraft	Percent of A&B RIs Involving Both Commercial and General Aviation Aircraft	Number of A&B RIs Involving at Least One Commercial Aircraft	Number of A&B RIs Involving at Least One General Aviation Aircraft	Number of A&B RIs Involving No Commercial Aircraft
2001	407	53	31%	16%	2%	28	31	25
2002	339	37	31%	16%	2%	8	31	29
2003	323	32	38%	14%	1%	9	24	23
2004	326	28	26%	16%	2%	6	27	22
2005	327	29	37%	20%	1%	9	23	20
2006	330	31	39%	18%	1%	10	24	21

Notes:

Total category of A&B runway incursions for Fiscal Year 1998 through Fiscal Year 2000 were 59, 69 and 67, respectively.

As of March 6, 2007, there were 5 category A&B incursions in Fiscal Year 2007. On March 6, 2006, there were 9 A&B incursions in Fiscal Year 2007.

Data prior to Fiscal Year 2001 contained many records with insufficient information to determine aircraft mix or severity.

Source: U.S. Federal Aviation Administration

Table 1

for the Air Transport Association, expressed airline reluctance to invest in expensive new hardware only to see it superseded or made irrelevant by FAA policy changes, adding that ATA favored "low-cost airport surveillance technology."

Dave Lotterer, Regional Airline Association VP—technical services, said that while moving-map displays have great safety enhancement potential, unresolved issues include the system's potential to get pilots "head-down," looking inside the cockpit while taxiing. Further, "there is a major disconnect between airport operators and charting suppliers, air traffic control uses government-produced charts while operators use commercial charts, and airports have no formal process for communicating changes to government and users. Moving maps lack reliability unless the charting process improves."

The need for clear and unambiguous communications and standardized communication procedures was emphasized by both Mont Smith and Darren T. Gaines, air safety investigator with the National Air Traffic Controllers Association (NATCA). Both men identified the dangers of embedded taxi clearance limitations, in which a pilot is cleared to his destination, but in the same clearance is told to hold short of a runway. Gaines called this single clearance with two clearance limits a "phraseology trap." He said that NATCA recommends that each controller/pilot communication contain a single clearance limit, and that complex taxi clearances be given in progressive instructions.

Smith agreed, noting the further confusion created by U.S.-sanctioned phraseology differing from what is recommended by the International Civil Aviation Organization. Serber, a Comair pilot, said differences even between the United States and Canada create problems, with U.S. pilots creating violations when they forget that in Canada each runway crossing clearance must be acknowledged.

Discussing the need to evolve phraseology to eliminate misunderstanding, Gaines raised the point that FAA no longer seeks or uses controller input in the design or modification of systems and procedures. "NATCA has zero safety influence with FAA," he said.

Serber immediately volunteered that FAA controllers are working in a poor safety environment. "Controllers need an ASAP [Aviation Safety Action Program]. We can't maintain an aviation safety culture under a punitive environment."

Gaines agreed: "Controllers desperately want, desperately need a non-punitive environment," he said, adding that FAA is the only large air traffic control provider that has not adopted the non-punitive safety culture model.

Talking about the importance of airport design, Serber noted the benefit of runway and taxiway layouts that eliminate so-called "hot spots," where the risk of inadvertent incursions is increased. He also urged the construction and use of "end-around" perimeter taxiways that provide the option of going around a runway instead of crossing it.

A recurring theme with most speakers was that the solution to runway incursions was not just a single system or program, but the construction of a structure consisting of "layers of information and alerts," as Serber described it: moving-map displays, runway status lights, surface movement radar, perimeter taxiways, training and communications, and visual aids, combining to provide multiple layers of protection. ●

Another View

Speaking as co-chairman of the newly constituted Runway Safety Initiative, Earl Weener, a Flight Safety Foundation Fellow, pointed out that the worst U.S. incursion accident took 34 lives. "Incursions are part of the new breed of safety issues — there are not a lot of accidents, but there are numerous incidents," he said.

Pointing out that the Runway Safety Initiative is looking at runway excursion and runway confusion combined with the incursion issue, he noted that worldwide in the 2002—2006 period, out of 512 total accidents there were only three incursion accidents — 0.6 percent of the total — in which 17 people died. However, there were 13 runway excursion accidents that caused 283 deaths, he said.

—JAD

The solution to runway incursions is not just a single system or program, but the construction of a structure consisting of "layers of information and alerts."

Safegate International

Compliance with world standards reduces the opportunity for error using visual docking guidance systems.

Graceful Arrivals

BY WAYNE ROSENKRANS

When a large commercial jet arrives at an airport gate, navigational errors of fractions of a meter can matter. A good outcome after inaccurate parking might be simple misalignment with the airbridge and ground service equipment, possibly delaying a flight while ground technicians reposition the airplane. But should an impact occur, even while braking from a taxi speed of 2 kt, damage resulting from a collision with the airbridge, a vehicle or ground service equipment can be hazardous and expensive, as shown by incidents over the past 10 years.

Technological solutions to parking reliably and accurately, developed since the late 1960s, increasingly are considered part of an airport's advanced surface movement guidance and control system (A-SMGCS) and they are being installed worldwide, some as pricey as US$60,000 per gate. Several thousand of the visual docking guidance systems (VDGSs) described by the standards and recommended practices (SARPs) in Annex 14, *Aerodromes,* Chapter 5, "Visual Aids for Navigation" of the International Civil Aviation Organization (ICAO) — and the advanced docking visual guidance systems (ADVGSs) for which ICAO has not published SARPs — primarily are intended to help airline flight crews to safely park at airport gates with minimal or no involvement of marshallers. ICAO has not made VDGSs mandatory but, for the airlines and airports that install them, has provided guidance on the selection of appropriate systems in its *Aerodrome Design Manual,* Part 4, "Visual Aids."

ICAO required that any installed VDGS comply by Jan. 1, 2005, with the SARPs, resulting in the installation of hundreds of ADVGSs, also called AVDGSs, in recent years as upgrades or replacements for noncompliant equipment.

ICAO basically requires that a VDGS display the selected aircraft type if different types are selectable, clearly display any malfunctions to the pilot, enable pilots to monitor and adjust azimuth and stopping point without turning their heads, provide closing-rate information so the pilot gradually can decelerate the aircraft to a full stop at the intended stopping position, and provide at least the left-seat pilot with azimuth guidance and a method of determining the stopping point on the stand centerline. ICAO further recommends that the closing rate to the stopping point be displayed for at least 10 m (32.8 ft) and that the system also can be used by the right-seat pilot.

The U.K. Civil Aviation Authority (CAA) said in 2005, "The ICAO Aerodromes Panel is developing criteria for the use of … ADVGS that provide more accurate guidance information to both pilots. These systems are becoming more customary at larger aerodromes, and pilots that regularly operate to and from international hubs are becoming more familiar with them. … The human factor issues associated with handling the differences between older VDGSs and newer ADVGS systems have been cited in a number of docking incidents. … Accordingly, [U.K.] aerodromes should consider the installation of ICAO-compliant VDGSs when upgrading or renewing facilities and, on international stands that are pier-served [i.e., have airbridges], the replacement of VDGSs with ADVGSs as soon as practicable."[1]

Although exact sets of features are product-specific, typical ADVGSs show the aircraft "established on course" to the gate from a distance of about 100 m (328 ft) from the stopping point, the type of aircraft expected to dock and when the docking aircraft is detected approaching the gate. At prescribed distances, a display panel in front of the pilots shows direction to turn, deviation from the centerline and the distance to the stopping point. Upon reaching the stopping point, the system typically displays "STOP" in large letters, followed by a confirmation such as "OK." An out-of-tolerance deviation from normal operation also generates the "STOP" display, and overshooting the stopping point by a specified amount may be displayed with a message such as "STOP/TOO FAR" or "T-FAR." Some systems also display "SLOW DOWN" if the aircraft exceeds the system's maximum allowable taxi speed.

In the early days of VDGS, aircraft-sensing technologies included pneumatic devices and electrical induction loops installed in grooves cut into aprons. Designers later recognized that safety would be improved by displaying all information from a single site, eliminating the need for pilots to turn their heads to separately check azimuth and nosewheel position. Current ADVGS sensing technologies include lasers, microwaves, a laser-radar combination called ladar, and specialized video cameras linked to three-dimensional computer image processing that recognizes the aircraft outline, position and closure rate. Display designs have evolved from round red-amber-green lights reminiscent of traffic lights for motor vehicles to digital Moiré patterns, light-emitting diodes (LEDs) and transreflective/backlit liquid-crystal displays (LCDs).

Some manufacturers currently advocate consistent appearance in information display as the ideal for flight crews, however. "We believe it to be critical to achieve a worldwide standard in order to reach an acceptable level of uniformity and hence decrease the risk for misinterpretation," said Jesper Svensson of Safegate International. "We believe in limited freedom in [designing] the AVDGS display. There is still a lot of room for innovation in terms of increased functionality and safety features." Megan Knox of Siemens Airfield Solutions similarly said that consistency in requirements for appearance of messages and operational procedures would be beneficial to pilots and airports, and would not affect innovation in ADVGS technology.

Some manufacturers have added capabilities such as aircraft-type identification check; interlocks to prevent operation of the airbridge at the wrong time; a function that scans the apron area for foreign objects before and during

Siemens Airfield Solutions

Safegate International

Safegate International


Siemens Airfield Solutions

docking and automatically stops the docking process until the detected object has been removed; an interface with gate-operating systems for automated initiation of docking; archiving images of the sequence of docking for analysis or investigation; compatibility with multiple centerlines and/or curved centerlines; backup power supply; and an interface with air traffic control so that the position of the aircraft entering and leaving the stand can be exchanged with the airport's A-SMGCS radar.

Step Ladder Becomes Shrapnel

Many VDGS-related safety recommendations emerged from a serious incident in October 2000 when the left engine of an Airbus A319 ingested a 14.5-kg (32-lb) aluminum stepladder while docking at a gate at Helsinki-Vantaa Airport in Finland.[2] The gate was equipped with an FMT aircraft parking and information system (APIS) ADVGS for self-parking. The investigators surmised that the step ladder, used temporarily for attaching and detaching an external power source, inadvertently was left outside an airbridge safety railing for about two months without being noticed. On the day of the incident, the ramp foreman arrived late because of a last-minute gate change and did not conduct any inspection to ensure a clear gate area. The airbridge operator was not required to confirm that the apron area was clear before switching on the APIS. The ladder could not be seen by the captain entering the stand because of shadows and the absence of contrasting colors. "Due to the commander's [delayed response], the aircraft stopped approximately 85 cm [33.4 in] after the system-indicated stop position and approximately 20 cm [7.9 in] left of the centerline," the incident report said.

None of the ground staff members was positioned at an emergency-stop button or had time to reach the button when they noticed the ladder. Shrapnel — including a piece weighing 1.7 kg (3.7 lb) — was propelled out of the front of the engine into a space occupied moments before by the weight-and-balance agent; small bits of metal also were propelled 40–50 m (131–164 ft) behind the airplane.

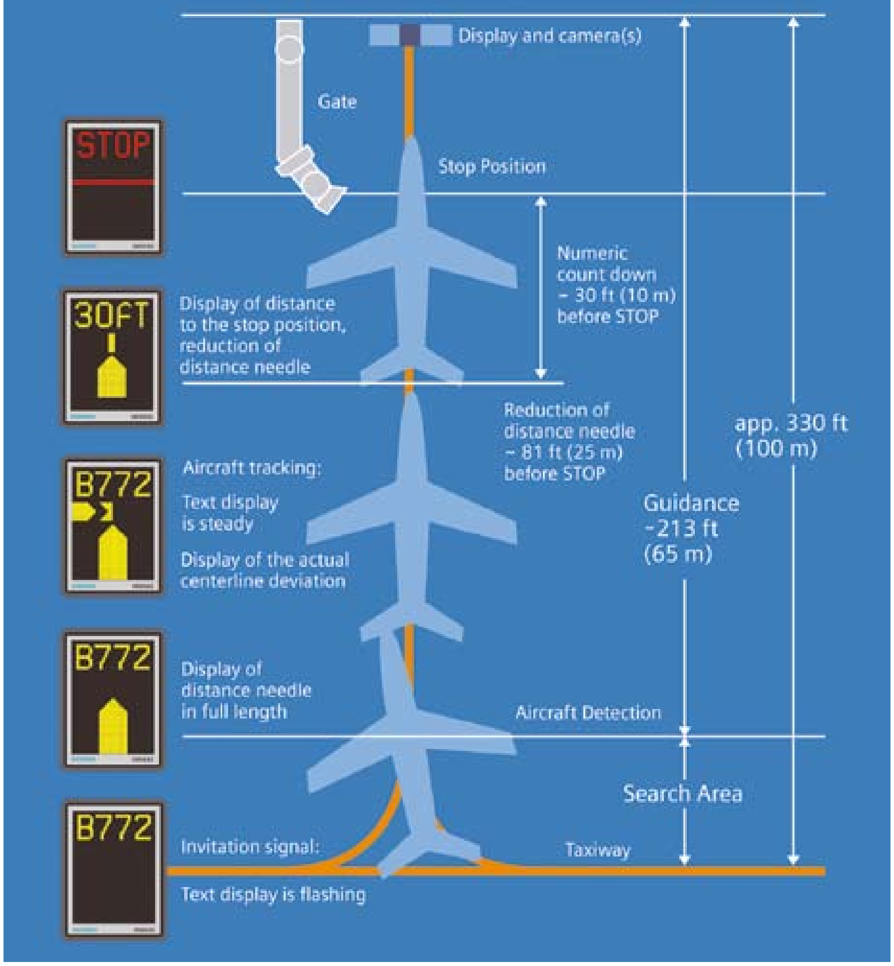
The investigation in part determined that the APIS operated "flawlessly" but docking duties had not been specified adequately in ground staff operating manuals and training; procedures were missing for conducting an emergency stop of a docking aircraft; the minimum advance arrival time to a stand for ground staff was not specified; use of ladders was not strictly controlled within the apron area; a decision to discontinue parking A319s at this gate — because of revised minimum clearance distances — had not been communicated to ground staff; and differences in clearances compared with ICAO standards were not published in Finland's aeronautical information publication (AIP).

Safegate International

Lessons From U.K. Airports

The U.K. Air Accidents Investigation Branch (AAIB) investigated 18 VDGS-related incidents from 1997–2006 at London Heathrow Airport, London Stansted Airport, London Gatwick Airport, Manchester Airport and Edinburgh Airport. In one incident, a McDonnell Douglas MD-11 in October 1999 collided with a van while the captain was parking at Stand K23 at Heathrow, causing scuff and scratch marks to the right engine nacelle. The captain previously had used only marshallers at this airport and did not know that self-parking using azimuth guidance for nose-in stands (AGNIS) with the parallax aircraft parking aid (PAPA)[3] was in effect — even though the captain's airline had agreed that self-parking would begin that day — and did not know how interpret this guidance. The AAIB report said, "[The commander] was … 'waiting for the light to turn red,' indicating to him when to stop, but the light did not turn red. … The aircraft had overrun the parking position by 15.75 m (51.6 ft) and pushed the van approximately [1.8 m (6.0 ft)] sideways with its right engine nacelle."[4]

A Boeing 777-200 in May 2005 collided with the airbridge at Stand 50 at Gatwick causing a tear and two large



Siemens Airfield Solutions

dents in the leading edge of the left engine intake cowl and substantial damage to the airbridge. The AAIB report said, "As the aircraft approached the allocated stand, both the commander and … copilot confirmed visually that the stand was clear of obstructions. … The commander stated that as the aircraft progressed onto the stand he saw that the AGNIS system indicated that the aircraft was no longer on the centerline, and he was momentarily distracted while regaining the centerline. He stated that when he looked again at the PAPA board, it indicated that the aircraft was then approaching the stopping point for the Boeing 777-300. … He applied the brakes and, on looking up, saw that the emergency-stop light, situated next to the AGNIS, was flashing." A dispatcher and several other people ran from the airbridge when it was struck. "The nosewheels had stopped 7.3 m [24 ft] forward of the correct parking position for a Boeing 777-200," the report said. "The AGNIS and PAPA board indicator lights and the emergency-stop light were serviceable and correctly calibrated." The airline subsequently developed a computer-based training package about aircraft parking aids for its crews, informed all pilots of the parking hazards associated with AGNIS–PAPA systems and met with the airport management about using guidance not compliant with the ICAO SARPs. In July 2006, the airport required a team leader or higher grade staff member to remain in the vicinity of the emergency-stop button during docking at gates where AGNIS/PAPA systems are still installed.[5]●

Notes

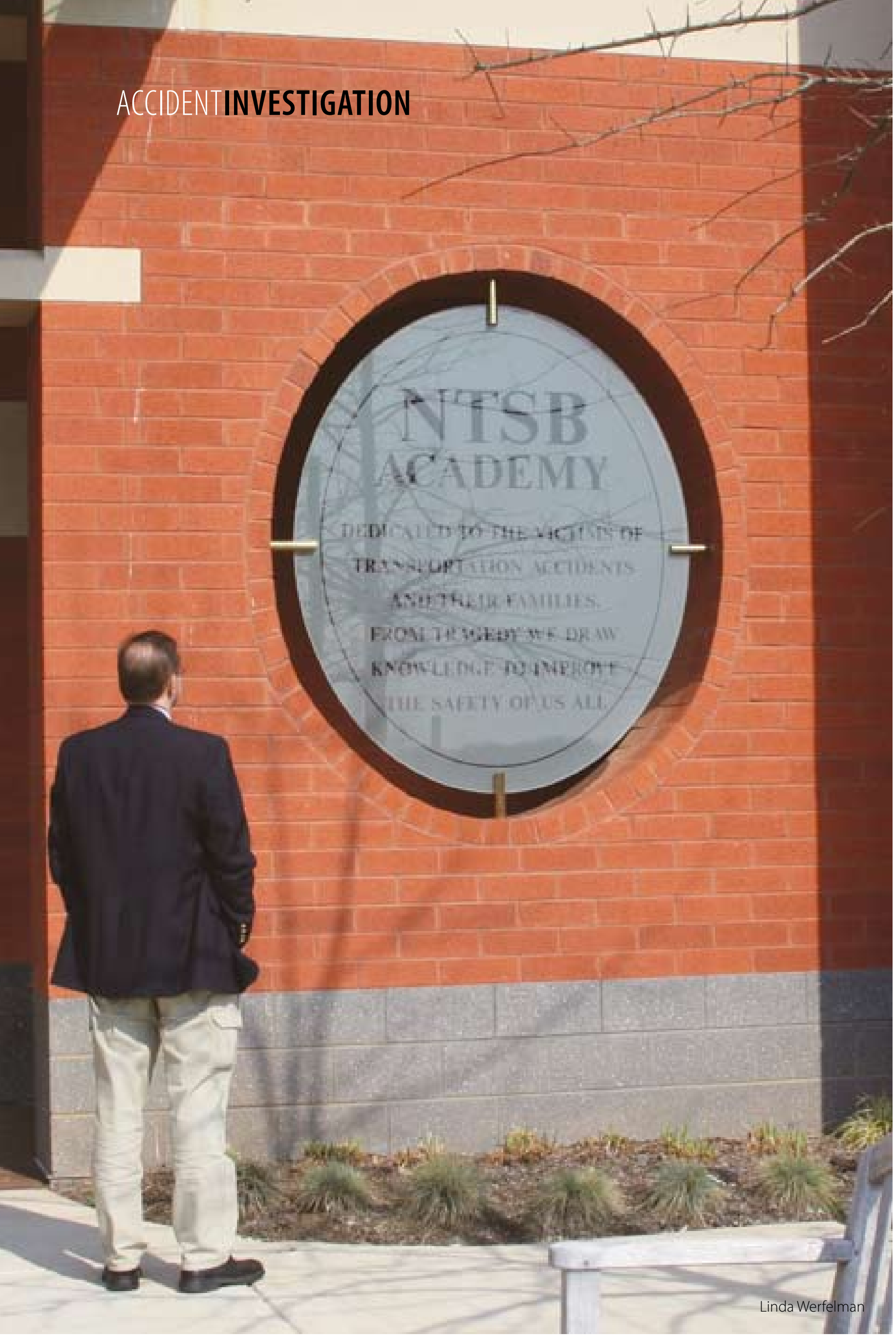
1. The International Federation of Air Line Pilots' Associations (IFALPA) in 1997 proposed that the International Civil Aviation Organization (ICAO) develop criteria for standards and recommended practices (SARPs) applicable to advanced docking visual guidance systems (ADVGS). In 2002, the ICAO Visual Aids Panel proposed such an amendment to Annex 14, but two years later, the ICAO Secretariat postponed action on this amendment after considering comments from states and international organizations. "Most importantly, some new VDGS installations have been recently provided at certain airports worldwide and these installations are not in full compliance with the proposed SARPs but are considered acceptable by pilots," ICAO said. The task of further studying ADVGS was referred to the Visual Aids Working Group of ICAO's Aerodrome Panel, also created in 2004, which has absorbed the functions of the Visual Aids Panel.

2. Accident Investigation Board Finland. "Engine Damage at Helsinki-Vantaa Airport on 17th October, 2000: OO–SSH, Airbus A319." Report no. B 3/2000 L. Oct. 25, 2001.

3. The U.K. Air Accidents Investigation Branch (AAIB) said, "Azimuth guidance for nose-in stands (AGNIS) comprises two closely spaced light bars, at cockpit level, positioned side-by-side in a box at the end of the stand and thus directly ahead of the pilot. The light bars appear to the pilot as either red or green, depending on the aircraft's lateral position relative to the stand's centerline. If the aircraft is on the centerline, both light bars are green. If the aircraft is to the left of the centerline, the left light bar is red while the right one remains green, and if it is to the right of the centerline, the right light bar is red while the left one remains green. The system is aligned to be used by the pilot in the left seat only. The parallax aircraft parking aid (PAPA) is a large reference board positioned at cockpit level at the end of the stand, some distance to one side of the AGNIS unit. … There is a horizontal slot in the reference board behind which is positioned a vertical fluorescent light tube. Several vertical reference marks are painted on the board, each identified as relating to a particular type, or group of types, of aircraft intended to use the stand. As an aircraft moves along the stand centerline, the vertical light tube appears to move across the slot as a result of the parallax effect. When the light aligns with the mark for the particular type of aircraft using the guidance, the aircraft is at the correct stopping point."

4. AAIB Report no. EW/G99/10/09.

5. AAIB Report no. EW/C2005/05/04.



Linda Werfelman

LESSONS

In the late 1990s, the U.S. National Transportation Safety Board (NTSB) faced a dilemma: what to do with accident investigators' painstaking reconstruction of what remained of Trans World Airlines (TWA) Flight 800, the Boeing 747 that exploded and struck the Atlantic Ocean after departure from Kennedy International Airport in New York on July 17, 1996, killing all 230 occupants.

The 747, pulled in pieces from the ocean and reassembled during the months-long investigation, was stored in a Long Island, New York, hangar for which the federal government paid US$2 million a year in rent. Never before had accident investigators put back together so large a section of a broken airplane, and they were convinced that the 93-ft (28-m) midsection of TWA Flight 800 would be an invaluable tool for training future investigators — but not if it remained in storage.

"We had this incredible piece of aircraft fuselage that told an amazingly tragic story, and no one was getting the benefit … those who could learn from it and hope to prevent that kind of thing from happening again," said NTSB Chairman Mark V. Rosenker. "Taking it away from that storage hangar and bringing it to a place where people studying accident prevention could gain from the impact of seeing it — that made great sense."

So, with a goal of combining classroom space with the learning opportunities made possible because of the presence of what Rosenker called an "incredible piece of accident research," construction began in 2000 on the NTSB Training Center — initially called the NTSB Academy — 30 mi (48 km) west of Washington in Ashburn, Virginia, U.S., on the Virginia campus of George Washington University.

The 72,000-square-ft (6,689-square-m) facility is owned by the university and leased by the NTSB, which has signed a 20-year agreement due to expire in 2021. The remains of TWA Flight 800 were moved to the Training Center in 2002, and the first accident-investigation classes were taught there in 2003.

The environment is unique, Rosenker said, not only because the coursework deals almost entirely with accident investigation procedures and techniques but also because the courses are able to use the reassembled 747 as a teaching tool.

He noted that there have been suggestions that the Training Center might someday house some of the recovered parts from Pan American Airlines Flight 103, which was destroyed Dec. 21, 1988, when a terrorist's on-board bomb exploded over Lockerbie, Scotland. All 259 people in the airplane, as well as 11 people on the ground, were killed.

A side-by-side display of key pieces of wreckage would be especially useful in illustrating the differences in damage caused by detonation of an on-board bomb and an exploding fuel tank, Rosenker said. The Pan Am wreckage currently is stored in a hangar at Farnborough (England) Airport.

Training Center classes have attracted employees of accident investigation agencies worldwide. Other training facilities exist — both in the United States and in other countries — and some universities offer classes in accident investigation, but they usually don't focus on investigational forensics and their efforts "are nowhere near as elaborate" as the Training Center's, Rosenker said.

The NTSB states the Training Center's mission, in part, as "to promote safe transport by ensuring and improving the quality of accident investigation through critical thought, instruction and research; communicating lessons learned, fostering the exchange of new ideas and new experience and advocating operational excellence; [and] providing a modern platform for accident reconstruction and evaluation."

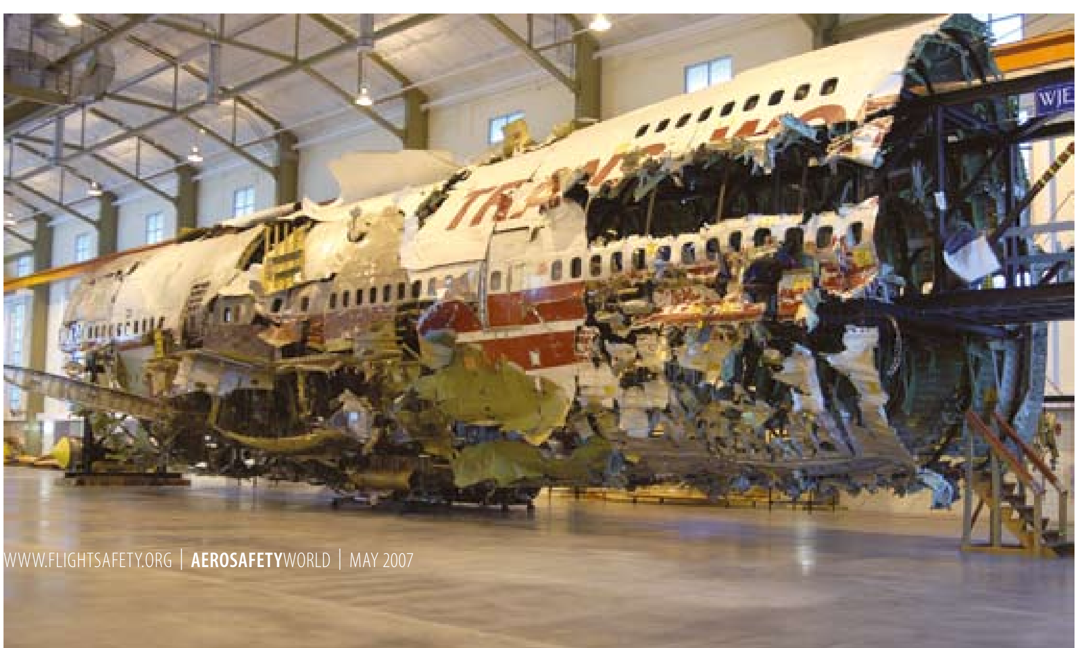
Another provision of its mission statement calls for "utilizing its high-quality training resources to facilitate family assistance and first-responder programs," as well as programs for other federal agencies. As a result, some Training Center classes deal with how to help the families of those killed in aircraft accidents — a responsibility assigned to the NTSB in legislation passed by Congress after the TWA Flight 800 accident. The legislation also gave the NTSB the responsibility of coordinating the response of federal, state, local and volunteer agencies to aviation accidents.

Classes — taught in the Training Center's five classrooms, all with Internet connectivity and advanced audio-visual equipment — are the heart of the facility. Subjects involve accident investigation in all modes of transportation, but many focus on aircraft accident investigation, and cite TWA Flight 800 as an example of how to recover parts after an accident, how to reassemble an accident aircraft and how an analysis

FROM THE WRECKAGE

The NTSB Training Center uses the reassembled remains of TWA Flight 800 as the centerpiece in its wide-ranging classes for aviation accident investigators.

BY LINDA WERFELMAN



U.S. National Transportation Safety Board

Linda Werfelman

of individual pieces can help lead to a conclusion about the probable cause of an accident.

For example, the forward portion of TWA Flight 800 shows no indication of smoke damage while the rear section, behind the wing, is charred. Virtually all of the pieces of metal on the right side twist and bend inward — an indication of an explosive force that originated outside the cabin, and an indication that it was the airplane's right side that struck the water. Each of these observations was crucial to investigators' efforts to find the cause of the crash.

In its final report on the accident, the NTSB said that the probable cause was "an explosion of the center-wing fuel tank (CWT), resulting from ignition of the flammable fuel/air mixture in the tank." The investigation did not identify the source of the spark that touched off the explosion, but the report said that the most likely source was "a short circuit outside of the CWT that allowed excessive voltage to enter [the tank] through electrical wiring associated with the fuel quantity indication system."

U.S. National Transportation Safety Board

The classes typically are not for beginners who have no knowledge of aviation but rather for people in the aviation industry who need to learn how the NTSB handles its investigations — typically because at some time, they may be working with NTSB personnel during an investigation. An actual investigation is not a good environment for basic instruction, NTSB officials say, citing the huge volume of investigative work that must be done.

"The last thing you want when you get a catastrophic accident — where you are dealing with a whole host of issues — is to have folks getting on-the-job training," Rosenker said. "You want them to have some understanding ahead of time of what we will do and what is expected of those who participate."

Other aviation-specific classes on the Training Center's 2007 calendar include survival factors in aviation accidents, managing communications during aircraft disasters and airport preparedness.

Some classes apply not only to aviation but also to other fields, such as biomechanics of high-impact injuries, investigation of human fatigue factors, interview procedures, human factors, accident site photography, disaster family assistance, accident/incident report writing, media training for NTSB investigators, and conducting effective technical presentations and meetings. Classes also are offered on issues that involve investigation of accidents in other modes of transportation.

Some classes are reserved for NTSB personnel, but most also are open to people who may someday work with the NTSB in investigating an accident, such as employees of airlines or other government agencies.

The Training Center's family assistance classes address all modes of transportation; attendees at one recent session came from airlines, cruise ship operators and railroads, as well as government agencies outside the transportation field.

About 1,700 people a year — most of them from outside the NTSB — enroll in the Training Center's classes, and NTSB officials say that they are working to increase the number of classes, to bolster enrollment and to provide more classes for NTSB employees. These were among items discussed in a November 2006 report by the U.S. Government Accountability Office (GAO), the investigative arm of Congress.

The report said that the Training Center has been under-utilized and recommended that the NTSB consider more aggressive marketing of its courses, subleasing some of the space within the Training Center and developing more courses that are tailored to NTSB personnel, who historically have attended courses offered by other institutions. The report also said that, although these strategies could increase revenues or decrease costs associated with the Training Center, "vacating the space may be the least-cost strategy."

In response, Rosenker said that the NTSB already has developed and submitted to Congress a business plan for the Training Center and is working to "improve the utility and cost-effectiveness of the facility."

The Training Center's classrooms already are available, for a fee, to other government agencies and outside organizations — typically those involved in transportation issues or education. In addition, several government agencies have contracted with the NTSB to lease space in the Training Center under "contingency of operations plans" — which require federal agencies to have access to office space away from Washington where key employees can continue their work in the event that their Washington routine is disrupted by events such as a major power failure, a severe storm or a terrorist attack.

The immediate goal, expected to be accomplished by fall 2007, is to contract with a vendor to provide teachers and new coursework for the Training Center, and eventually to expand the number of classes offered there each year from about 20 to 40 or 50, Rosenker said. NTSB personnel would continue to appear as guest lecturers, but professional instructors would teach most of the classes.

Five years from now, he said, the goal is to have established "an effective, self-sufficient training center, which provides value to the students and anyone who is participating in an investigation."●

Further Reading From FSF Publications

FSF Editorial Staff. "Boeing 747 In-Flight Breakup Traced to Fuel-Tank Explosion." *Accident Prevention* Volume 58 (May 2001).

Linda Werfelman

A BAE Jetstream 41 is used in Training Center discussions of accident survival factors.

More Bird Strike Reports, Please

A U.K. CAA regulation that requires reporting all bird strikes is achieving its purpose.

BY RICK DARBY

A change in U.K. regulations requiring the reporting of all bird strikes rather than, as formerly, only those causing "significant" damage or those that might affect flight safety, has succeeded in increasing the number of reports by aircraft operators and airports.

That is the conclusion of a study[1] commissioned by the U.K. Civil Aviation Authority (CAA), based on reports in a period before the requirement (1990–2003) and the two years after reporting became mandatory (2004–2005). The research was principally concerned with bird strikes involving commercial air transport and licensed airports. Strikes occurring in the United Kingdom or involving U.K.-registered aircraft abroad were included.

The study's methodology included two complementary efforts. The first was a quantitative analysis of the data from the CAA Mandatory Occurrence Reporting Scheme (MORS)[2] database and the CAA bird strike database. The second was a qualitative review of reporting, based on structured interviews of aircraft and airport operators. For this article, we will look at the quantitative measures.

The MORS database is designed to register events that endanger or potentially endanger aircraft. "For a bird strike to qualify as an MOR, the specific test stated is that it cause 'significant damage or loss or malfunction of any essential service,'" the report said.

Beginning in January 2004, a new regulation required operators to report all bird strikes to the CAA bird strike database. "Before this date, it had been mandatory to report only those strikes in which damage to aircraft was sustained, which had in some CAA references and guidance been defined in more limiting terms, only requiring reporting of bird strikes causing 'significant' damage or damage that 'might affect flight safety,'" the report said. "The CAA was therefore aware that reporting levels may have been deteriorating, and the intent of the new mandate was to assure a proper and more accurate level of reporting."

"The intent of the new mandate was to assure a proper and more accurate level of reporting."

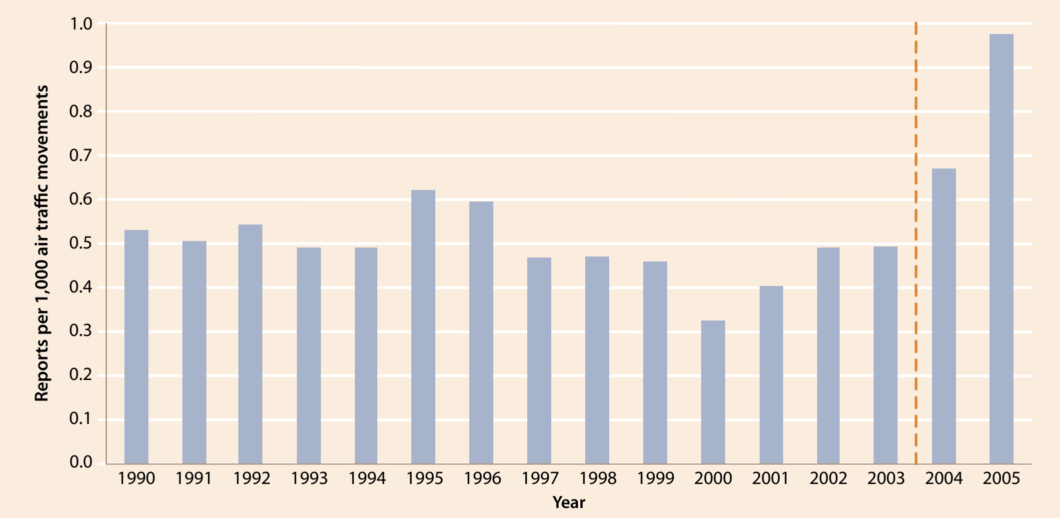
The rate of reports to the CAA bird strike database has fluctuated (Figure 1). Because the volume of aircraft traffic changes, the researchers needed to factor out differences in the number of bird strikes associated with differences in the number of flights. "It was decided to use air transport movements (ATMs) as the measure, since ATMs are one of the most reliable and complete measures," said the report. "To establish the extent to which random fluctuations might confound the interpretation of data, a statistical test was performed on the numbers of strikes in the CAA database, comparing the observed year-on-year variability with that which would be expected from a purely random process. The results strongly indicated that real changes in underlying factors are more important than purely random variation."

Thus, the higher rate of reports per 1,000 ATMs shown in Figure 1 for 2004 and 2005, compared with prior years beginning in 1990, effectively measures an actual increase — the goal of the regulatory change.

The report also examined the ratio of "non-serious" to "serious" reported incidents (Figure 2). MORS incidents were considered "serious," and CAA database incidents (except those that were also reported to MORS) were considered "non-serious." The rationale for the comparison was that individuals are more inclined to report incidents that they believe have safety implications, and organizations "tend to have more rigorous procedures for ensuring that serious incident reports are collected, analyzed and passed on as necessary," the report said. "It is apparent … that, in the period prior to the mandate [changing the reporting requirements],

U.K. Bird Strike Reports Increased After Change in Requirement

CAA Bird Strike Database, 1990–2005



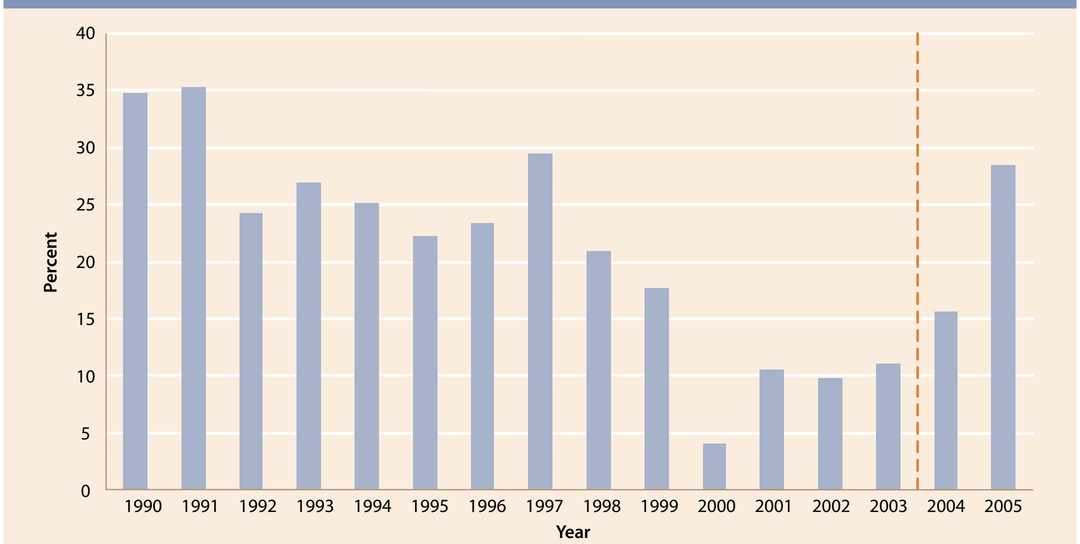
Note: The orange dashed line indicates the date of the mandate to report all bird strikes.

Source: U.K. Civil Aviation Authority

Figure 1

U.K. Data Show Improved Bird Strike Reporting

Ratio of 'Non-Serious' to 'Serious' Reports, 1990–2005



Note: The orange dashed line indicates the date of the mandate to report all bird strikes.

Source: U.K. Civil Aviation Authority

Figure 2

the rate of reporting 'non-serious' incidents was declining markedly relative to the reporting rate for 'serious' ones but that it recovered after the mandate took effect."

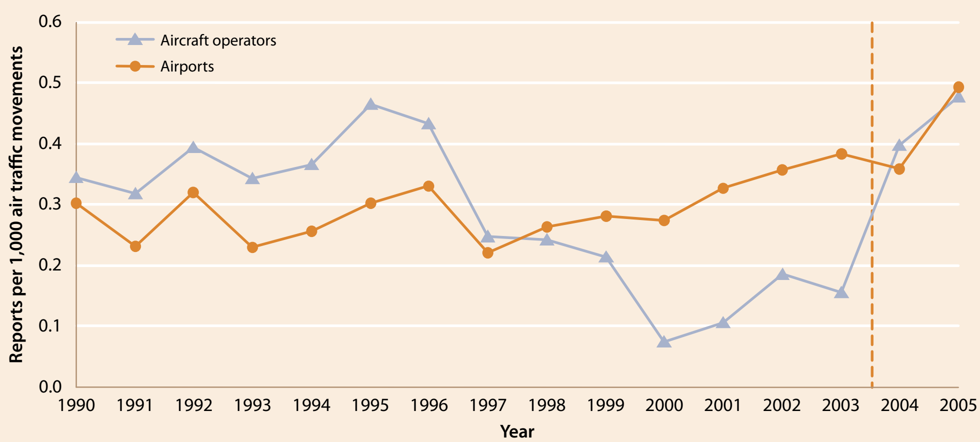
The study also compared the rate of reports to the CAA database from aircraft operators and from airports during the periods before and after the advent of the new reporting regulations (Figure 3). The analysis showed "a marked decline in the reports from aircraft operators up to the year 2000, recovering slightly thereafter and more sharply when the mandate came into effect in 2004," said the report. "No credible mechanism could be identified that could have so substantially changed the *actual* number of bird strikes that air operators could be expected to report, so the implication is that there have been major changes in the completeness of reporting by aircraft operators."

The report made an effort to compare the reporting situation in the United Kingdom with other International Civil Aviation Organization (ICAO) states, all of which theoretically report strikes to the ICAO bird strike database. "However, few actually do so," the report said.

France, Germany and Italy were considered to offer the most reasonable comparison of reported bird strike rates, on the grounds that they were like the United Kingdom in having a well-developed system of aviation safety management and similar bird habitats. As Table 1 shows, the rate of bird strikes per 1,000 ATMs was fairly consistent among the four states. There was more variation in the percentage of what the report labeled "serious" strikes, although the terminology for Germany and France differed from the United Kingdom's, and no data from Italy enabled such a comparison. ●

Operators, Airports Increase Bird Strike Reporting, 2004–2005

U.K. CAA Bird Strike Database, 1990–2005



Note: The orange dashed line indicates the date of the mandate to report all bird strikes.

Source: U.K. Civil Aviation Authority

Figure 3

Reported U.K. Bird Strike Rates Similar to France, Germany, Italy

State	Strikes per 1,000 ATMs	Serious Strikes
France	0.52 (average, 1990–2000 commercial movement)	14% ("serious incidents")
Germany	0.60 (average, 1998–2002 civil movement)	28% ("damaging")
Italy	0.53–1.94*	No data
United Kingdom	0.54 (average, 1990–2005)	5.6% (MORs)

ATMs = Air traffic movements MORs = Mandatory occurrence reports

*No national statistics could be obtained; the range shown is for four airports.

Source: U.K. Civil Aviation Authority

Table 1

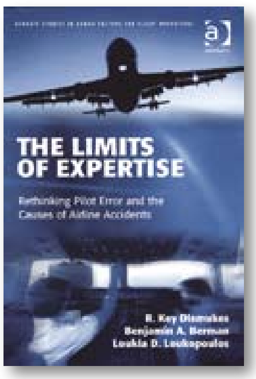
Notes

1. U.K. Civil Aviation Authority (CAA), Safety Regulation Group. "The Completeness and Accuracy of Birdstrike Reporting in the UK." CAA Paper 2006/05. November 2006. Available via the Internet at <www.caa.co.uk/docs/33/2006_05.pdf>.

2. CAA, Safety Regulation Group. CAP 382. "The Mandatory Occurrence Reporting Scheme: Information and Guidance." November 2005.

Factors in Vulnerability

A study of pilot error in accidents finds recurrent themes.



BOOKS

The Limits of Expertise: Rethinking Pilot Error and the Causes of Airline Accidents

Dismukes, R. Key; Berman, Benjamin A.; Loukopoulos, Loukia D. Aldershot, England, and Burlington, Vermont, U.S.: Ashgate, 2007. 364 pp. Figures, tables, glossary, bibliography, index.

The great majority of commercial pilots are highly experienced, thoroughly trained and regularly checked, and typically have advanced safety technology at their disposal. They operate according to a flight operations manual and checklists that prescribe carefully planned procedures for almost every conceivable situation, normal or abnormal, they will encounter. How can all this expertise co-exist with the "pilot error" that we are told is a factor in more than half of airline accidents?

The naïve view is that pilots who make an error are somehow less expert than others. That view, the authors of *The Limits of Expertise* say, is wrong. The pilot who makes an error — as seen in hindsight —typically does not lack skill, vigilance or conscientiousness. He or she *is* behaving expertly, in a situation that may involve misinformation, lack of information, ambiguity, rare weather phenomena or a range of other stressors, in a possibly unique combination.

"A particularly problematic misconception about the nature of skilled human performance is that, if experts can normally perform some task without difficulty, then they should always be able to perform that task correctly," the authors say. "But in fact, experts in all domains from time to time make inadvertent errors at tasks they normally perform without difficulty. This is the consequence of the interaction of subtle variations in task demands, incomplete information available to the expert performing the task, and the inherent nature of the cognitive processes that enable skilled performance."

Human cognitive processes are by their nature subject to failures of attention, memory and decision making, the authors say. At the same time, human cognition, despite all its potential vulnerability to error, is essential for safe operations. In theory, a perfectly programmed flight computer could operate the aircraft from takeoff to landing without human intervention, but no one would dream of conducting normal passenger operations that way.

"Computers have extremely limited capability for dealing with unexpected and novel situations, for interpreting ambiguous and sometimes conflicting information, and for making value judgments in the face of competing goals," the authors say. Technology helps make up for the limitations of human brainpower, but by the same token, humans are needed to counteract the limitations of aviation technology.

The authors say, "Airline crews routinely deal with equipment displays imperfectly matched to human information-processing characteristics, respond to system failures and decide how to deal with threats ranging from unexpected weather conditions to passenger medical emergencies. Crews are able to manage the vast majority of these occasions so skillfully that what could have become a disaster is no more than a minor perturbation in the flow of high-volume operations. But on the rare occasions when crews fail to manage these situations, it is detrimental to the cause of aviation safety to assume that the failure stems from deficiency of the crews. Rather, these failures occur because crews are expected to perform tasks at which perfect reliability is not possible for either humans or machines. If we insist on thinking of accidents in terms of deficiency, that deficiency must be attributed to the overall system in which crews operate."

The authors do not, however, argue that human error is just part of the price of doing business — it must still be reduced, and to be reduced, the factors associated with it must be understood as well as possible, which is the aim of their study. They reviewed 19 major accidents in U.S. air carrier operations from 1991 through 2000 in which flight crew error was found to be an important causal factor by the U.S. National Transportation Safety Board (NTSB).

The methodology was similar to that used in a 1994 NTSB study, on which Berman was the principal investigator, "A Review of Flightcrew-Involved, Major Accidents of U.S. Air Carriers, 1978 through 1990." That publication was reprinted in *Flight Safety Digest*, April 1994.

The book's purpose differs from that of NTSB accident reports. In his foreword, the Hon. Carl W. Vogt, former NTSB chairman and former Flight Safety Foundation Board of Governors chairman, says, "Uncovering the causes of [flight crew] error is one of investigators' greatest challenges because human performance, including that of expert pilots, is driven by the confluence of many factors, not all of which are observable in the aftermath of an accident. Although it is often impossible to determine with certainty why accident crewmembers did what they did, it is possible to understand the types of error to which pilots are vulnerable and to identify the cognitive, task and organizational factors that shape that vulnerability. And it is possible to identify recurrent themes of vulnerability across a large set of accidents."

Common themes in pilot error–induced accidents, according to the authors, include:

- "Inadvertent slips and oversights while performing highly practiced tasks under normal conditions;
- "Inadequate execution of highly practiced normal procedures under challenging conditions;
- "Inadequate execution of non-normal procedures under challenging conditions;
- "Inadequate response to rare situations;
- "Judgment in ambiguous situations that hindsight proves wrong; [and]
- "Deviation from explicit guidance or standard operating procedures."

REPORTS

Unmanned Aircraft Pilot Medical Certification Requirements

Williams, Kevin W. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-07/3. Final report. February 2007. 14 pp. Figures, tables, references, appendix. Available via the Internet at <www.faa.gov/library/reports> or from the National Technical Information Service.*

"Although the term 'unmanned aircraft' suggests the absence of human interaction, the human operator/pilot is still a critical element in the success of any unmanned aircraft [UA] operation," the report says. "For many UA systems, a contributing factor to a substantial proportion of accidents is human error."

This research study was undertaken to recommend pilot medical qualifications for UA operations, although not all the questions have been settled yet. "Research may be required to investigate the effects on pilot performance of different types of console display interfaces; how UA flight mission profiles affect pilot workload, vigilance, fatigue and performance; and to determine whether prior flight experience is important in both training and operation of UA," the report says.

To develop recommendations, the researchers proceeded in three steps. First, they conducted a literature review of existing UA pilot requirements. Second, they analyzed current and potential UA commercial applications and airspace use. The third step was to assemble a team of subject matter specialists to review proposed UA pilot medical certification requirements and recommend how they should be changed or expanded.

The team meeting discussed whether the FAA should create a new medical certification category for UA pilots or use an existing certification. "The rapid consensus [of] the group was that the creation of a new certification would be prohibitive for a number of reasons related to the difficulty, expense and time of initiating any new rule making activity," the report said.

The question then became which existing medical certification or certifications to apply. One suggestion was that an air traffic controller medical certificate would be appropriate, because the activity of a UA pilot was in some ways more like a controller's than a conventional pilot's. Other suggestions included an additional requirement for the UA pilot to have an automobile driver's license as an indication of accountability and professionalism, and identifying the factors associated with the risk of pilot incapacitation for each UA application and basing the level of medical certification on that.

It was noted that the severity of the consequences of UA pilot incapacitation is somewhat less than that of manned aircraft. "First, factors related to changes in air pressure can be ignored, assuming that control stations for non-military operations will always be on the ground," the report said. "Second, it was pointed out by one participant that many of the current UA systems have procedures for lost data link. Lost data link, where the pilot cannot transmit commands to the aircraft, is functionally equivalent to pilot incapacitation. For those systems with an adequate procedure for handling a lost data link, pilot incapacitation does not compromise safety to the same extent as it would in a manned aircraft. Third, the level of automation of a system determines the criticality of pilot incapacitation, since some highly automated systems … will continue flight [and land] whether a pilot is present or not."

The group decided to recommend third-class (private pilot) medical certification. Since that meeting, the FAA Office of Aerospace Medicine has suggested that a second-class (commercial) medical certification would be more appropriate.

The report says, "The main reasons for this recommendation are that some UA pilots are required to maintain visual contact with the aircraft and a third-class medical certification requires only 20/40 vision, with or without correction. On the other hand, second-class medical certification requires 20/20 vision, with or without correction. A second reason for a second-class medical is that there are currently no commercial pilots that have less than a second-class medical."

The report also notes that the waiver process available to pilots can authorize handicapped people to receive medical certification if they demonstrate the necessary ability. "This process gives individuals who might not be able to fly manned aircraft an opportunity to receive medical certification for flying an unmanned aircraft," the report says.

WEB SITES

U.K. Air Accidents Investigation Branch (AAIB), <www.aaib.gov.uk/publications/index.cfm>

As part of the U.K. Department for Transport, AAIB is responsible for investigating civil aircraft accidents and serious incidents that occur within the United Kingdom. In support of the organization's purpose to improve aviation safety, AAIB has created a database of reports and makes it accessible through its Web site.

The Publications section offers quick access to the most recently published reports, selected non-British reports and monthly bulletins containing lists of accident/incident reports dating back to 1996.

A custom search feature accessible from the Publications opening page permits searching by date from 1980 to the present; by aircraft categories such as "public transport — fixed wing" or "public transport — helicopter"; and by keywords.

Each accident/incident entry or title links to a report that may include basic data, a summary of events, the complete report, contributing factors and recommendations. Reports may be read on line, printed or downloaded at no cost.

National Business Aviation Association (NBAA), <www.nbaa.org>

NBAA supports companies and individuals who fly general aviation aircraft for business. The organization focuses its advocacy efforts on aviation safety, operational efficiency, air traffic control modernization, research and development, U.S. Federal Aviation Administration reform and other issues affecting business aviation.

NBAA's Web site has information for both members and nonmembers. Instead of a separate members-only section, member and nonmember information is mingled so that researchers can navigate freely through the site, as well as read, print and download documents. Only when a reader clicks on a document title that is member-restricted does a pop-up window appear asking for a member log-in number.

Some of the free materials among the more than 3,000 documents available are:

- *NBAA Update* — a weekly e-mail newsletter "providing the latest operational, regulatory and political news for the business aviation community";
- *NBAA Business Aviation Fact Book* — a compilation of business aviation data (the current edition is dated 2004, with a new edition expected later this year);
- *NBAA Automated Flight Deck Training Guidelines* — "the NBAA-recommended minimum training guidelines necessary to satisfy an automated flight deck instructional program";
- *Guidelines for Business Aviation Maintenance Training* — a guidance document giving "manufacturers and training providers a clear understanding of NBAA member company needs and expectations regarding the training of maintenance personnel"; and
- *Training Guidelines for Single Pilot Operations of Very Light Jets and Technically Advanced Aircraft* — "NBAA-recommended training guidelines for the next generation of very light jets." ●

Source

* National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161 U.S.A.
Internet: <www.ntis.gov>

— *Rick Darby and Patricia Setze*

An Automation Anomaly

Software did not block erroneous acceleration data.

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 on aircraft accidents and incidents by official investigative authorities.

JETS

Crew Had No Guidance for Response

Boeing 777-200. No damage. No injuries.

The aircraft was climbing through Flight Level (FL) 380, about 38,000 ft, after departing from Perth, Western Australia, for a scheduled flight to Kuala Lumpur, Malaysia, the evening of Aug. 1, 2005, when the flight crew observed a "LOW AIRSPEED" advisory on the engine indicating and crew alerting system (EICAS). At the same time, the primary flight display (PFD) showed a full-right slip/skid indication, said the Australian Transport Safety Bureau (ATSB) report.

The PFD initially indicated that airspeed was nearing stall speed; it then indicated that airspeed was nearing the overspeed limit. "The aircraft pitched up and climbed to approximately FL 410, and the indicated airspeed decreased from 270 kt to 158 kt," the report said. "The stall warning and stick shaker devices also activated."

The pilot-in-command (PIC) disengaged the autopilot and lowered the nose. "The aircraft autothrottle then commanded an increase in thrust, which the PIC countered by manually moving the thrust levers to the idle position," the report said. Nevertheless, the aircraft pitched nose-up again and climbed 2,000 ft.

"The flight crew notified air traffic control (ATC) that they could not maintain altitude and requested a descent and radar assistance for a return to Perth," the report said. "The crew were able to verify the actual aircraft groundspeed and altitude with ATC."

PFD indications appeared normal during the descent. The PIC engaged the left autopilot but then disengaged it when the aircraft pitched nose-down and banked right. "A similar result occurred when the right autopilot was selected, so the PIC left the autopilot disengaged and manually flew the aircraft," the report said.

The PIC was unable to disengage the autothrottle system with the disconnect switches on the thrust levers or the disconnect switch on the mode control panel (MCP). "The reason it remained active was because the flight crew did not deselect the autothrottle arm switches [on the MCP] from the 'ARMED' position to the 'OFF' position," the report said.

The aircraft was 3,000 ft above ground level when the PFD again indicated an erroneous low-airspeed condition and the autothrottle system responded with a thrust increase. The PIC apparently countered this again by moving the thrust levers to the idle position. The flight crew landed the aircraft without further incident.

Investigators found that the flight data recorder (FDR) had recorded unusual vertical, lateral and longitudinal accelerations when the upset occurred. "The acceleration values were provided by the aircraft's ADIRU [air data inertial reference unit] to the aircraft's primary flight computer, autopilot and other aircraft systems during manual and automatic flight," the report said.

The investigation determined that the conditions leading to the incident began in June 2001, when one of several accelerometers failed and began providing erroneous high-acceleration data to the ADIRU. The ADIRU software then excluded data from the failed accelerometer in acceleration computations. However, another accelerometer failed just before the upset occurred, and a software anomaly allowed the ADIRU to use erroneous data from the accelerometer that had failed four years earlier. The result, said the report, was that erroneous acceleration data were provided by the ADIRU to the flight control systems.

"The crew were faced with an unexpected situation that had not been foreseen."

There was no checklist in the quick reference handbook (QRH) addressing the unreliable airspeed indications that the flight crew had received before the upset occurred. "When the hardware [i.e., accelerometer] failure occurred, combined with the software anomaly, the crew were faced with an unexpected situation that had not been foreseen," the report said.

Among actions taken in response to the incident investigation were an emergency airworthiness directive issued by the U.S. Federal Aviation Administration (FAA) requiring installation of new ADIRU software and a revision of the 777 QRH by Boeing to include an "Airspeed Unreliable" checklist.

Sidestick Activations Lead to Tail Strike

Airbus A321. Substantial damage. No injuries.

The first officer, the pilot flying, said that the aircraft seemed to lose inertia as it crossed the runway threshold at 50 ft while landing at Fort Lauderdale/Hollywood (Florida, U.S.) International Airport on Sept. 18, 2005. "The first officer stated that before touchdown, he lowered the nose a little bit, and the aircraft touched down firmly," said the U.S. National Transportation Safety Board (NTSB) report. The captain told investigators that he believed the flare was initiated too late and was incomplete.

The aircraft bounced on touchdown, and the first officer lowered the nose to prevent a tail strike. "The captain remembered that, as the nose of the aircraft was lowering prior to the second touchdown, he may have pulled back on his sidestick controller slightly to prevent the nose gear from striking the runway at too great a speed," the report said.

The tail struck the runway during the second touchdown. None of the 197 occupants was injured.

FDR data indicated that both sidestick controllers were being activated simultaneously when the tail strike occurred. "According to the manufacturer, when both sidestick controllers are activated simultaneously … in the same or opposite directions and neither pilot takes priority via the takeover push button, the system adds the signals of both pilots algebraically," the report said. "Airbus had issued flight crew operating bulletins concerning bounced landings and tail strikes, but the pilots stated that no classroom or simulator training was received to reinforce the meaning and contents of the bulletins."

'Heavy' Controls Traced to Misrouted Cable

Boeing 737-700. Minor damage. No injuries.

After completing a scheduled flight from Melbourne, Victoria, to Sydney, New South Wales, Australia, the night of Aug. 9, 2005, the pilot reported "heavy" flight controls. "An inspection by maintenance engineers revealed that the left lower rear elevator cable was incorrectly routed around a stiffener and that the stiffener and cable section had been damaged as a result of contact between them," said the ATSB report.

About two weeks before the incident, a contract maintenance organization had replaced eight elevator control cable sections while performing a scheduled maintenance check of the aircraft. The cable replacements were required by Boeing Service Bulletin 737-27-1254 Revision 1.

The contract maintenance organization's forward planning department was not assigned to provide full work details from the service bulletin, and work task cards from a previous job were copied and used instead. "The task cards contained insufficient instructions for the required work to be satisfactorily completed," the report said.

While preparing a rear cable for replacement, a trainee failed to secure it before removing the cable keeper. When the keeper was removed, the unsecured cable slipped out of sight. "While recovering the cable, the trainee and an aircraft maintenance engineer inadvertently misrouted the cable around the stiffener," the report said. "When the replacement cable was pulled into place, it followed the same incorrect route around the stiffener." The two workers did not inform their team leader or make a record of the temporary loss of the old cable; they also did not verify that the new cable was routed correctly.

While performing duplicate inspections of the cable replacements, two maintenance engineers heard a rubbing noise but thought that it came from a cable pressure seal. They also noticed a heaviness in elevator control movement. However, they failed to conduct thorough investigations of the two anomalies.

The report indicated that time pressures might have contributed to the workers' failure to inform their team leader of the temporary cable loss and their less stringent duplicate inspections of the cable work. The duplicate inspections were recorded on a form that was not current. The form, which had been replaced in 2003, "did not reflect the correct scope of duplicate inspections required," the report said.

"The investigation has highlighted the necessity of using forward planning processes for critical work tasks and the necessity to report and record all nonroutine work events," the report said. "Had the loss of control cable run integrity been recognized as a critical event and a record been made of the event, then more rigorous inspections may have detected the misrouted cable."

— Bart Crotty

Learjet Overruns Snow-Covered Runway

Learjet 35A. Substantial damage. No injuries.

The airplane was on a positioning flight from Salt Lake City, Utah, U.S., to Kansas City, Missouri, to pick up passengers for a charter flight the night of Jan. 28, 2005. Nearing the destination, Kansas City International Airport, the flight crew learned that the airport was closed because an airliner had slid off a contaminated taxiway and a one-hour hold could be expected before approach clearance.

The crew had specified Lincoln (Nebraska) Airport, which has a 12,901- by 200-ft (3,932- by 61-m) runway, as the alternate airport on their flight plan; however, they requested and received clearance to divert to the nearby Charles B. Wheeler Downtown Airport, which has a 7,000- by 150-ft (2,134- by 46-m) runway. Reported visibility at the airport was 1.25 mi (2,000 m) in light snow and mist. The runway had just been plowed full length and 50 ft (15 m) on both sides of the centerline, but 1/4 in (6 mm) of snow remained on the plowed area.

The tower controller told the Learjet crew that braking action had been reported as fair; the controller did not say that the report had been made by the pilot of a Cessna 210, a light single-engine airplane. "The Cessna 210 pilot did not use brakes during landing and did not indicate this to [the tower controller] during his braking-action report," the NTSB report said.

The tower controller told the Learjet crew that braking action had been reported as fair.

The crew conducted the instrument landing system (ILS) approach to Runway 19. The copilot said that the airplane touched down about 1,000 ft (305 m) from the threshold and that deceleration appeared normal until the airplane was about 1,500–2,000 ft (457–610 m) from the departure end of the runway, where speed "stabilized" at 20–30 kt. The wheel brakes were ineffective in stopping the airplane.

The Learjet overran the runway and the gravel runway safety area, struck the ILS localizer antenna array, struck and dragged a section of chain link perimeter fence, crossed a road, penetrated a steel guard rail and came to rest on the slope of a flood levee.

NTSB said that the probable cause of the accident was "the contaminated runway conditions during landing" and that contributing factors were insufficient runway-condition information, the crew's operation of the airplane with inoperative thrust reversers (per provisions of the minimum equipment list) and their decision not to divert to their planned alternate airport.

TURBOPROPS

Smoke Traced to Altimeter Short Circuit

Fokker 50. Minor damage. No injuries.

About 15 minutes after departing from Stockholm, Sweden, for a scheduled flight to Wasa, Finland, the morning of June 1, 2006, a red warning flag appeared on the commander's electromechanical altimeter and information displayed on the altitude selector disappeared. The flight crew saw smoke emerge from the center console and detected the odor of an electrical fire, said the Swedish Accident Investigation Board report.

The commander declared an emergency and turned back to Stockholm. The pilots donned their oxygen masks, and the commander transferred control to the copilot before conducting checklist operations.

Radio communication with ATC was lost for five minutes because the audio connection to the commander's oxygen mask had not been selected. "Since the technical failure in the aircraft's altimeter system also resulted in the loss of the transponder's height-reporting information, the period of lost communication with the aircraft was a further cause of concern to air traffic control," the report said.

The smoke ceased during the return flight, and the crew took off their oxygen masks and donned their headsets, which restored radio communication with ATC. The approach and landing were conducted without further incident. None of the 20 occupants was injured.

Investigators found that an electrical wire in the altimeter, which was manufactured in 1988, had become trapped between a capacitor and the metal base plate. Damage to the wire resulted in a short circuit that caused the capacitor to overheat.

Close Encounter With Fitful Head

Dornier 328-100. No damage. No injuries.

The aircraft, operated by an Icelandic company, was on a charter flight with 17 passengers and three crewmembers from Aberdeen, Scotland, to Sumburgh Airport, on the southeast coast of the Shetland Islands, on June 11, 2006. The airport was reporting winds from 150 degrees at 9 kt, 7,000 m (4 mi) visibility and a few clouds at 600 ft, said the U.K. Air Accidents Investigation Branch (AAIB) report. Runway 09 was in use.

"The commander was familiar with Sumburgh Airport, although he had last operated there with a different company seven or eight years previously," the report said. "The copilot had only been to Sumburgh once, about six months previously."

The commander told investigators that he intended to show the copilot local terrain features during a visual approach. He told the copilot that he would fly to a navigation waypoint 5 nm (9 km) west of the airport, then toward Fitful Head, an area of high terrain on the southwest coast of the island, before turning to a right base to Runway 15. He also briefed the localizer/DME (distance-measuring equipment) approach to Runway 09, in case they could not conduct a visual approach.

The aircraft was nearing the waypoint when the approach controller approved the crew's request for a visual approach to Runway 15. "The copilot reported that he could not see the airport, as it was obscured by cloud, but could see high ground ahead and to the right," the report said. "He asked the commander if he intended to turn to the right before the high ground, and the commander said he would."

The report said that as the aircraft descended toward Fitful Head, "neither the commander nor copilot were visual with the coastline or the headland itself, though both were in visual contact with the surface of the sea." Visibility decreased, and the commander was beginning a right turn when the terrain awareness and warning system (TAWS) generated a "CAUTION TERRAIN" warning and a "TERRAIN, TERRAIN, PULL UP" warning. The commander did not level the wings and initiate a maximum-performance climb, as required by the airplane flight manual.

"The copilot described looking up and seeing a cliff or steep hill ahead of the aircraft as the commander increased the bank angle to the right," the report said. The landing gear warning horn then sounded, indicating that the aircraft was below 500 ft radio altitude.

The "TERRAIN, TERRAIN, PULL UP" warning and the landing gear warning horn continued as the aircraft was flown parallel to and 0.6 nm (1.1 km) from the cliffs and 400 to 600 ft below their tops. "The copilot was alarmed by the situation and considered taking control from the commander," the report said. "However, he thought that to attempt to do so while the aircraft was maneuvering at low level might place the aircraft in a more hazardous situation."

The coastline receded as the aircraft continued eastward, toward the airport, and the TAWS warnings ceased. The approach and landing were conducted without further incident.

Freezing Rain Forces Freighter to Descend

Cessna 208B Caravan. No damage. No injuries.

Meteorological conditions were conducive to freezing rain throughout the cargo flight's route along the western coast of Norway, from Bergen south to Stavanger, the morning of Jan. 19, 2006, said the report by the Accident Investigation Board of Norway.

Icing conditions were encountered during the climb to FL 110. The commander, flying the aircraft on autopilot, maintained airspeed above 105 kt, the recommended minimum airspeed in icing conditions at the time.

About 30 minutes after departure, the icing conditions became considerably worse, the report said. The flight crew saw ice accumulating behind the deice boots. "Flight speed was decreasing, and as they entered mountain waves and lost altitude, it became impossible to return to FL 110," the report said.

The commander disengaged the autopilot and turned back to Bergen. He applied full power and maintained 105 kt, which resulted in a descent of about 700 fpm. At FL 090, the commander was able to maintain altitude. "Full engine power was still required to maintain 105–110 kt," the report said. "According to the crew, normal cruising speed at cruise power is 135–145 kt."

Ice began to break off the aircraft during the approach to Bergen, and the crew conducted a landing without further incident.

The report noted that two months after this serious incident, the FAA, responding to Caravan accident investigations in Canada and the United States, issued Airworthiness Directive 2006-06-06, which requires, in part, disengagement of the autopilot at the first indication of ice accumulation and an increase in the minimum airspeed in icing conditions with flaps retracted to 120 kt. The directive also prohibits continued flight in moderate or severe icing conditions.

PISTON AIRPLANES

Directional Control Lost in Thunderstorm

Cessna 402B. Substantial damage. No injuries.

Visibility was 1/2 mi (800 m) in heavy thunderstorms and rain when the airplane arrived at Fort Lauderdale (Florida, U.S.) Executive Airport during a positioning flight from South Bimini, Bahamas, on July 23, 2006. Winds were reported as variable at 6 kt, gusting to 25 kt, when the pilot landed the airplane on Runway 31.

During the landing roll, the airplane veered off the runway and struck a runway sign. The nose landing gear collapsed, and the propellers struck the ground.

NTSB said that the probable causes of the accident were "the pilot's continued flight into adverse weather and his failure to maintain directional control during the landing roll."

Unsecured Door Forced Into Compartment

Britten-Norman Trislander. Minor damage.
No injuries.

During takeoff from Saint Brieuc, France, for a scheduled flight with three passengers to Guernsey, Channel Islands, the morning of June 7, 2006, the pilot heard a loud bang. "The commander could not identify the cause but, after establishing that all three engines were operating normally and that the aircraft was under control, he returned to Saint Brieuc," the AAIB report said.

After landing the aircraft and disembarking the passengers, the pilot found that the forward baggage door had been forced into the baggage compartment. "During the short flight, aerodynamic forces shut the door with sufficient violence to push it into the fuselage aperture," the report said.

An inspector for the French Direction Générale de l'Aviation Civile found that the door-locking mechanism functioned normally. An engineer for the operator concluded that the door had not been secured before takeoff.

The report said that to avoid tipping the aircraft onto its tail, the operator's loading procedure was to place a trestle under the tail and embark the passengers before loading baggage. "The operator considered that it was not good practice to leave the cockpit unattended with passengers aboard," the report said. "Consequently, a commander could not leave the aircraft interior to check the baggage door when loading was complete."

There are no baggage-door-warning lights in Trislanders. "Responsibility for checking the security of the baggage door was delegated to a ground handler, whose duty it was to report to a commander that all the doors were secure prior to the engines being started," the report said.

Multiple Failures Spoil Training Flight

Beech 76 Duchess. Destroyed. Three minor injuries.

A flight instructor was providing airplane-familiarization training for a commercial pilot in Glendale, Arizona, U.S., on June 22, 2005. There also was one passenger aboard the airplane. After shutting down the left engine and feathering the propeller to demonstrate one-engine-inoperative (OEI) procedures, the instructor was unable to restart the engine, the NTSB report said.

After several unsuccessful attempts to restart the engine, both pilots detected the odor of burning insulation and saw a trace of smoke emerge from behind the instrument panel. Electrical power then was lost to all instruments and radios except one navigation/communication radio and the fuel gauges.

The instructor turned back to the airport and requested and received clearance to conduct a straight-in approach to Runway 01. "The [instructor] attempted to extend the landing gear but did not get a down-and-locked indication for the nose gear," the report said. "He queried the tower controller as to whether or not the landing gear was down, and the controller informed him it was not down and [told the instructor] to abort the landing."

The instructor conducted an OEI go-around and circled to land on Runway 19. "Although the [instructor] was able to extend the landing gear, he was unable to maintain altitude," the report said. "He declared an emergency just before impacting an open dirt field 1/4 mi [0.4 km] north of the runway." The occupants exited the airplane before it was consumed by a post-impact fire.

The report said that examination of the wreckage revealed no pre-existing mechanical malfunctions or failures.

HELICOPTERS

Disorientation Leads to Water Contact

MBB BO-105. Destroyed. Two fatalities.

The Canadian Coast Guard helicopter, operated by the Transport Canada Aircraft Services Directorate, had transported personnel and supplies to a lighthouse off the southern tip of Burin Peninsula in Newfoundland and Labrador, and was returning to Marystown with the pilot and a passenger aboard to pick up a technician late in the afternoon of Dec. 7, 2005.

The forecast for the area included 2,500-ft ceilings and 2–6 mi (3–10 km) visibility in light snow showers and scattered areas of stratocumulus clouds with bases at 400 ft, 1/2-mi (800-m) visibility in snow and gusts to 30 kt, said the report by the Transport Safety Board of Canada.

"When last observed, the helicopter was about 1 nm [2 km] east of Marystown, flying slowly at low altitude, in heavy snow and in near-dark conditions," the report said. At 1800 local time — one hour after the expected time of arrival — the helicopter was reported overdue to search and rescue authorities. The bodies of the pilot and passenger were found in Mortier Bay, east of Marystown, later that night.

Attempts to locate the helicopter by detecting signals from its underwater locator beacon (ULB) were unsuccessful. The report said that the ULB likely malfunctioned. The helicopter was located in about 100 ft of water by side-scanning sonar 10 days after the accident. "All major components were accounted for and were near the main fuselage," the report said. "The close distribution of wreckage items on the sea bottom was consistent with a helicopter that was intact when it struck the water. … Examination of the helicopter did not reveal any pre-existing mechanical abnormalities that could have contributed to the occurrence."

The examination indicated that the helicopter was in tail-low forward flight, with the engines producing high power, when it struck the water. The report said that the pilot likely had become disoriented in conditions including reduced visibility in heavy snow and darkness, lack of visual references and turbulence. "It is likely that the pilot flared rapidly to slow the helicopter. The tail contacted the water heavily, breaking off and causing the subsequent loss of control." The helicopter then rotated and struck the water again with substantially more force. The life raft mounting bracket failed, and the raft was pinned in the wreckage. Both emergency locator transmitters also sank with the aircraft.

The occupants survived the impact and escaped from the helicopter. The pilot, who was wearing a life vest, died of hypothermia; the passenger, who was not wearing a life vest, drowned. Although they had been available, an immersion suit was not used by the pilot and a passenger-transportation suit was not used by the passenger.

"None of those who flew on [the helicopter] the day of the accident had received helicopter emergency egress/water survival training," the report said. "Regulations do not require this training, and it was [available from but] not required by the operator."

The pilot had flown helicopters in Newfoundland for the Canadian Coast Guard for 27 years. He had 20,000 flight hours. "He was not instrument-rated and did not have a night endorsement," the report said.

"None of those who flew on the helicopter the day of the accident had received helicopter emergency egress/water survival training."

Loose Coupling Causes Tail Rotor Failure

Eurocopter AS 365N Dauphin. Substantial damage. No injuries.

Winds were from the north at 15 kt, gusting to 25 kt, when the helicopter, facing southwest, lifted off from a hospital-rooftop heliport in Valparaiso, Indiana, U.S., for a medical services flight to Chicago, Illinois, on July 14, 2005. The pilot established a 4- to 6-ft hover and began a right pedal turn. Despite his continued application of right antitorque pedal, however, the helicopter stopped turning when it reached a westerly heading, the NTSB report said.

"The aircraft then went into a sudden and uncommanded yaw to the left," the pilot told investigators. "I was unable to stop the yaw, and by the time I was heading 090 degrees, the tail hit a roof structure just west of the pad [and the aircraft] then rolled on its right side." The pilot, physician, nurse and patient were not injured.

Examination of the helicopter showed that the fenestron — tail rotor — drive shaft had failed about 6 in (15 cm) aft of the main gearbox. The report said that the failure was caused by excessive play in the tail rotor drive shaft coupling, which had been installed improperly by the operator's maintenance personnel. ●

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
March 3, 2007	Ruhnu Island, Estonia	Britten-Norman Islander	destroyed	3 NA
The occupants received unspecified injuries when the airplane struck trees and crashed on final approach in fog.				
March 5, 2007	Zell am See, Austria	Aerospatiale 322/Diamond DA-20	destroyed	8 fatal
All seven occupants of the helicopter and the pilot of the airplane were killed when the aircraft collided at about 3,600 ft near a ski slope.				
March 7, 2007	Vreden, Germany	Eurocopter EC-120B/Robinson R22	minor/substantial	2 minor, 4 none
The helicopters collided while hovering at Stadtohn Airport. The four occupants of the EC-120 were not injured; the two occupants of the R22 received minor injuries.				
March 7, 2007	Yogyakarta, Indonesia	Boeing 737-400	destroyed	22 fatal, 118 NA
The airplane, en route on a scheduled flight from Jakarta, overran the 7,215-ft (2,199-m) runway and came to a stop in a rice paddy, where it was destroyed by fire.				
March 8, 2007	Mogadishu, Somalia	Ilyushin IL-76TD	destroyed	15 none
The airplane, en route from Entebbe, Uganda, was on final approach when a projectile fired from a small boat struck the fuselage near the left main landing gear and caused a fire. The airplane was landed safely. The only fire-fighting vehicle available at the airport had to be fueled and reached the airplane about an hour later.				
March 8, 2007	Kauai, Hawaii, U.S.	Aerospatiale AS 350BA	substantial	4 fatal, 3 serious
The pilot reported hydraulic system failure before the air-tour helicopter crashed while landing at Princeville Airport.				
March 9, 2007	Lilongwe, Malawi	Piper Seneca	destroyed	2 fatal
Visual meteorological conditions prevailed when the airplane crashed on a farm field at 0405 local time, soon after departing from Lilongwe for a charter flight to Karonga.				
March 11, 2007	Headcorn, England	de Havilland Turbo Beaver	destroyed	1 fatal, 8 NA
The airplane stalled and crashed during takeoff for a training flight. The pilot was killed; the eight parachutists received unspecified injuries.				
March 11, 2007	Kauai, Hawaii, U.S.	McDonnell Douglas 369FF	destroyed	1 fatal, 3 serious, 1 none
The air-tour helicopter was in cruise flight near the shoreline of Haena when the output shaft and rotor blades separated from the tail rotor gearbox. The helicopter struck trees and crashed during an attempted emergency landing on a campground.				
March 12, 2007	Dubai, United Arab Emirates	Airbus A310	substantial	236 NA
The airplane came to a stop near the end of the 13,124-ft (4,000-m) runway with the nose landing gear collapsed after the flight crew rejected the takeoff. There were no fatalities.				
March 14, 2007	near Salvador, Brazil	Rockwell Shrike Commander	destroyed	4 fatal
During a charter flight from Petrolina to Salvador, the flight crew reported that they had a technical problem and were losing altitude. The airplane crashed in an open field 60 km (32 nm) north of Salvador.				
March 17, 2007	Samara, Russia	Tupolev Tu-134A-3	destroyed	6 fatal, 51 NA
Runway visual range was 200 m (700 ft) in freezing fog when the airplane struck terrain 400 m (1,312 ft) from the runway threshold while landing.				
March 20, 2007	Fort Lauderdale, Florida, U.S.	Piaggio P180 Avanti	substantial	2 none
The airplane, on a positioning flight from Teterboro, New Jersey, veered right when the first officer applied the right wheel brakes to correct a left drift on landing. The left main landing gear collapsed.				
March 20, 2007	Newark, New Jersey, U.S.	Boeing 777	NA	NA none
The flight crew rejected the takeoff after a contained failure of the right engine. The airplane was towed back to the ramp.				
March 23, 2007	Mogadishu, Somalia	Ilyushin IL-76TD	destroyed	11 fatal
The airplane had delivered equipment needed to inspect another IL-76TD that was struck by a projectile while landing on March 8. While taking off for the return flight to Minsk, Russia, the airplane was struck by a missile and crashed.				
March 23, 2007	Istanbul, Turkey	Airbus A320-200	substantial	NA none
The right main landing gear separated when the airplane overran the runway while landing. There were no injuries.				
March 29, 2007	Sanford, Florida, U.S.	McDonnell Douglas MD-80	NA	152 none
The airplane was landed with the nose landing gear retracted.				

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.

International Federation of Airworthiness

Flight Safety Foundation

International Air Transport Association

Joint meeting of the FSF 60th annual International Air Safety Seminar IASS,
IFA 37th International Conference, and IATA

SHARING GLOBAL SAFETY KNOWLEDGE

Seoul, Korea

GRAND HILTON SEOUL HOTEL

Hosted by KOREAN AIR