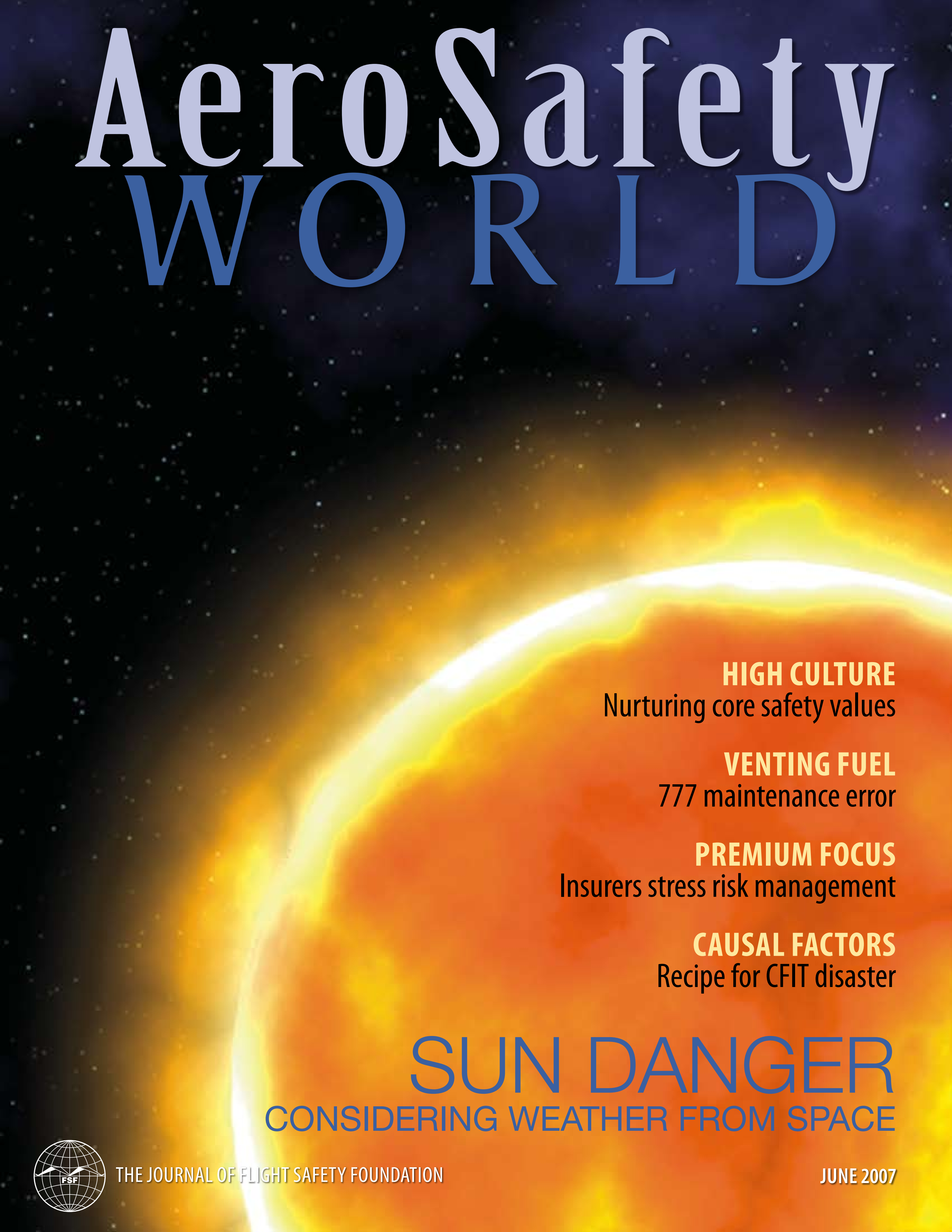
AeroSafety WORLD



HIGH CULTURE
Nurturing core safety values

VENTING FUEL
777 maintenance error

PREMIUM FOCUS
Insurers stress risk management

CAUSAL FACTORS
Recipe for CFIT disaster

SUN DANGER
CONSIDERING WEATHER FROM SPACE

FSF THE JOURNAL OF FLIGHT SAFETY FOUNDATION

JUNE 2007

Trust

In the past few weeks, I have been reminded of just how badly politics mix with safety. There are two separate storms brewing in the United States that could undermine the key ingredient of our safety programs — trust.

The first storm is the user fee debate, which has been building for years. Airlines and business aviation are battling over the question of who pays for how much of the air traffic control system. I worry that this debate could impact our future safety efforts.

One of the core functions of Flight Safety Foundation has been to spread safety innovations from one segment of the industry to another. But the debate is so intense and the feelings are so bitter that now I am not sure I can get safety people from the airlines and business aviation in the same room.

We can get a sense of what is at risk by looking at some of the safety programs these communities have shared in the past. Our Approach and Landing Accident Reduction (ALAR) program has always reached out to airline and business aviation audiences. Our Ground Accident Prevention (GAP) program has been driven by the airlines, but some of the first products you will find on our Web site address business operations. The Foundation's work in the area of fatigue is supporting long-range operations in Boeing 777s as well as Gulfstream 550s.

While there have always been competing interests, we have been able to put them aside. I hope that the trust and sense of mission that have held us together through the aftermath of the 9/11 attacks and spiraling fuel prices are not lost in this debate. Who knows what the next challenges will be — carbon-emission limits, avian flu, personnel shortages? One thing is certain: We are always going to need each other.

The other storm involves air traffic controllers' growing distrust of the Federal Aviation Administration (FAA). In a recent survey of controllers, less than 10 percent said that they trust FAA management. That is pretty serious if we think about the challenges that the FAA faces. First, it has to deal with ever-increasing demand on a system that is being pressed to its limits. Second, it must start dealing with a large turnover as controllers hired after the 1981 PATCO strike start to retire. Finally, the organization is going to have to create and then transition to a Next Generation Air Transportation System, which must be revolutionary to be successful.

The only way to deal with challenges like these is to lean heavily on tools such as safety management, threat and error management, normal operation safety studies and so on. These tools rely on open and honest reporting and exchange of safety information. In other words, all of these tools rely on trust.

I don't deny anybody the right to lobby for their interests or fight for a fair deal. But I know that we cannot let the festering aviation issues breed the crippling mistrust that could stop safety improvements in their tracks. At the end of the day, regardless of who wins or loses, thousands of people are going to have to reach down deep and find a way to trust again. There is no choice. We live in a system that is built on trust.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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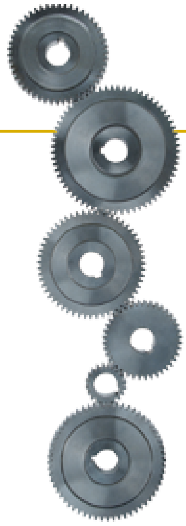

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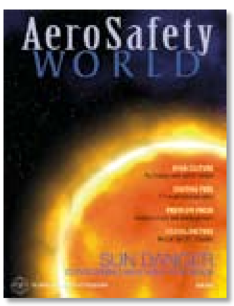

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Safety threats from the sun prompt greater interdependence of aviation professionals and solar scientists.
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 ISSN 1934-4015 (print)/ ISSN 1937-0830 (digital). Published 12 times a year.

AeroSafetyWORLD

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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.

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Attitude

The aviation safety community is justifiably proud of what it has accomplished in the past decade or so. Swimming uphill against a thought stream that held few changes were needed since flying was already safe, safety specialists established a completely new threat-targeting paradigm, using data from accidents, incidents and events to predict where efforts should be focused.

This evolved the idea of "just culture" in an organization, holding that encouraging the flow of information is more important than punishing those who make mistakes. Two authors in this issue of *AeroSafety World* describe very clearly the benefits that flow from such an approach in a safety culture.

But governments have struggled with the conflicting imperatives of the accident investigation process and the criminal justice system. In the United States, policy and practice — more than rules — protect the process. While analyses and accident reports produced by the National Transportation Safety Board by law cannot be used in criminal or civil courts, the factual information gathered by investigators is fair game for the courts, and investigators can be called to participate in criminal cases.

Courts have shown an inclination to protect the investigation process, ruling against those seeking NTSB-developed information, widening the prohibition against the introduction of NTSB analysis to cover the release of other types of information.

Jim Hall was NTSB chairman in 2000 when, in a speech, he described one such ruling: "During oral arguments, the chief judge indicated that it was the court's desire to allow the board to do its job and to keep it out of litigation. Using a few choice words, he said that 'we are trying very hard to keep lawyers from screwing that up with this agency.' Unfortunately, given the litigious nature of our society, such challenges to our procedures and authority may continue."

It is no more than a matter of U.S. Department of Justice (DOJ) policy that individuals are not prosecuted after an accident; criminal charges generally are reserved for investigations that turn up evidence of aggravated corporate misbehavior. This policy keeps information flowing in U.S. investigations.

But that is just a policy, and policies change. Should that happen — and we've lately seen previously unimaginable things coming out of DOJ — who in their right mind would reveal information that might be turned against them in later legal proceedings?

But, so far, it remains part of the U.S. culture that accident survivors and participants are not charged with a crime.

Exactly the opposite is true in many countries, where the requirement to prosecute is part of the culture, written into laws and even national constitutions.

This is why the battle against the criminalization of aircraft accidents is going to be so much more difficult than other recent challenges, such as the effort to reduce controlled-flight-into-terrain (CFIT) accidents. The fight against CFIT is a logical effort of hardware and procedures that does not confront issues of tradition, culture and emotion. Those of us who see the clear benefit of prosecutorial restraint need to temper our attitude with an appreciation for the gravity of the changes we are advocating.

J.A. Donoghue

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

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March 10–12, 2008

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

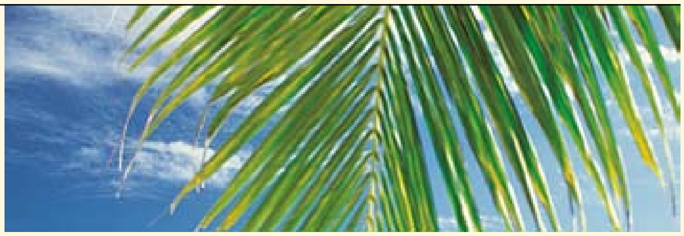
JW Marriott Bucharest Grand Hotel, Bucharest, Romania

Corporate Aviation Safety Seminar

April 29–May 1, 2008

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

The Innisbrook Resort and Golf Club, Palm Harbor, Florida



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Fax this form to Flight Safety Foundation. For additional information, contact Ann Hill, ext.105; e-mail: hill@flightsafety.org.

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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 5–6 ➤ 5th Annual Regional Airline Industry Flight Technology Conference. Regional Airline Association. Washington. <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 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.

JULY 23–25 ➤ Asia Pacific Aviation Summit. Terrapinn Limited. Sydney, Australia. Vanessa Riley, <vanessa.riley@terrapinn.com>, <http://www.terrapinn.com/2007/aviation>, +61 2 9021 8808.

AUG. 6–9 ➤ Unmanned Systems North America. Association for Unmanned Vehicle Systems International. Washington. <info@auvsi.org>, <http://www.auvsi.org/symposium>, +1 703.845.9671.

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>.

AUG. 27–30 ➤ ATA Non-Destructive Testing Forum. Air Transport Association of America. Orlando, Florida, U.S. <ata@airlines.org>, <http://www.airlines.org/operationsandsafety/events/>, +1 202.626.4000.

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. 5–6 ➤ 19th FAA/ATA International Symposium on Human Factors in Maintenance and Ramp Safety. U.S. Federal Aviation Administration and Air Transport Association of America. Orlando, Florida, U.S. <ata@airlines.org>, <http://www.airlines.org/operationsandsafety/events/>, +1 202.626.4000.

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. 11–15 ➤ 17th ACI Africa Annual Assembly, Regional Conference & Exhibition. Airports Council International. Arusha, Tanzania. <events@aci-africa.aero>, <http://www.aci-africa.aero/en/index.php?idp=4&>.

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. 19–22 ➤ 12th Aviation Expo/China 2007. C5 China. Beijing. <cpbj@cpbjlf.com>, <http://www.cpexhibition.com/aviation>.

SEPT. 25–27 ➤ NBAA2007: Helping Businesses Take Flight. National Business Aviation Association. Atlanta. Donna Raphael, <drapahel@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. 1–2 ➤ UKFSC Annual Seminar: Technical Innovation and Human Error Reduction. U.K. Flight Safety Committee. Heathrow. <admin@ukfsc.co.uk>, <http://www.ukfsc.co.uk/annual%20seminar.htm>, +44 (0) 1276 855193.

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

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

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

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

Safety News

NTSB Recommends TCAS Enhancements

Aircraft that are equipped with a traffic-alert and collision avoidance system (TCAS) also should have an enhanced aural and visual warning in the event that the system stops functioning, the U.S. National Transportation Safety Board (NTSB) says.

The NTSB has recommended that the U.S. Federal Aviation Administration (FAA) also require the enhanced warnings for existing and future system designs. Accompanying recommendations called on the FAA to evaluate the feasibility of including aural and visual warnings in future systems designed for ground collision avoidance.

In issuing the recommendations, the NTSB cited the September 2006 accident in which a Gol Airlines Boeing 737-800 and an Embraer Legacy 600 business jet collided over the Amazon. The 737 was destroyed and all 154 occupants were killed. The Legacy sustained minor damage, and its flight crew conducted an emergency landing; the five people in the airplane were not injured.

The NTSB said that preliminary findings from the accident investigation reveal "no indication of any TCAS alert on board either airplane." Both airplanes had Mode S transponders and were equipped with TCAS II, which provides traffic advisories and resolution advisories in the event of a collision risk.

In a third recommendation, the NTSB said that the FAA should inform pilots who use transponders or TCAS units about "the circumstances of this accident and the lack of a conspicuous warning to indicate the loss of collision protection resulting from a compromise in functionality of either the transponder or TCAS unit and ask all pilots who use transponders or transponder/TCAS units to become familiar with the annunciations currently used to indicate failure or lack of active functionality of these components."

The accident remains under investigation by Brazilian authorities.

© Honeywell International

Simulated Approaches

Researchers at the U.S. National Aeronautics and Space Administration (NASA) have completed a study of approaches to very closely spaced runways that found that pilots had no preference for landing on the left or the right runway.

The study, conducted at the NASA Ames Simulation Laboratories, involved scenarios in which a computer-generated lead Boeing 757 and a following 757 represented by the advanced cockpit flight simulator were flown to parallel runways that were 750 ft (229 m) apart. Enhanced cockpit displays provided the simulator pilots who were "flying" the following airplane with the position and airspeed of the lead airplane. Pilots flew approaches to the runways under eight scenarios, involving different wind and visibility conditions, and different spacing between the two airplanes.

The pilots preferred the procedures with clear visibility and greater spacing between the two aircraft — 10 seconds rather than five seconds, according to a preliminary report on the study.

Another report will be issued after additional data analysis is completed.

U.S. National Aeronautics and Space Administration

Campaign Against Fatigue

The U.S. Federal Aviation Administration (FAA) and the union representing air traffic controllers in the United States should work together to reduce the potential for fatigue among air traffic controllers, the U.S. National Transportation Safety Board (NTSB) said.

In recommendations to the FAA and the National Air Traffic Controllers Association, the NTSB called for cooperative efforts to "reduce the potential for controller fatigue by revising controller work-scheduling policies and practices to provide rest periods that are long enough for controllers to obtain sufficient restorative sleep, and by modifying shift rotations to minimize disrupted sleep patterns, accumulation of sleep debt and decreased cognitive performance."

The NTSB also recommended that the FAA develop a fatigue awareness and countermeasures training program for controllers and those who develop controller work schedules.

The recommendations were prompted by the ongoing investigation of an Aug. 27, 2006, accident in which a Comair CRJ-100 crashed during takeoff from Blue Grass Airport in Lexington, Kentucky, U.S. The airplane was destroyed, and all but one of the 50 people in the airplane were killed. The NTSB's preliminary investigation found that, after receiving a takeoff clearance for Runway 22, the crew had mistakenly conducted the takeoff on Runway 26, which — at 3,500 ft (1,068 m) — is about half the length of Runway 22.

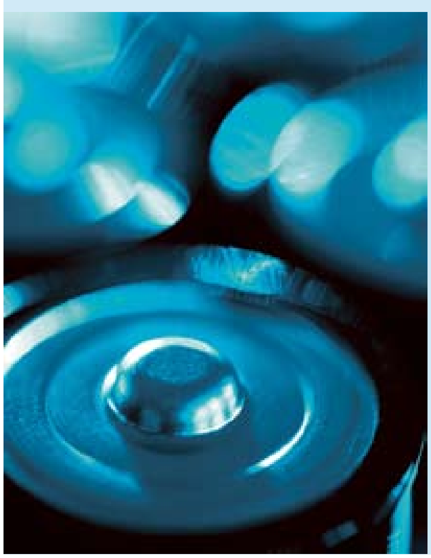
U.S. Federal Aviation Administration

The preliminary investigation found that the air traffic controller who cleared the accident airplane "had worked a shift from 0630 to 1430 the day before the accident, then returned nine hours later to work the accident shift from 2330 until the time of the accident at 0607 the next morning," the NTSB said. "The controller stated that his only sleep in the 24 hours before the accident was a two-hour nap the previous afternoon between these two shifts."

A related recommendation called on the FAA to require controllers to complete training in resource management skills designed to improve their judgment, vigilance and safety awareness.

Battery Warning

The Civil Aviation Safety Authority of Australia (CASA) has reiterated a warning about the risks presented by lithium batteries being transported as freight or in baggage.



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CASA cited earlier advice from the U.S. Department of Transportation (DOT), which said that spare lithium batteries should be transported in carry-on baggage rather than checked, spares should be kept in their original packaging, and loose batteries should be covered in insulating tape or carried in a plastic case to prevent contact with metal.

The DOT warning followed two fires this year on commercial airplanes that were attributed to loose lithium batteries; in each instance, the fire was extinguished by crewmembers and the airplanes were landed safely.

End-Around Taxiway Opens

What is believed to be the second "end-around" taxiway in the world has opened at Hartsfield-Jackson Atlanta (Georgia, U.S.) International Airport. End-around taxiways eliminate the need for aircraft to be taxied across active runways to reach their arrival gates, instead allowing crews to taxi to the end of a runway and then turn onto a taxiway that travels directly to the gate area.

The new US$42.5 million taxiway, which is expected to accommodate the 700 aircraft that are landed daily on Hartsfield-Jackson's northernmost runway, is part of a $6 billion airport development project. The world's first end-around taxiway was opened in Germany at Frankfurt Airport.

Crackdown on Icing

The U.S. Federal Aviation Administration (FAA) is proposing to amend airworthiness standards for transport category airplanes certificated for flight in icing conditions to require the aircraft to be equipped with a method of ensuring the timely activation of an airframe ice-protection system (IPS).

The FAA notice of proposed rule making (NPRM) was published April 26 in the *Federal Register*. Public comments on the proposal will be accepted through July 25, and a final rule may be issued after a review of the comments.

The FAA said that the proposed amendment followed a review of icing accidents and incidents that identified a number of events in which a flight crew was "either completely unaware of ice accretion on the airframe, or was aware of ice accretion but judged that it was not significant enough to warrant operation of the airframe ice-protection system."

The NPRM acknowledged the difficulty — especially at night, during times of heavy workload or when clear ice is accumulating — of determining whether there is enough ice to activate an ice protection system and said that flight crews "must be provided with a clear means to know when to activate" an airframe IPS.

The NPRM said that one of three alternatives would be acceptable: "a primary ice-detection system that automatically activates or alerts the flight crew to activate the airframe IPS; or a definition of visual cues for recognition of the first sign of ice accretion on a specified surface, combined with an advisory ice-detection system that alerts the flight crew to activate the airframe IPS; or identification of conditions conducive to airframe icing as defined by an appropriate static or total air temperature and visible moisture for use by the flight crew to activate the airframe IPS."

Praise for the SMS

Canadian aviation officials and industry leaders are crediting the 2005 introduction of safety management system (SMS) regulations in Canada with a subsequent decrease in the aviation accident rate.

After a meeting in Ottawa, the Canadian Aviation Executives Safety Network issued a statement that credited SMS with providing an additional layer of safety oversight within the aviation system.

"The safety management system is an international initiative recognized as the most significant advancement in aviation safety in recent years," said Michael DiLollo, senior vice president of Air Transat. "I believe that the development, implementation and maintenance of SMS in all areas of aviation activity is key to improving the safety and well-being of the aviation industry."

In Other News …

The government of **Nigeria** has withdrawn the operating licenses of seven airlines that failed to meet an April 30 deadline for their recapitalization. … The U.S. Federal Aviation Administration (FAA), which evaluates civil aviation authorities to determine whether they comply with International Civil Aviation Organization safety standards, has said that **Indonesia** is not in compliance. ... Authorities at many international airports outside the United States do not expect introduction of the **Airbus A380** to cause delays at their facilities, the U.S. Government Accountability Office says in an analysis of potential safety and capacity issues.

Compiled and edited by Linda Werfelman.


LOOKING FOR A
RELIABLE **CO-PILOT**?
WE'VE BEEN IN
THE **RIGHT SEAT**
FOR OVER 60 YEARS.

High

In Airline Aviation

BY GEORGE H. SNYDER JR.

On Sept. 11, 1991, a commuter flight operating between cities in Texas crashed after a structural failure occurred during descent, killing all 14 people aboard the aircraft.

The U.S. National Transportation Safety Board (NTSB) investigation revealed that fasteners removed from the leading edge of the horizontal stabilizer during maintenance the night before had not been replaced before the aircraft was returned to revenue service. The aircraft crashed on its second flight of the day.[1]

Immediately following the accident, the airline's maintenance program underwent a U.S. Federal Aviation Administration (FAA) National Aviation Safety Inspection Program (NASIP) evaluation. The inspection found very few deficiencies, and the FAA ultimately complimented the airline on its internal evaluation systems. Several months later, the same airline had a similar incident; one of its aircraft had to turn back when it was discovered that something was wrong. It appeared that bolts had been removed from a wing panel and not replaced. The NTSB later commented that even a fatal accident and an FAA NASIP were not enough to overcome what appears to have been a failure of corporate culture.[2]

There is nothing to indicate any fundamental flaws with the NASIP process or any other similar inspection process. Even the most comprehensive, well-executed inspection process captures only a snapshot of an organization's capabilities and performance. This process should be considered as one of many significant data points in determining the overall operational safety health of an airline.

The 1991 accident was seen as a turning point in assessing the importance of an airline safety culture by Meshkati (1997)[3] and by then-NTSB member John Lauber, who suggested that the probable cause of the accident also should have included "the failure of [the airline's] management to establish a corporate culture which encouraged and enforced adherence to approved maintenance and quality assurance procedures."[4]

Issues involving corporate culture were contributory or causative to airline accidents long before 1991, and, most likely, afterward. However, continuation of this negative influence on safety is by no means inevitable if global airline industry stakeholders continue to work together in a spirit of partnership and collaboration.

Defining Safety Culture

The challenge of defining airline safety culture became evident during the development of crew resource management (CRM) methodologies. In early versions of training courses in the mid-1980s, we were told that an organization's culture involved behaviors that were "encouraged, discouraged or tolerated." Many versions of these words followed, probably none readily understood by the line employees whose behavior most contributed to this concept.

Our collective confusion at that time, possibly extending to the present, is best explained by Pidgeon's (1998) informal observation that existing empirical efforts to study safety culture have been "unsystematic, fragmented and, in particular, underspecified in theoretical terms."[5] It is no wonder that airline line managers and staff were not able to quickly grasp the importance of an organizational safety culture.

There is a common notion that while you may not be able to define something, you certainly can recognize it when you see it. Following on this thought, University of Illinois researchers Zhang, Wiegmann, von Thaden, Sharma and Mitchell, in a paper titled *Safety Culture: A*

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Culture In Corporate Aviation

The art of creating and sustaining a beneficial safety culture in different settings.

BY PETER V. AGUR JR.

Aviation safety is not a goal unto itself; it is the most critical part of the journey. The accident rates of major commercial airlines and corporate aviation are statistically equivalent. A more universally effective safety culture could allow corporate aviation to become the least hazardous mode of air travel. A brash claim? Maybe not.

A review of accidents involving professionally flown aircraft shows that four out of five events included procedural intentional and/or procedural unintentional noncompliance (PINC, PUNC) by pilots. PINCs and PUNCs are reduced dramatically when an effective safety culture exists.

Building a safety culture in a corporate aviation operation is very different from building one in the commercial aviation arena, because:

- *The core businesses are different.* An airline's core business is aviation, while corporate aviation is routinely a supporting service of an enterprise whose core business is not aviation.
- *The goals of the businesses are different.* Commercial aircraft are operated solely for the purpose of revenue and profit. Corporate aviation is a service center in support of the core business.
- *The aviation knowledge of top executives is different.* The leaders and senior managers engaged in commercial aviation are usually aviation professionals. Their counterparts in corporate aviation have no need to know the business and operational issues of the aviation function.
- *Their operational standards are different.* The governing rules of commercial aviation, Federal Aviation Regulations (FARs) Parts 121, 135 and their international counterparts, are rigorous to protect the traveling public. Corporate aviation is held to the much lower standard of FARs Part 91 and international counterparts.

The challenge is to create and maintain an effective safety culture within a corporate aviation operation where there is an apparent potential for less focus and discipline. An effective corporate safety culture starts at the top, in the offices of the executive officers, and permeates the entire organization all the way out to the airport. The safety culture comes in three parts: vision, co-reponsibility and performance.

The Vision

An effective corporate aviation safety culture starts with a vision for safety. That vision comes in two modes — the grand vision of a powerful top executive and the focused vision of the aviation services unit leader.

It is imperative that the top corporate executives describe a vision of safety. Ideally, the chief safety officer (CSO) is also the company chairperson or the chief executive officer (CEO). If not,

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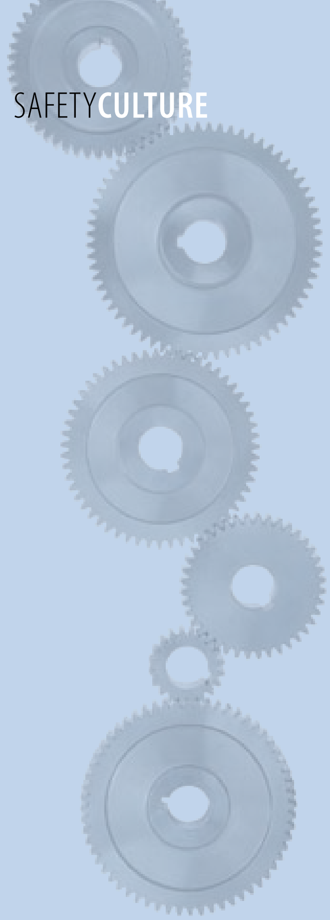

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Concept in Chaos, cite some common elements of an airline safety culture:

- Shared values at a group level;
- Close relationship to management and supervisory systems;
- Emphasis on the contributions of everyone;
- Impact on the behavior of all employees in the workplace;
- Relationship between reward and performance;
- A corporate willingness to learn from errors, incidents and accidents; and,
- Stability.[6]

The University of Illinois team developed the following definition of safety culture, which I find to be pragmatic, understandable and useful to front-line airline employees:

> *The enduring value and priority placed on worker and public safety by everyone in every group at every level of an organization. It refers to the extent to which individuals and groups will commit to personal responsibility for safety; act to preserve, enhance, and communicate safety concerns; strive to actively learn, adapt and modify [both individual and organizational] behavior based on lessons learned from mistakes; and be rewarded in a manner consistent with these values.*[7]

This definition brought together the need for personal commitment to safety, communication, learning, adapting, modifications and reward. These are the attributes that airline safety directors have been focusing on for years, recently finding their way into the precepts of modern safety management system (SMS) programs.

Categories

Any discussion of airline safety cultures must include the elements of national, organizational and professional differences.[8] Everything that occurs within an airline — from employee hiring, establishment of standard operating procedures (SOPs), employee training, performance evaluations, managerial oversight, and ultimate levels of compliance and conformance — is driven in various ways by these important cultural components.

I have found no national, organizational or professional subculture that contains characteristics incompatible with the establishment of an effective airline safety culture. Clearly, every category brings differences to the table — both positive and less positive. But, at the end of the day, people are people, no matter where they live, what they do or whom they do it for. This is the single most important concept for a global airline safety manager to keep and use.

There is a tendency to equate national culture distinctions — specifically individualism-collectivism, power distance, uncertainty avoidance and rules and order —with certain geopolitical regions.[9] If allowed to progress, this thought process leads to the conclusion that the presence or absence of these group characteristics is incompatible with acceptable levels of operational safety.

However, through my experiences, I conclude that these generalizations are simplistic and counterproductive. Rather than indicating predetermined performance, they merely indicate that a variety of prescriptive measures, respectful of culture and tradition, may be required in order for assorted groups to achieve optimal safety performance.

Organizational culture distinctions can either mimic the national culture within which they exist or, alternatively, exist essentially unaltered across a wide expanse of geopolitical boundaries.[10] This latter characteristic describes a global airline's multiple international airport station network. While the geopolitical location of an outstation may support individualistic cultural attributes, a strong spirit of collectivism often is found among the airline's home office and regional employees at that location that optimizes their collective safety performance.

Lastly, unique attributes exist within different professions that may be leveraged or compensated for to ensure the presence of an optimal safety culture. While experienced airline employees take great pride in their professionalism, they may at times overrate their abilities to counter the effects of stress and fatigue. This personal concept of invulnerability may actually impede, rather than optimize, their safety performance.[11]

Modern airline organizations no longer exist in isolation but operate instead as a "system of systems, a culture of cultures." To establish and maintain a positive safety culture, airline management must take these complementary and conflicting dimensions into account in their selection of staff and creation of SOPs, training programs, evaluation processes and supervisory practices.

Culture Elements

The University of Illinois researchers described five general areas that compose the foundation of an organization's safety culture.

The airline's commitment is most clearly evidenced by the presence or absence of a prominently displayed safety policy signed by the president and chief executive officer, frequently updated or revalidated. This forms the basis of an explicit safety contract between management, employees and customers. The policy clearly establishes safety as a core value, presents the company's safety expectations, reinforces the commitment to provide employees with the necessary training and resources, and identifies the reporting of human errors as a corporate learning experience not subject to disciplinary action or retaliation, while stating that willful and deliberate noncompliance with laws, civil aviation regulations and company policies and procedures will not be tolerated.

Airline management cannot effectively promote a safety culture from behind closed doors. Safety bulletins and circulars are not credible to employees who observe their supervisors circumventing government regulations and company policies in favor of commercial advantages or, possibly worse, never see their supervisors at all. A chief pilot flying an unpopular trip on a weekend, at night and in bad weather, demonstrating that SOPs are not merely daylight, clear-weather commodities, can exemplify the presence of an effective airline safety culture. Alternatively, an equally powerful indicator might be a maintenance foreman painstakingly troubleshooting a discrepancy in the rain and at night with an airplane full of passengers already an hour behind schedule.

Employees must view themselves as active participants in the airline safety culture rather than as disenfranchised observers. They must see, and management must support, a direct correlation between the quality of their work performance and the overarching safety performance of the airline as a whole. What they do or, more importantly, what they do not do, must be seen to make a critical difference. Rather than pass over an opportunity to perform an


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additional inspection, ask questions or seek clarification, the employee should feel empowered by his supervisors to take these actions without fear of negative consequences.

When cabin attendants immediately before takeoff passed to the cockpit a passenger's observations that the aircraft's ground spoilers were fully extended, that event became one of the most poignant indicators of a strong corporate safety culture that I have ever validated. In this case, there had been an unprecedented cable connection failure between the actuator handle in the cockpit and the spoiler panels, failing in a way that bypassed the takeoff configuration warning system. There is every indication that, absent that warning, the crew would have attempted a takeoff with potentially disastrous results. Repeating an earlier point, everyone must be an active participant in the safety culture concept.

While an airline safety culture must empower employees with the ability to take strong measures to ensure operational safety, it must also hold them accountable for their actions. Safety performance bonus programs are an integral part of an effective SMS.

In one memorable example, a contract ramp worker went above and beyond the scope of his responsibilities when he questioned a person running across the ramp to board a shuttle bus en route to the remote aircraft parking location. While it turned out that the person was an airport employee who had inappropriately used his airport ID to bypass normal check-in and security processes, the person's intent could have been far more sinister. The ramp worker's actions were formally recognized when the airline's head of safety and security rewarded him with two round-trip business-class tickets to a destination of his choice. The impact of these types of corporate gestures cannot be understated when it comes to creating and maintaining a safety culture.

On the other hand, there are times when an employee deliberately disregards laws, regulations, policies or procedures and puts the airline, fellow employees and passengers at risk. Prior to making any type of final determination, the safety culture concept requires a comprehensive, objective investigation to determine if the act involved a willful disregard for safety.

There are several possible outcomes of such an investigation: It may be found that the employee is not fully suited to his or her job responsibilities, or that the airline's SOPs are not clearly stated or realistic, or that the training in support of these standards is not comprehensive, or that management and oversight of the employee's upholding of these standards is deficient.

My experience as head of safety for two major airlines showed me that a brutally honest review usually finds the organization, not the individual, in need of remedial action. In the unlikely event that such is not the case, the airline must move quickly and decisively to remove this behavior from the workplace.

Please note that I intentionally stated that the "behavior" must be removed from the workplace, not necessarily the "person." If management counseling, additional training and evaluation bring an employee's performance to required standards, the safety culture will have scored a decisive and overwhelming win. The rehabilitated employee most likely will become an extremely effective ambassador of the safety culture to the remainder of the work force. Unfortunately, in cases where the "behavior" cannot be successfully isolated from the "person," the logical course of action for the airline to pursue is clear.

A final necessary element in an airline safety culture is an effective safety hazard reporting system. While word of mouth and informal reporting/advisory channels may appear to work well in smaller organizations, a formalized reporting process is invaluable. Today's airline safety culture requires an overarching company policy that provides indemnity for employees reporting safety hazards and inadvertent unsafe acts, identification of mandatory reporting events, reporting forms customized for each employee group, an effective investigation and analysis process, assignment of corrective action to the appropriate department or agency, follow-up to assure that corrective measures are delivering desired results, and, finally, a feedback loop to the reporting employee advising him that his concerns have been addressed and resolved. Information and communication are the lifeblood of an airline's safety culture.

Investigation and Analysis

It is difficult to question the safety benefits of a technically sound, open, honest and comprehensive accident investigation process. There are many areas of the world where independent investigation agencies provide comprehensive fact-finding, exhaustive root cause analysis and valuable safety recommendations. Likewise, some airline organizations have the technical expertise and corporate initiative to perform similar high-quality internal investigations of safety events below the threshold of state involvement; others should strive to achieve this capability. Further, other parties should be invited into the investigation, including appropriate labor organizations.

In a dysfunctional safety culture, formal and informal investigations are not undertaken in a spirit of openness and candor; rather, deception, secrecy and deflection of accountability are key precepts. In these cases, there are two separate tragedies — the first being the event itself where innocent people may have been injured or lost their lives, and the second, even greater tragedy, an opportunity is lost to identify root causes and develop lifesaving safety recommendations and future accident prevention strategies.

Internal safety investigations that are never completed, analysis that is either nonexistent or fundamentally flawed, and assignment of accountability that results in blame and punishment as a terminating action should be challenged rather than accepted. Whether the investigation is being conducted at either a governmental or organizational level, the truth is the truth, and the quest must not end until that truth is fully revealed.

Blame and Punishment

A June 2006 Australian Transport Safety Bureau (ATSB) report titled *Assessing Institutional Resilience: A Useful Guide for Airline Safety Managers* includes the thoughts of Professor James Reason on the concept of blame: "Disciplinary policies are based on an agreed (i.e., negotiated) distinction between acceptable and unacceptable behavior. It is recognized by all staff that a small proportion of unsafe acts are indeed reckless and warrant sanctions, but that the large majority of such acts should not attract punishment. The key determinant of blameworthiness is not so much the act itself — error or violation — as the nature of the behavior in which it was embedded. Did this behavior involve deliberate unwarranted risk-taking, or a course of action likely to produce avoidable errors? If so, then the act would be culpable regardless of whether it is an error or a violation."[12]

An effective airline safety department, and by default, its leader, is viewed as the creator and staunch defender of the corporate safety culture. The safety department must initiate investigations in an unbiased, open and responsive manner, providing those involved in the incident a good reason to feel comfortable in providing pertinent details. This comfort is further strengthened when safety department personnel are recognized as having high levels of technical expertise. While there is a general reluctance among technically oriented airline professionals to receive correction, such reluctance is minimized if those they respect deliver it.

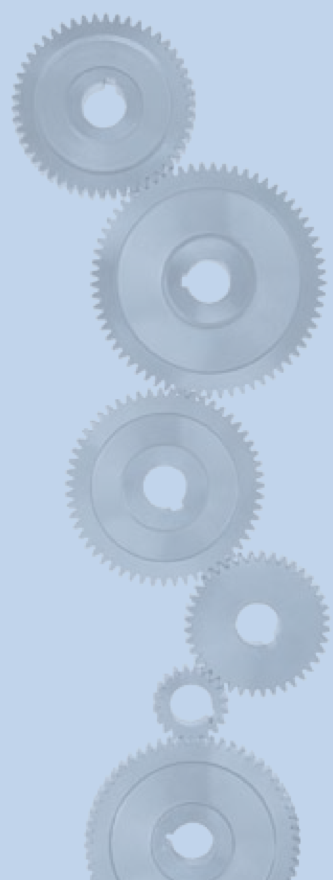
With few exceptions, the concept of blame and punishment within an airline safety culture is simplistic and counterproductive. The assignment of blame artificially and prematurely restricts the investigation process, and the resultant pronouncement of punishment largely simulates a terminating action. When the specter of blame, discipline and retribution is removed from the investigation process, information and communication exchanges abound.

Commercial Interests

Risk management and a strong safety culture are in harmony with an airline's commercial interests. Passengers have been increasingly subjected to crowded terminals, invasive security procedures, reduced in-flight amenities and periodic delays and cancellations. Surprisingly, these factors alone have not resulted in any appreciable declines in overall demand levels. However, demand levels for carriers or countries where questions of operational safety are raised are quite different. Passengers will tolerate many things, but they will not tolerate a perception that an airline or specific region of the world is unsafe.

Aviation industry participants who feel that minimizing their safety investments improves their long-term commercial interests are sadly mistaken. Analysis of an airline's market capitalization levels during a period of incidents or accidents clearly shows a downturn when other factors are held constant. When such safety perceptions improve, the airline's financial picture gradually improves.

Drilling down a bit further, the argument of production versus protection, money versus safety[13] becomes a little clearer in this story: Moments before the pushback of an international widebody flight, a late transfer bag appeared. With mistaken good intentions, a baggage handler jumped into his tug and drove as fast as he could across the ramp to the aircraft. In violation of established ramp procedures, he drove full-speed directly toward the aircraft's bulk cargo door. It was raining, the ramp was wet, and he was unable to bring the tug to a stop. The collision rendered the aircraft



unserviceable for four days. The driver recovered from his injuries and returned to work.

High costs can accompany an event below the level of an accident or incident. For example, the absence of an effective cockpit window inspection program allowed electrical arcing from heater filaments to shatter the window. The flight was canceled, the aircraft was de-fueled, the passengers were re-accommodated, the catering supplies were unloaded and discarded, crewmembers were rescheduleded, and cargo customers were paid performance penalties.

Had the airline's safety culture dictated in the first case that, regardless of circumstances, ramp personnel are strictly required to comply with airport driving regulations and bring their vehicle to a complete stop no closer than ten ft from the aircraft, the aircraft ground damage and employee injury would no doubt have been prevented with substantial savings to the company. Had chronic windshield arcing discrepancies been viewed as symptoms rather than root cause, a more comprehensive inspection program may have been instituted before the flight's cancellation, again saving a great deal of money.

Leadership

It is difficult to cite an example of a strong airline safety culture without an equally strong and committed leader. The influence of the top corporate officers cannot be understated. Regardless of the existence of safety policies, infrastructure or SOPs, if the safety culture is not explicitly supported at the highest levels of the company, all other safety management tools are rendered ineffective.

The head of safety is an equally critical position, as he or she must turn the chairman's vision into a functional reality. The elements of a strong safety culture may resound with universal appeal in the corporate offices, but when placed up against longstanding company practices and short-term commercial interests, it is the head of safety working together with the operating department heads that ultimately must make it work.

Leadership within an airline safety culture does not have to be accompanied with a title or office. Each employee group normally has an informal designee to whom everyone looks for guidance and support. These informal leaders set the peer standards in the workplace that are either harmonized, or in direct contradiction, with established company policies and procedures. The results of either can easily be seen in the safety performance of the respective work groups.

Conclusion

We should remember that there is no preordained safety advantage or deficiency in national, organizational or professional cultural subsets, that there are important elements of a safety culture that must be present in order to optimize its performance, that investigation and analysis must be open and honest, that blame and punishment have little value in ensuring continued safety, that organizations focusing on safety enhance their commercial advantage rather than detract from it, and that strong leadership is critical to maintaining the safety culture.

Regardless of whether the airline is operating a fleet of Airbus 380s or Cessna 180s, the precepts and importance of a safety culture remain constant.●

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then the CSO must be someone who can look that highest of the high, the CEO, directly in the eye and say "no," without it being a career modifier.

About 15 years ago, John Luke, Sr., then the CEO of what is now MeadWestvaco, a Fortune 500 company, told me he expected a standard of care from his aviation services that would allow anyone to feel perfectly at ease placing his or her children aboard the company aircraft, every day and every leg. He also said that he expected the standard of care to be the same for everyone.

Not every CEO understands the need for such a clear corporate aviation safety vision. Some take it for granted that the regulations and their pilots will protect them. One executive was candid enough to say, "I don't think our pilots are suicidal. They sit in the seats with the best view. They can see it coming." His optimism was admirable, but the greatest source of fatalities in professionally flown aircraft continues to be controlled flight into terrain (CFIT). In other words, his trust may have been misplaced.

It is essential that a CEO/CSO be the source and lead champion for the aviation safety vision. This gives the safety vision the powerful authentication of authority from the corner office. That is why Flight Safety Foundation and the National Business Aviation Association recommend that flight operations manuals contain a letter from the CEO declaring the corporate aviation safety vision and a clear statement of crew authority.

One CEO added the statement, "Any passenger who challenges the safety-based decisions of a crew during a trip will lose his or her corporate aircraft travel privileges." His declaration made it perfectly clear to the entire organization that the responsibility for safety spanned from the corner office to the cockpit and cabin.

Co-Responsibility

The responsibility for safety is shared throughout the corporate organization, but it starts at the top. Bill Esrey, former chairman at Sprint, endorsed a policy that required all frequent corporate aircraft passengers to attend a half day of cabin safety training. Even though the program was mandatory, the participants were quickly infected with the cultural importance of safety. The enthusiasm shown by newly appointed aircraft users to attend the course was strong evidence of how the previous graduates were assuming an informal responsibility to promote the program.

Unlike Esrey, some CEOs mistakenly believe the responsibility for aviation safety rests solely at the airport. They take their trust in their pilots' survival instincts too far. The worst executive passengers mistakenly assume that the behaviors they use to achieve success within their core business — demanding more and more of their people and refusing to take "no" for an answer — also work at the airport. These hard-chargers push for 18-plus hour duty days, demand to go into challenging airports in high risk conditions and anything else that will accommodate their busy lives. The pressure they put on crews is rarely subtle. It is a no-win situation. That is why the CSO must be directly co-responsible for safety.

When there is no CSO, the role of chief safety champion falls to the corporate aviation manager. To be effective, an aviation manager must have his or her own clear and strong safety vision, as well as the strength of character to champion it despite the lack of authority endowed by a CSO.

To be most effective, co-responsibility for safety must be a core value of the entire aviation services organization. It is hugely egotistical or naive for an aviation department leader or safety officer to assume he or she can manage safety into all phases of the operation. No manager can be everywhere all the time to make sure everyone performs properly. No one manager has *all* the good ideas. The collective eyes, ears and wisdom of the entire team are far more powerful in assuring safe outcomes.

The power of co-responsibility for safety is fundamental. It is the foundation of crew resource management (CRM), the defining standard for teamwork among aviation professionals.

Performance

As I have said, safety involves all members of the organization. However, aviation professionals are primarily responsible for safe performance, and safe performance starts with leadership.

In Corporate Aviation

A great leader sets people up to succeed. For someone to be successful the goals must be clear and measurable, the resources must be appropriate and the processes must be effective.

In aviation, the goals are a clear and unchangeable hierarchy of performance: safety (including security), service and efficiency.

Occasionally, the priority of those goals gets confused. A few years ago, I had a conversation with a billionaire who admitted he demanded that his helicopter crew launch into known icing conditions. His reasoning: "Why should I have aircraft if I cannot go where I want when I want?" He had not accepted the primacy of safety as the ultimate and limiting performance goal.

How do you tell a 500-pound gorilla what to do? You let an 800-pound gorilla deliver the message. To the relief of his flight crews, the billionaire's board of directors helped him understand that they wanted him around for longer than the next trip.

Safe trips start with having the right tools for the job — appropriate resources. When working on fleet plans, I ask executives, "Do you want to be limited by aircraft capacity or staff capacity?" In other words, does the corporation want to be able to fly anytime the aircraft is available (i.e., not flying and not in maintenance), or is it OK for an aircraft to be mechanically ready to go but not be flown because the pilots are out of time?

The most frequent response is they want enough pilots to perform the vast majority of trip requests. This is logical. The value delivered by flight crews is too great for most corporations to skimp on staff. But it is up to the aviation leader to clearly define the staff requirements and their limitations. Otherwise, the service delivery team will stretch themselves in an effort to do too much with too few people, raising risks.

The technical resources of corporate aviation can create a safety advantage over its commercial colleagues. The airlines are constrained by efforts to maintain fleet commonality as well as contain costs. Many corporations have a policy of aggressive investment in aviation safety; if it enhances safety, it will be fit into the budget. That is why new technologies often find their way into corporate aircraft well in advance of commercial aircraft. Fully integrated digital avionics suites are becoming the norm for new business aircraft. In addition, much of the legacy corporate fleet is being retrofitted with digital displays or augmented with supplemental screens for weather uplink, terrain awareness, airport surface moving maps, and a host of other technologies that improve the crew's situational awareness, which is a very safe thing.

The *processes* used to orchestrate these resources into action are where safe performance is truly achieved. The standard of performance usually expected by corporate executives is "best practices or better." Executives often do not know exactly what that means, nor

do most aviation professionals because, until recently, there was no practical definition of "best practices." Standard practices are established by government regulations and manufacturers' operational guidelines and limitations. These standards essentially prevent failure. They are a litany of "Thou Shalls" and "Thou Shalt Nots" designed to avoid bent metal and harmed bodies. Taking performance standards to the next level, to best practices, calls for the proactive achievement of intended outcomes, including the assurance of safety.

From a practitioner's point of view, best practices call for the clear definition of intended outcomes and the ideal processes for creating them. The next step is to monitor the processes in action and proactively manage variances to assure that performance is maintained within the expected parameters.

A practical example of this occurred when Mike May was director of aviation for Southern Company. His operation included three U.S. bases; Atlanta, Georgia; Birmingham, Alabama; and Pensacola, Florida. During one particularly thunderstormy day, Mike overheard a conversation between a relatively new captain from Birmingham and one of his Atlanta-based senior captains. The youngster was describing how bad the weather was over the Atlanta-Birmingham route and that he planned to delay his return trip until things quieted down. The senior captain from Atlanta was boasting that he had flown hundreds of flights in identical conditions and he was sure he could leave soon, as scheduled.

Mike asked the senior captain to join him in his office. In private, Mike explained to the senior captain that he needed his help in urging young pilots not to exceed their capabilities, putting aircraft and people at risk. He then asked the captain how they could do that. The ensuing conversation became the foundation for a new practice. When there is to be a judgment call, the most conservative perspective will prevail and it will be applied across the board until conditions change. In other words, on that particular day, nobody would fly between Birmingham and Atlanta until the weather improved enough to satisfy the young captain, and nobody could pressure him to change his mind.

The opposite of this safe and effective leadership behavior is a declaration by the director of aviation or maintenance that policies and standards may be amended with his or her approval. In other words, this is a declaration that the department's policies and standards are variable. This approach may appear to be high service — standards can be adjusted to make it easier to complete the mission — but it has two major flaws: it can place service above safety in the hierarchy of performance, and it clearly undermines the authority of the safety delivery team — the crew.

Crews are a critical element of one of the most effective best practices that is gaining wide acceptance: the safety management system (SMS). The core of SMS's success is the rigorous application of risk assessment and mitigation encompassing all facets of a trip. Texas Instruments (TI) uses an extremely effective multi-functional approach. Prior to each trip, the scheduler, lead aircraft technician and the crew, including the cabin safety attendant, meet to discuss the trip and all its parameters and variables — aircraft, equipment, maintenance status, passengers, cargo and baggage, times, catering, weather, airports, runways, fixed-base operators, ground transportation, etc. The goal of the meeting is at the heart of the SMS, to assure a safe and effective trip that is punctuated by no surprises. Upon the aircraft's return home, the trip is not complete until the same team debriefs the entire trip, every leg. TI has developed an effective and proactive management of the trip process that works well for them. It keeps the goals of safety, service and efficiency in appropriate order and focus. It identifies potential risks and variances, and then allows the power of team problem-solving to produce the most effective guidelines and solutions.

TI has the full complement of tools:

- A clear executive and organizational vision with a strong emphasis on safety;
- Culturally driven co-responsibility permitted by a pervasive authority to perform; and,
- Universally understood standards of performance couched in a well-documented operations manual, implemented effectively through a set of practices and processes structured around an SMS.

But TI is the exception. The vast majority of corporate aviation is being conducted with less than the complete set of tools. Even so, corporate aviation's safety rate is equal to that of the major commercial airlines. How low will our accident rate be when the TI standard becomes the norm? Let's find out together. Let's build a widespread corporate aviation safety culture. It starts with your corporation and your aviation department. ●

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Forecasting a STAR

BY WAYNE ROSENKRANS

Scientists urge aviation professionals to obtain space weather training before intense solar radiation and geomagnetic storms expected around 2012.

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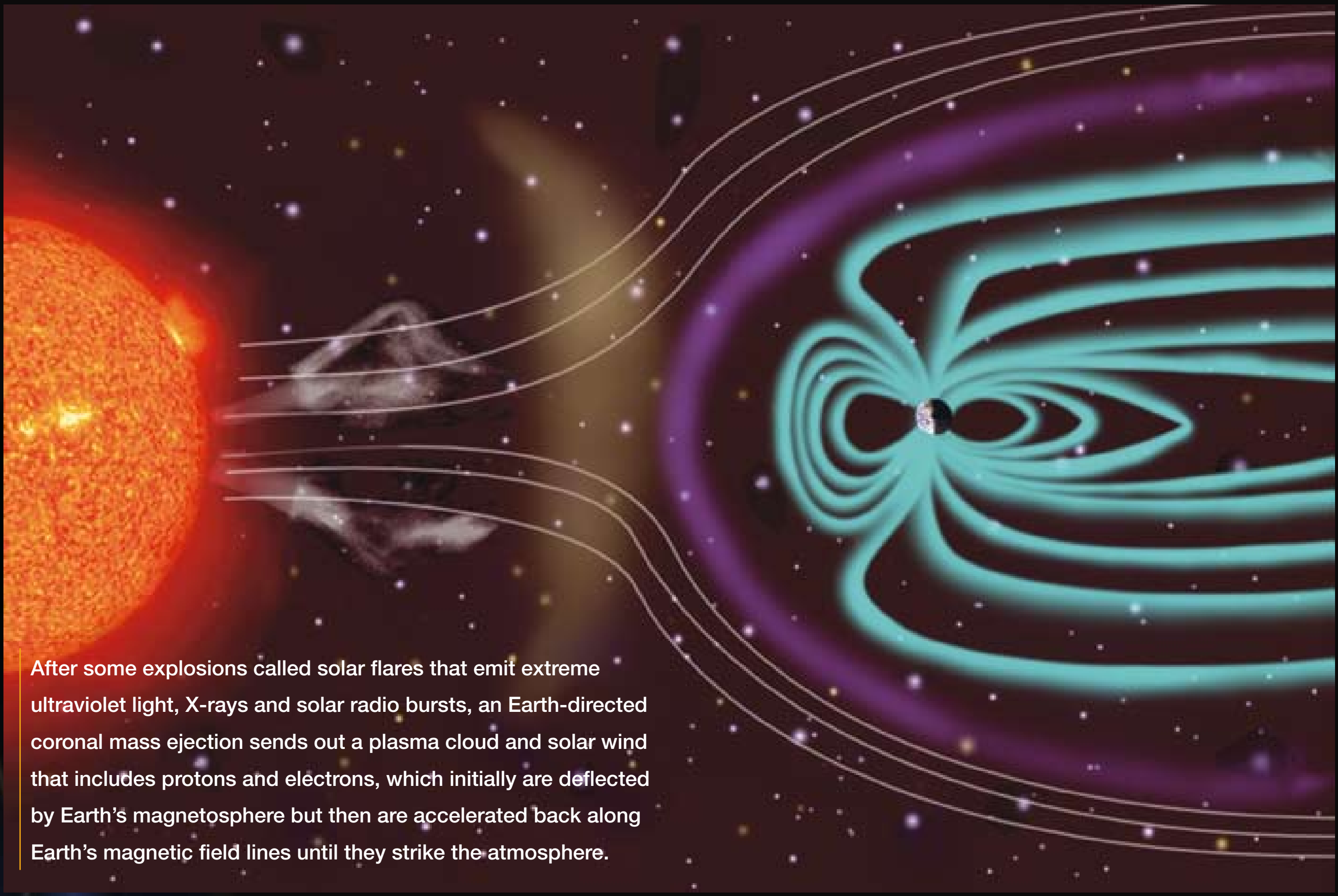
Aviation concern for space weather is not new. Dispatchers and flight crews at airlines carrying the growing volume of passenger and cargo traffic on four north transpolar routes between North America and Asia routinely conduct comprehensive checks on solar activity. But some specialists now recommend that a far wider range of aviation professionals receive training on space weather regardless of where on Earth they work. Their specific proposal says, "The U.S. Federal Aviation Administration (FAA) should define a minimum set of requirements for incorporating space weather into operational training for aircrew (pilots and cabin crew), dispatchers, air traffic controllers, meteorologists and engineers."

The report advocating this training — issued in March 2007 by the American Meteorological Society (AMS) Policy Program and SolarMetrics, a U.K. consultancy, with funding from the National Science Foundation and U.S. National Space Weather Program — cites the following internationally accepted definition of space weather by the U.S. Office of the Federal Coordinator for Meteorological Services and Supporting Research: "Space weather refers to the conditions on the sun and in the solar wind,[1] magnetosphere, ionosphere and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health." The report summarizes interviews with 50 subject specialists and products of a two-day workshop in November 2006, involving 60 space weather, government/military and civil aviation specialists.[2]

According to a June 2006 assessment of the National Space Weather Program, "When the [program] began in 1995, space weather needs of civil aviation were rarely noted, although such needs were widely recognized for U.S. Department of Defense missions, especially high-altitude



U.S. National Aeronautics and Space Administration

After some explosions called solar flares that emit extreme ultraviolet light, X-rays and solar radio bursts, an Earth-directed coronal mass ejection sends out a plasma cloud and solar wind that includes protons and electrons, which initially are deflected by Earth's magnetosphere but then are accelerated back along Earth's magnetic field lines until they strike the atmosphere.

reconnaissance missions or those in polar regions." One finding by participants in the workshop was, "Neither the aviation industry nor the space weather community has a clear understanding of the aviation industry's requirements for space weather information (e.g., content, timing, interpretation, level of risk)." The report also said, "The challenge for the scientific community is that in order to increase investment in space weather research, the aviation community needs to demonstrate a need, which requires further risk assessment of the impacts. However, the aviation community is still trying to understand why they should care about space weather."

Until this decade, airlines mainly have been concerned about space weather–related risks during high-latitude operations (above 50 degrees north) and polar operations (above 78 degrees north). "Effects include disruption in high-frequency (HF) communications, satellite navigation system errors, and radiation hazards to humans and avionics," the AMS report said. "These concerns … become even more important at all latitudes when considered within the framework for the Next Generation Air Transportation System (NextGen) … an interagency initiative to transform the U.S. air transportation system by 2025."

Pro-Training Rationale

Several events have demonstrated the relevance of space weather to aviation. In April 2007, for example, the U.S. National Aeronautics and Space Administration (NASA) said that researchers at Cornell University had confirmed that "a solar flare created an intense solar radio burst causing large numbers of receivers to stop tracking the global positioning system (GPS) signal[s]." The researchers who studied effects of two solar flares on Dec. 5–6, 2006, found that although these effects occurred during a period of minimum sunspot activity — called solar minimum — the burst produced 10 times more radio-frequency noise on Earth than they had ever recorded. “The burst produced 20,000 times more radio emission than the entire rest of the sun,” said Dale Gary, Ph.D., a physicist at the New Jersey Institute of Technology. “This was enough to swamp GPS receivers over the entire sunlit side of the Earth.”

Also in April 2007, the 12 voting members of the international Solar Cycle 24 Panel issued a consensus prediction that solar cycle 24 — the 24th cycle of quiet to stormy to quiet status since astronomers recorded the 1755–1766 cycle — would begin in March 2008, plus or minus six months. Opinion was divided as to the characteristics of the solar maximum in the new cycle: some predicted that the sunspot number would peak at 140, plus or minus 20, in October 2011; others predicted that the sunspot number would peak at 90, plus or minus 10, in August 2012.[3]

In March 2006, scientists at the U.S. Center for Atmospheric Research — using computer simulations and satellite-based observations of the sun’s interior — predicted “an increase in solar activity in late 2007 or early 2008, and there will be 30 to 50 percent more sunspots, [solar] flares and coronal mass ejections in [solar] cycle 24.” Based on their relatively new methods of helioseismology,[4] which trace acoustic waves reverberating inside the sun, this solar cycle will begin about one year later than had been predicted using older methods, according to NASA.

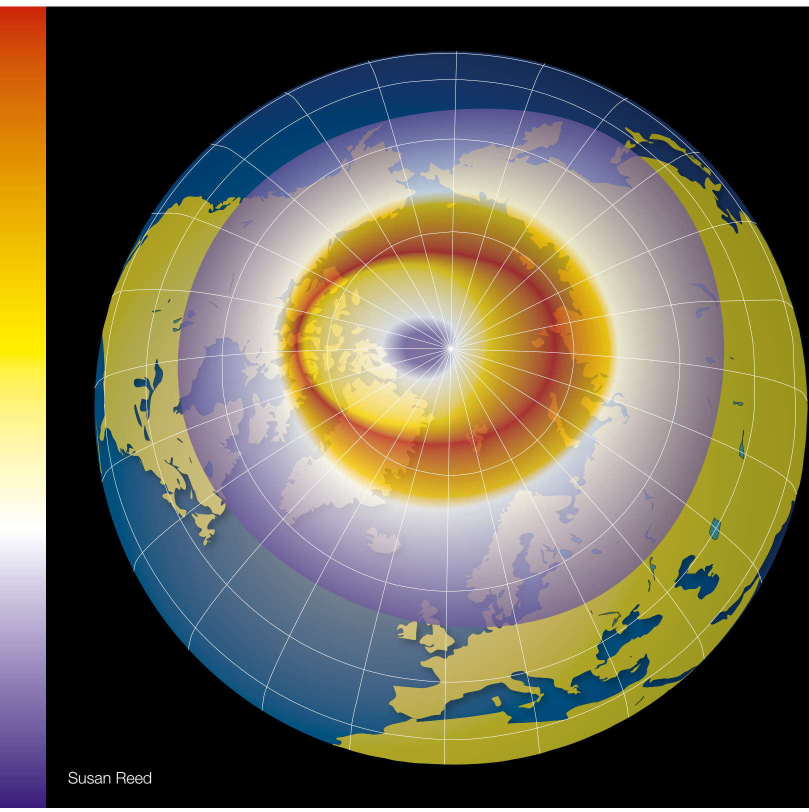
On Oct. 28, 2003, the FAA issued its first solar radiation alert, advising airlines, “Satellite measurements indicate high levels of ionizing radiation coming from the sun. This may lead to excessive radiation doses to air travelers at corrected geomagnetic latitudes above 35 degrees north, or south. Avoiding excessive radiation exposure during pregnancy is particularly important. Reducing flight altitude may significantly reduce flight doses. Available data indicate that lowering flight altitude from 40,000 ft to 36,000 ft should result in about a 30 percent reduction in dose rate. A lowering of latitude may also reduce flight doses, but the degree is uncertain. Any changes in flight plan should be preceded by appropriate [air traffic control (ATC)] clearance.”

Four transpolar routes between Asia and North America enable fuel-efficient, time-saving flights, but space weather–related time penalties can be 80 minutes for rerouting or 210 minutes if an en route stop is required.

On several days in October and November 2003, flights from the United States to Europe were conducted at lower-than-normal altitudes. According to the U.S. National Oceanic and Atmospheric Administration (NOAA), “Airlines took unprecedented actions in their high-latitude routes to avoid the high radiation levels and communication blackout areas caused by three of the largest sunspot clusters in more than 10 years. … Airlines and air traffic controllers experienced problems almost daily, including severe degradation of high-latitude communications.”[5]

The FAA’s wide area augmentation system (WAAS) for GPS also was affected by the fall 2003 space weather storms. “For a 15-hour period on Oct. 29 and an 11-hour interval on Oct. 30, the ionosphere was so disturbed that the vertical error limit, as defined by the FAA’s lateral navigation–vertical navigation (LNAV/VNAV) specification to be no more than 50 meters [164 ft], was exceeded,” NOAA said.

Teleconferences of dispatchers and space weather forecasters, sometimes held daily as requested by airlines, also have enabled airlines to conduct flights on transpolar routes when data from the sun seemed to preclude the flights. “Perhaps the best example of the value of [a space weather storm] intensity prediction was on Nov. 3, 2003, when [a solar] flare erupted," NOAA said. "Airline companies immediately assumed [that] a flare this large would surely produce a significant radiation storm. NOAA Space Environment Center (SEC) forecasters told these dispatchers that because of the source location [of the flare] on the sun, an S3 storm [the 'strong' level on the NOAA Space Weather Scales that airlines have established as their 'go/no go' threshold for transpolar



Susan Reed

Monitoring the power flux carried by solar protons and electrons just above Earth's atmosphere at the North Pole, a U.S. polar-orbiting satellite's instruments transmit data to generate color-coded statistical maps of the aurora that help airline dispatchers visualize areas where these high-speed particles produce the aurora as they collide with the atmosphere.

flights] was not likely. No route alterations were made, and the prediction materialized when a moderate-size S2 radiation storm unfolded."

Priority Policy Issues

The workshop participants agreed that priority space weather–aviation policy issues are communication that enables observations and forecasts to be integrated effectively into global flight operations; standardization of information and regulations; education and training; and cost benefit and risk analyses. To improve current practices, they proposed that the Cross Polar Trans-East Air Traffic Management Providers' Working Group — augmented by representatives of NOAA SEC and International Space Environment Services — help aviation stakeholders define future requirements; International Space Environment Services standardize the information formats; and the National Space Weather Program interact more frequently with the aviation community to ensure that future requirements factor into space weather research plans. Similarly, NextGen should be coordinated with NOAA SEC and relevant global initiatives on space weather, the report said.

Aircraft on the transpolar routes typically are equipped with GPS receivers and inertial reference units. For dispatchers and flight operations managers responsible for these flights, best practices for operating them have been refined by experience. By applying company policies for comparing data on the NOAA SEC Web page to predetermined ranges of values, and speaking with NOAA space weather duty forecasters to resolve any uncertainty, dispatchers know when they must consider rerouting flights to avoid specific transpolar routes. "Dispatchers receive space weather information from in-house meteorologists, private-sector companies and NOAA SEC alerts and forecasts, or go directly to the NOAA SEC Web site," the report said. "Typically, dispatchers … review [this Web site] and will modify polar flight plans if there is a threat of HF communication loss. … Some polar route operators will use [HF data link and] more expensive satellite communications as a backup communications medium; however, only the Iridium/Intelsat systems are available above 82 degrees north [latitude] and their installation [on] commercial aircraft is not widespread due to the costs."

Guidance Versus Regulation

Workshop participants favored additional official guidance for airlines to prepare them for the effects of space weather storms, and they said that regulators should respect the competitive requirement of a level playing field and not impose unwarranted costs. A related recommendation called for the FAA to mandate the use of space weather information by operators.

Workshop participants suggested that the FAA lead the aviation industry in collecting data about airline decisions, results and costs from using space weather forecasts; conduct related risk-benefit analysis and coordinate research studies. "Very little information

is available on how much space weather is responsible for delays or reroutes on polar routes [and related delays and costs]," the report said. "The International Civil Aviation Organization (ICAO), World Meteorological Organization, International Organization for Standardization and International Space Environment Services should harmonize their separate standards for aviation space weather information, products and services based upon a set of requirements [and] the FAA should provide [aircraft operators] with a minimum set of requirements for making decisions based on space weather information."

Beyond Transpolar Flights

Predeparture route changes and en route diversions caused by space weather storms and the resulting HF communication degradation or blackouts can affect flight operations in many world regions other than the polar regions. "[Flight crews operating in] the North Atlantic and Pacific Ocean [flight information] regions use HF for aircraft position reporting to maintain separation while outside of ATC radar coverage," the report said. "Even relatively minor space weather disturbances can seriously disrupt the HF signal, causing significant impact on these oceanic region procedures. While the newest aircraft can make use of the latest automated satellite reporting system, reducing their reliance upon HF in such regions, ATC can only communicate with older aircraft via HF. … Over vast areas of the South American and African continents, and the Indian Ocean, HF is the only means of communication. Furthermore, in some parts of central Africa, HF is the only way of communication between neighboring ATC units."

Very high frequency (VHF) radio communication also can be susceptible to effects of space weather storms. "Although less prone to interference, VHF signals can be lost in the noise produced by solar flares, a point not generally considered when investigating temporary losses of communication between aircraft and ATC," the report said.

GPS also is susceptible to space weather storm effects, according to the report. When they occur, however, the GPS receivers alert the flight crew if signals are unusable so that alternate navigation means can be used to complete the flight. "During a geomagnetic storm, the altitude of the lower boundary of the ionosphere changes rapidly and can introduce [GPS] horizontal and vertical errors of several tens of meters," the report said. "Dual-frequency satellite receivers actually measure [and correct for] the effect of the ionosphere on the satellite signals and can better adjust to, but not eradicate, these difficult circumstances."

Radiation Dose Issues

Even people who never fly are exposed to a normal background level of ionizing radiation from the particle shower produced by galactic cosmic rays. During high-altitude flight, the dose rates are greater compared with the dose rates on the ground, however, and international authorities provide analytical tools and guidance to estimate the level of health risk. "The 'particle shower' and corresponding level of radiation dose reach a maximum intensity at around 66,000 ft … and then slowly decrease with decreasing altitude down to sea level," the report said. "The dose rates also increase with increasing latitude until reaching about 50 degrees, whereupon they become almost constant. … The solar cycle can give plus or minus 20 percent variations in dose from solar minimum to [solar] maximum."

The reason for the FAA's October 2003 solar radiation alert was that energetic particles — highly accelerated protons and electrons — from solar flares increase dose rates at typical cruise altitudes all over the Earth. The critical issue for occupants of aircraft operating in polar and high-latitude regions is that the dose rate also increases more rapidly because of geomagnetic storms than because of increasing altitude and/or latitude. "Most solar flares emit protons with energies … [that] can produce [ionizing radiation] increases at aircraft altitudes and, on average, there have been approximately three events per solar cycle with sufficient intensity and energies to produce significant radiation in the atmosphere," the report said. The Earth's magnetic poles are especially vulnerable because of the shape and properties of the planet's magnetic field; geomagnetic storms weaken everywhere on Earth the protection provided by the magnetic field. "The Earth's magnetic field does offer some protection, but [ionizing radiation] particles can spiral down the [magnetic] field lines, entering the upper atmosphere in the polar regions where they produce additional ionization in the ionosphere and increase the radiation at aircraft altitudes," the report said.

Avionics Vulnerability

Despite protective design engineering and flight procedures, satellites have experienced temporary errors or permanent failures during space weather storms. Although these are more rare in large commercial jets or business jets — because avionics have been designed to continue functioning during the most severe space weather storms known, and because of the protection of Earth's ionosphere and magnetic field — avionics engineers remain vigilant. "The [space weather storm] hazard can … increase the risk of errors or failures in micro-electronic components installed in aircraft systems (e.g., flight and engine management computers)," the report said. "New technologies will increasingly use smaller and smaller microelectronics, thereby further increasing the risks. … The electronic components of aircraft avionics systems are susceptible to damage from the highly ionizing interactions of cosmic rays, solar particles and the secondary particles generated in the atmosphere. This can corrupt systems leading to erroneous commands … [or] high current drain, leading to burnout and hardware failure."

Closing Policy Gaps

Discussion of ICAO's relevant standards and recommended practices led workshop participants to conclude that few currently apply to space weather reports and forecasts. "Annex 15, *Aeronautical Information Services,* does allow for issuance of a notice to airmen for solar radiation, but provides very little guidance for message content," the report said. "The ICAO International Airways Volcano Watch Operations Group … is assessing needs for information about solar radiation storms."

During NOAA SEC's Space Weather Workshop in April 2007, the authors of the AMS–SolarMetrics report discussed the next steps in their sponsoring organizations' initiative to promote space weather training to aviation professionals. The steps include briefing/meeting with committees of the U.S. Congress in July 2007; another aviation-oriented workshop Nov. 29–30, 2007; and further development of the policy framework and implementation of report recommendations until August 2008.[6]

Public interest in space weather — especially how it will affect society's reliance on communication and navigation technologies in civil aviation and other critical industries — prompted many scientists to revisit the geomagnetic "superstorm" of August and September 1859, the top-ranked event in the modern history of space weather storms.[7] One team's historical detective work at NASA Goddard Space Flight Center documented how telegraph services all over the world had been disrupted, ship captains at sea had observed vivid auroras at extremely low geomagnetic latitudes, and in many parts of the United States, red and white light from clouds in the night sky had been bright enough for people to read outdoors. Moreover, an English astronomer's 1859 observations of sunspots with an advanced telescope around the time of the superstorm — and his groundbreaking deductions about the causal relationship between the dates and times on his sunspot drawings and the strange phenomena observed in Earth skies — helped to launch the quest for the knowledge on which current transpolar flights now depend.[8] ●

For an enhanced version of this article and links to space weather information, go to <www.flightsafety.org/asw/june07/spaceweather.html>.

Notes

1. The term "solar wind" describes the continual outward flow of protons, electrons and magnetic field from the sun in all directions.
2. Fisher, Genene; Jones, Bryn. "Integrating Space Weather Observations and Forecasts Into Aviation Operations." American Meteorological Society (AMS) and SolarMetrics, March 2007. Fisher is a senior policy fellow of the AMS; Jones, CEO of SolarMetrics, is an airline captain and space weather research scientist.
3. Biesecker, Douglas; Solar Cycle 24 Panel. "The Solar Cycle 24 Consensus Prediction." A presentation to the U.S. National Oceanic and Atmospheric Administration (NOAA) Space Environment Center (SEC) Space Weather Workshop. April 2007.
4. Helioseismology is the study of the solar interior structure and dynamics by analysis of the propagation of acoustic waves through the sun's interior.
5. National Weather Service, NOAA, U.S. Department of Commerce. "Service Assessment: Intense Space Weather Storms October 19–November 7, 2003." April 2005.
6. Fisher; Jones. "Results From the Aviation and Space Weather Policy Workshop." A presentation to the Space Weather Workshop, April 24, 2007.
7. Odenwald, Sten; Green, Jim; Boardsen, Scott; Cliver, Edward. "The 1859 Geomagnetic Superstorm." A presentation to the NOAA SEC Space Weather Week conference, April 2006.
8. Clark, Stuart. *The Sun Kings: The Unexpected Tragedy of Richard Carrington and the Tale of How Modern Astronomy Began.* Princeton University Press, 2007.

CFIT in Queensland

Metro pilots lost the big picture during a difficult approach.

BY MARK LACAGNINA

U.S. National Oceanic & Atmospheric Administration (NOAA)

An experienced pilot with a history of noncompliance with standard operating procedures (SOPs), an inexperienced and nonassertive copilot, excessive airspeeds and descent rates during a nonprecision approach in bad weather, and the operator's disregard of its own rules and training standards were found to have played roles in the May 7, 2005, crash of a Fairchild Metro 23 in Queensland, Australia.

In its final report, the Australian Transport Safety Bureau (ATSB) said, "The accident was almost certainly the result of controlled flight into terrain [CFIT] — that is, an airworthy aircraft under the control of the flight crew was flown unintentionally into terrain, probably with no prior awareness by the crew of the aircraft's proximity to terrain." Both pilots and all 13 passengers were killed in the accident, which occurred near Lockhart River.

The Metro 23 and eight other aircraft were operated by Transair from its main base in Brisbane and ancillary bases in Cairns, Grafton and Inverell.[1] The company employed 21 full-time pilots.

The morning of the accident, the flight crew had flown the Metro from Cairns to Lockhart River and Bamaga. The accident occurred on the return trip to Cairns, on the leg from Bamaga to Lockhart River (Figure 1).

Exceeding the Limits

The pilot-in-command (PIC), 40, held an airline transport pilot license and had 6,072 flight hours, including 3,249 flight hours in Metros. He was employed by Transair as a line pilot in March 2001, promoted to supervisory pilot in September 2002 and to Cairns base manager in August 2003.

The report said that there were no records indicating that the PIC had received training on crew resource management (CRM), as required by the *Transair Operations Manual*.

The PIC had a history of noncompliance with SOPs. A previous employer had placed him on probation for not following company procedures. Flight data recorder (FDR) data from the accident aircraft indicated that descent rates and airspeeds had exceeded those specified by Transair's SOPs during two previous instrument approaches conducted by the PIC. Several Transair copilots had expressed concern to a supervisory pilot that the PIC did not follow company procedures, including airspeed limits. One copilot said that the PIC would slow down only if asked to do so by a copilot he respected. Another copilot said that he had to be assertive to prevent the PIC from descending below the minimum sector altitude.

"The chief pilot [of Transair] reported that he could not recall ever receiving any specific

Accident Flight Route

Source: Australian Transport Safety Bureau

Figure 1

Fairchild SA-227DC Metro 23

@ Craig Murray/Airliners.net

Designer Edward J. Swearingen's Merlin corporate/business aircraft first flew in 1965 with Pratt & Whitney Canada PT6A-20 engines. All subsequent versions of the Merlin and its longer-fuselage, 19-passenger regional airline derivative, the Metro, have had Garrett, now Honeywell, TPE331 engines.

The original SA-226TC Metro was introduced in 1969 and was replaced in 1974 by the Metro II, which has larger windows and improved systems. The SA-227AC Metro III, introduced in 1981, has longer wings, a higher useful load and more powerful engines. Maximum takeoff weight was increased from 14,500 lb (6,577 kg) to 16,500 lb (7,484 kg) with the introduction of the more powerful SA-227DC Metro 23 in 1990.

The Merlin/Metro series was produced by Swearingen Aircraft Co., Fairchild Aircraft Corp. and Fairchild Dornier. Production was terminated in 1999.

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

complaints about the operational performance of the PIC," the report said. The chief pilot was the managing director of Transair and also served as training director and as one of the company's two check pilots.

The copilot, 21, held a commercial pilot license and had 655 flight hours, including 150 flight hours in Metros. He had no experience in turbine aircraft or multi-pilot operations before being employed by Transair in March 2005. "A family member reported that the copilot was given a training manual to study and was not provided with any formal classroom training during his ground school," the report said. His records indicated that he had passed aircraft ground training despite earning a score of 77 percent on a test of aircraft systems and operating limitations; the company operations manual required a minimum score of 80 percent. The copilot also was not checked by a check pilot, as required by the manual, before he began line operations.

"Pilots who flew with the copilot reported that he was keen to learn," the report said. "The copilot's flying ability and systems knowledge were generally reported as being consistent with his flying experience." The copilot also was described by colleagues as quiet, shy and nonassertive.

The PIC and copilot previously had flown together on 10 days, completing 27 flight sectors. The copilot had told other Transair pilots that the PIC was difficult and authoritarian, and that he did not provide effective instruction and did not comply with SOPs.

Bad Weather

Before departing from Bamaga at 1107 local time, the PIC told a ground agent that the weather was bad at Lockhart River and that they might not be able to land there.

The forecast winds were from 130 degrees at 15 kt, gusting to 25 kt. The crew elected to conduct the area navigation/global navigation satellite system (RNAV/GNSS) approach to Runway 12, which had a minimum descent altitude (MDA) of 1,040 ft — or 120 ft lower than the MDAs for the RNAV/GNSS approach to Runway 30 and the nondirectional beacon (NDB) approach.

The airport did not have a control tower. The automatic weather station at the airport recorded only wind direction and velocity, temperature and rainfall data. A meteorological observer performed observations three times a day but did not have the capability to communicate directly with pilots. The observation performed at 1200 the day of the accident did not include information on visibility or cloud bases.

The report said that Australian Bureau of Meteorology estimates indicated that "the cloud base was probably between 500 ft and 1,000 ft above mean sea level, and the terrain to the west of the aerodrome, beneath the Runway 12 RNAV/GNSS approach, was probably obscured by cloud."

The PIC likely was the pilot flying because recorded radio transmissions were made by the copilot. There was no record of communication between the pilots because the cockpit voice recorder (CVR) had malfunctioned and provided no usable data for the last 30 minutes of the flight.

The copilot had an endorsement on his instrument rating to conduct NDB approaches, but he was not endorsed for RNAV/GNSS approaches. There was no record that he had received company-required training on the use of global positioning system (GPS) equipment as the sole source of navigation information.

"The crew commenced the … RNAV/GNSS approach, even though they were aware that the copilot did not have the appropriate endorsement and had limited experience to conduct this type of instrument approach," the report said.

Complex Procedure

The approach procedure was relatively complex, and the crew's workload during the approach likely was very high (*ASW*, 2/07, p. 46). The aircraft was not equipped with an autopilot.

"There was a significant potential for [CRM] problems within the crew in high-workload situations, given that there was a steep trans-cockpit authority gradient and neither pilot had previously demonstrated a high level of CRM skills," the report said. "A steep gradient between a dominant PIC and a submissive copilot may result in the PIC not listening to the concerns of the copilot and/or the copilot being less willing to communicate important information to the PIC."

The report also said that the copilot's lack of training and experience in conducting RNAV/GNSS approaches might have made it difficult for him to detect deviations during the approach.

At 1139, the copilot announced on the airport's common traffic advisory frequency (CTAF) that the Metro was over "Whiskey Golf" — the LHRWG waypoint, an initial approach fix — and was inbound to "Whiskey India" — LHRWI, the intermediate fix, which was 12.5 nm from the runway threshold (Figure 2).

Unstabilized Approach

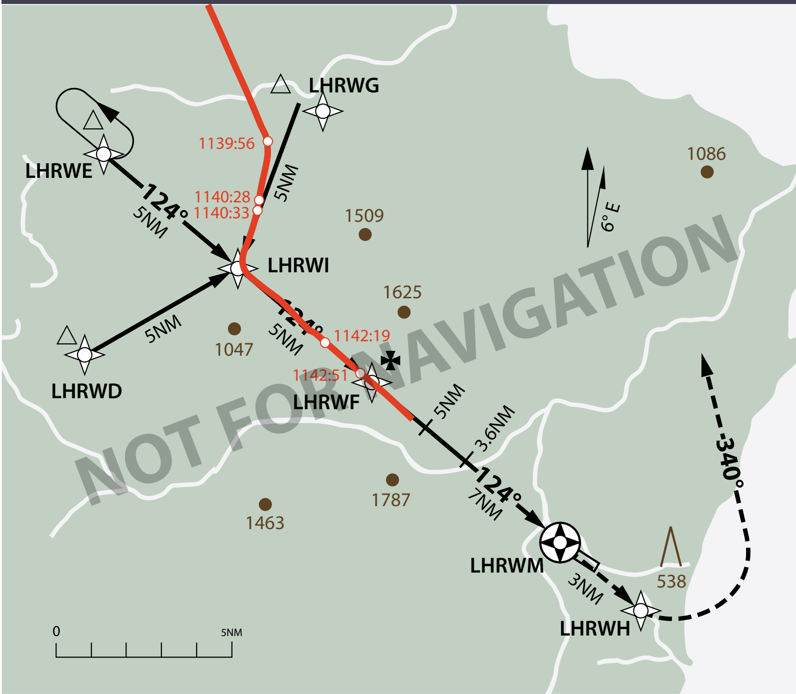
FDR data indicated that the aircraft accurately tracked the final approach course. However, airspeeds and descent rates exceeded those specified in the *Transair Operations Manual* and those appropriate for a stabilized approach, the report said. The company operations manual did not provide specific guidance for conducting a stabilized approach.

The report cited the elements of a stabilized approach recommended by Flight Safety Foundation that include a maximum speed of V_{REF}, landing reference speed, plus 20 kt and a maximum descent rate of 1,000 fpm.[2]

An appropriate approach airspeed for the Metro under the existing conditions would have been about 130 kt. FDR data indicated that airspeed was about 226 kt when the aircraft crossed the initial approach fix and about 176 kt as it crossed the intermediate fix.

The aircraft then descended from 3,500 ft to 3,000 ft and remained at that altitude momentarily (Figure 3, p. 32). "During this level flight,

Approach Track



Source: Australian Transport Safety Bureau

Figure 2

the aircraft's speed reduced to the maximum half-flap extension speed (180 kt) and the flaps were extended [to half of their travel]," the report said. "The aircraft did not descend below the segment minimum safe altitude (2,200 ft) during this initial descent and leveling."

Soon after the landing gear was extended, about 1.4 nm from the final approach fix, the aircraft began to descend at 1,000 fpm. Airspeed was about 177 kt when the aircraft crossed the final approach fix. Power then was reduced, and the descent rate increased. Airspeed remained about 175 kt and the average descent rate was 1,700 fpm during the last 48 seconds of the flight. The aircraft descended below 2,060 ft, the published minimum altitude for the approach segment, soon after crossing the final approach fix.

"The higher-than-specified speeds and rates of descent reduced the amount of time available to the crew to configure the aircraft for the approach, accomplish the approach procedures and maintain their awareness of their position on the approach," the report said.

Turbulence was encountered during the last 25 seconds of the flight, which further increased the crew's workload. The report said, however, that there was no indication that the aircraft encountered wind shear.

Two GPWS Alerts

The crew likely received two ground-proximity warning system (GPWS) "TERRAIN, TERRAIN" alerts. Postaccident simulations of the aircraft's flight path indicated that the first alert would have occurred about 25 seconds before impact. The second alert would have been followed by continuous "PULL UP" warnings for the final five seconds of the flight. FDR data indicate that the crew did not respond to either alert.

However, the simulations also indicated that a GPWS "TERRAIN, TERRAIN" alert could result during a normal descent on final approach in aircraft with flaps in the approach configuration, even if the aircraft was established on the constant descent angle and/or above the segment minimum safety altitude. The report said that GPWS alerts that occur during normal operations increase the chances that pilots will ignore them in other situations.

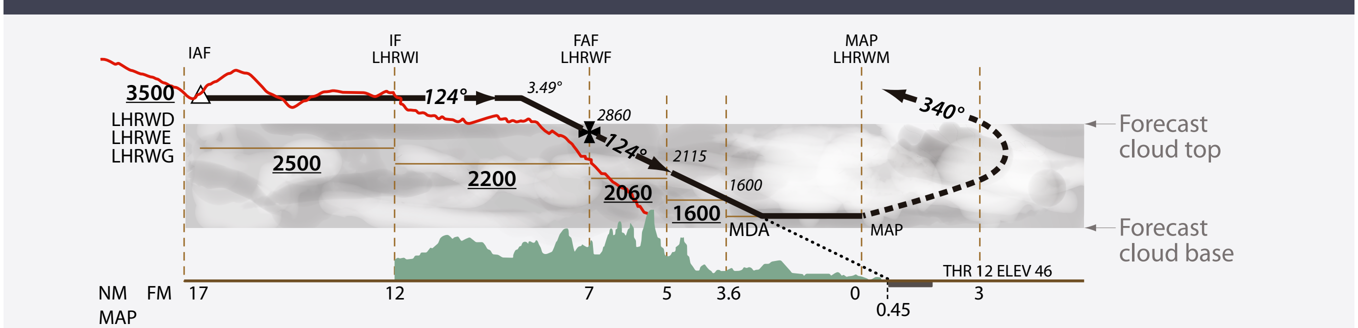
The second GPWS alert came too late. "There would have been insufficient time for the crew to effectively respond to the GPWS alert and warnings that were probably annunciated during the final five seconds prior to impact," the report said.

The accident likely would not have occurred if the aircraft had been equipped with a terrain awareness and warning system (TAWS), which provides predictive terrain-hazard warnings, the report said.

At 1143, the aircraft struck trees at 1,210 ft — about 90 ft below the crest of the northwest slope of South Pap, a heavily timbered ridge in the Iron Range National Park — about 11 km (6 nm) northwest of the airport. This high terrain was not depicted on the approach chart (see sidebar, p. 33). Initial impact occurred 850 ft below the published minimum altitude for the approach segment. "The aircraft was destroyed by the impact forces and an intense, fuel-fed, post-impact fire," the report said.

Investigators found no indication in the FDR data that a flight control or power plant problem occurred before impact. "There were no radio transmissions made by the crew on the air traffic services frequencies or the Lockhart River CTAF indicating that there was a problem with the aircraft or crew," the report said.

Approach Profile



ELEV = elevation FAF = final approach fix FM = from IAF = initial approach fix IF = intermediate fix MAP = missed approach point MDA = minimum descent altitude NM = nautical miles THR = runway threshold

Source: Australian Transport Safety Bureau

Figure 3

Chart Safety Factors

"Safety factors" related to the design and charting of area navigation/global navigation satellite system (RNAV/GNSS) approach procedures were identified by the Australian Transport Safety Bureau (ATSB) in its final report on the Transair Metro 23 accident.[1] The report cited the importance of communicating these factors, even though they were not found to have contributed to the accident.

Among the cited safety factors was the unique method used by Airservices Australia to name waypoints. The report said that the similar, unpronounceable five-letter names cause chart clutter and make it difficult for pilots to distinguish waypoints shown on charts or displayed by on-board global positioning system (GPS) equipment.

"There was also no regulatory requirement for instrument approach charts … to include colored contours to depict terrain, as required by International Civil Aviation Organization (ICAO) Annex 4, to which Australia had not notified a difference," the report said.

The Transair flight crew likely used Jeppesen charts, rather than Airservices Australia charts, during the accident flight. The report said that the Jeppesen chart for the RNAV/GNSS approach to Runway 12 at Lockhart River had several design aspects that "could lead to pilot confusion or a reduction in situational awareness." Examples included limited information on distance to the missed approach point (MAP), nonalignment of information on the plan view and profile view, the typography used for waypoint names and minimum segment altitudes, and the absence of information on the offset, in degrees, between the final approach course and the runway centerline.

As of 2005, more than 350 RNAV/GNSS approach procedures had been designed by Airservices Australia and approved by the Australian Civil Aviation Safety Authority (CASA) based on ICAO criteria.

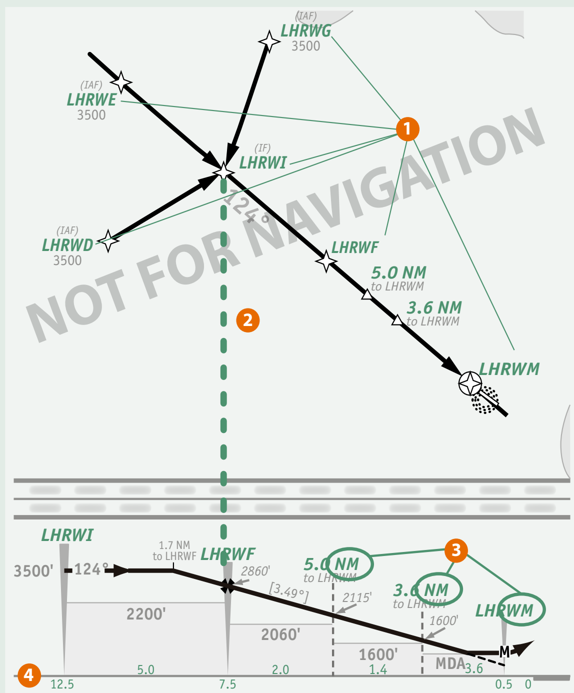
The five-letter waypoints for these procedures are shown on charts in uppercase. The first three letters identify the airport, the fourth indicates the general direction from which the aircraft travels on final approach, and the fifth is a standard letter that identifies the purpose of the fix — for example, "I" for intermediate fix, "F" for final approach fix and "M" for missed approach point (*ASW*, 2/07, p. 47). Thus, the only variation in the waypoint names for a specific approach is the last letter.

"Research has shown that people can automatically (that is, instantly) identify a number among letters, but when identifying a letter among other letters, identification is slower," the report said. "Research also has shown that when searching for a letter in three-letter or five-letter sequences, the time taken to detect the letter increases the further its position is moved from the first letter."

The information alignment factor on the Jeppesen chart resulted from the absence in the profile view of the initial approach fixes — LHRWD, LHRWE and LHRWG. The first waypoint in the profile view is the intermediate fix, LHRWI. This caused LHRWI in the plan view to be aligned vertically with LHRWF in the profile view. The report said that this can cause a pilot to become confused when scanning the chart.

Another factor specific to the Jeppesen chart is the use of the same typeface and type size for waypoints and the stepdown fixes — 5.0 NM and 3.6 NM — on the final approach segment. The report said that this results in similar appearance of the letter "M" in the stepdown fixes and in LHRWM, and could lead to misidentification of the MAP in high-workload situations.

In addition, the stepdown fixes on the Jeppesen chart are the only specific



1. Similarity of waypoint names may make them more difficult to differentiate.
2. The vertical alignment of two different waypoints may cause confusion.
3. Labels end with the same letter and use the same typeface and size for different information.
4. The lower set of numbers shows the distances to the runway, but not to the missed approach point. The upper set of numbers shows the distance for each segment to the missed approach point, but not the distances from a waypoint to the missed approach point.

Source: Australian Transport Safety Bureau indications of distance to the MAP. The scale at the bottom of the profile view shows distances to the runway threshold. The scale below the profile view on the Airservices Australia chart, on the other hand, shows distances to the MAP.

Because of terrain northwest of the airport, the approach procedure is relatively complex. The final approach course is offset five degrees from the runway centerline because of a mountain northwest of the airport — the 1,787-ft obstacle spot elevation depicted on the plan view (Figure 2, p. 31). The constant descent angle is 3.49 degrees, rather than the optimal 3 degrees. The distance from the final approach fix to the MAP is 7 nm, rather than the optimal 5 nm. The stepdown fixes for the final approach also resulted from terrain considerations. The report said that these factors add to pilot workload and increase the chances for position confusion.

Neither the Airservices Australia chart nor the Jeppesen chart depicts terrain with color contours, as required by ICAO under specific conditions, such as when the final approach gradient is steeper than 3 degrees. The report said that the charts provide no indication of the existence of high terrain under the approach path, such as the ridge struck by the Metro.

ATSB recommended that these safety factors be considered when designing and approving RNAV/GNSS approaches. "There are limited options available to overcome these design problems," the report said. "However, the overall influence that these variations can have needs to be considered by CASA when evaluating and deciding whether to accept the approach."

— ML

Note

1. The Australian Transport Safety Bureau defines safety factor as "an event or condition that increases safety risk" and one that, if repeated, "would increase the likelihood of an occurrence [accident or incident] and/or the severity of the adverse consequences associated with an occurrence."

Deficiencies Uncovered

The report said that factors contributing to the accident included limitations in Transair's safety policies and procedures, and deficiencies in regulatory oversight of the company.

"In particular, [Transair's] flight crew training program had significant limitations, such as superficial or incomplete ground-based instruction during endorsement training, no formal training for new pilots in the operational use of [GPS] equipment, no structured training on minimizing the risk of CFIT and no structured training in CRM (or human factors management) and operating effectively in a multi-crew environment," the report said.

The company's SOPs lacked clear guidance on approach speeds, aircraft configuration, elements of a stabilized approach and standard phraseology for challenging another crewmember's decisions and actions.

ATSB made no recommendations regarding Transair, because the company surrendered its air operator certificate and ceased operations in December 2006.

ATSB did, however, recommend improvements to government surveillance of regular public transport operators. The report said that the Australian Civil Aviation Safety Authority (CASA) "did not provide sufficient guidance to its inspectors to enable them to effectively and consistently evaluate several key aspects of [Transair's] management systems. These aspects included evaluating organizational structure and staff resources, evaluating the suitability of key personnel, evaluating organizational change and evaluating risk management processes."

In November 2006, CASA told ATSB that it was recruiting personnel with management and safety management expertise to improve its surveillance of operators. In March 2007, CASA said that it "has [provided] and continues to provide substantial guidance material in all aspects of surveillance." ATSB responded that it still believed that the guidance provided to inspectors "was and is inadequate" and recommended "further work to address this safety issue."

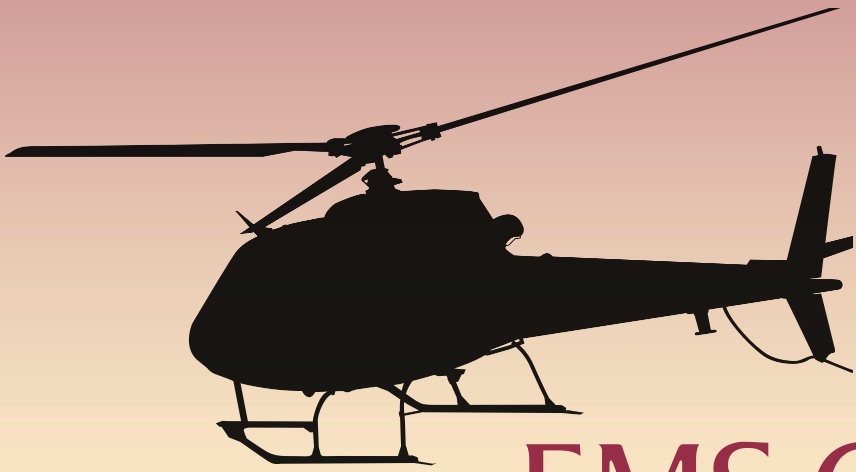
The report noted that CASA was taking action to address other recommendations, including the implementation of regulations requiring regular public transport operators to provide CRM training and to have a safety management system.●

This article is based on Australian Transport Safety Bureau Transport Safety Investigation Report 200501977, "Collision With Terrain, 11 km NW Lockhart River Aerodrome, 7 May 2005, VH-TFU, SA227-DC (Metro 23)." The 532-page report contains illustrations and appendixes.

Notes

1. "Transair" was the trading name for Lessbrook Proprietary Limited, which operated the accident aircraft under its air operator certificate.

2. Flight Safety Foundation (FSF). "Killers in Aviation: FSF Task Force Presents Facts About Approach-and-Landing and Controlled-Flight-Into-Terrain Accidents." *Flight Safety Digest* Volume 17 (November–December 1998) and Volume 18 (January–February 1999).



During final approach, the AS 350B3 pilot could not move the cyclic.

BY MARK LACAGNINA

EMS Control Loss

Investigators were unable to determine why a loss of control occurred during an emergency medical services (EMS) flight the night of Dec. 14, 2004, in Apache Junction, Arizona, U.S. The final report by the U.S. National Transportation Safety Board (NTSB), issued in late April 2007, discussed four previous control system discrepancies encountered by pilots of the Eurocopter AS 350B3 and a phenomenon called "hydraulic servo transparency."[1] However, the report contained no analysis of the findings of the investigation.

The helicopter was operated by Petroleum Helicopters Inc. (PHI). The pilot was on duty at the company's EMS crew facility at Williams Gateway Airport in Phoenix at 2200 local time when she was assigned to pick up an accident victim at a shopping mall about 9 nm (17 km) away, and to transport the patient to a hospital.

The pilot held a commercial rotorcraft pilot certificate and had 4,604 flight hours in helicopters. After being hired by PHI in October 2001, she accumulated 80 flight hours as pilot-in-command (PIC) of AS 350B3s, 300 flight hours as PIC of Messerschmitt-Bolkow-Blohm BO-105s and 300 flight hours as PIC of Bell 206Ls. She also had 2,631 flight hours as a Robinson R22 flight instructor.

The pilot conducted preflight checks of the helicopter and had the engine running when two medical crewmembers arrived for the flight. The helicopter departed from the airport at 2229.

Parking Lot Approach

Police and firefighters secured a landing area in a mall parking lot. Fire trucks were positioned at all four edges of the designated landing area. The pilot circled the area several times and discussed obstructions, including tall light poles and power lines, with ground personnel.

Visual meteorological conditions prevailed, and a local weather-observing station was reporting variable winds. However, the pilot said that the winds were calm at the landing site. She maneuvered the helicopter to conduct an approach from the northeast.

After clearing power lines on final approach, the helicopter was about 100 ft above ground level and had been slowed to 20 to 25 kt when the nose gently rose and moved right. The pilot said that when she used cyclic control to correct the movement, the helicopter rolled left "significantly and violently" and began to spin. The report said that the pilot, who was wearing a non-noise-canceling headset, remembered seeing the hydraulic system warning light illuminate but did not hear the aural warning.

The pilot saw shopping-mall buildings nearby and applied full-left cyclic control to avoid colliding with them. "She then grabbed the cyclic with both hands and pulled back and right, but it did not move," the report said. "The anti-torque pedals appeared to work and stopped the spin." Two witnesses said that they heard a hissing sound, similar to the bleeding of airbrake pressure in a large truck, as the helicopter descended.

The helicopter struck the landing area in a steep nose-down and left-side-down attitude at 2237. The left side of the nose section was crushed, the left landing skid failed, the main rotor blades fragmented, and the tail boom was broken at the attachment point with the fuselage. One medical crewmember was killed; the other medical crewmember and the pilot received serious injuries.

A substantial amount of fuel was spilled onto the parking lot, but there was no fire. "The engine continued to run after the ground impact, and [the surviving medical crewmember] and multiple rescue personnel moved numerous switches in the cockpit in an attempt to shut down the engine, hence all postimpact switch positions were unreliable [for investigation purposes]," the report said. Firefighters stopped the engine by spraying fire-suppressant foam into the intake.

Control Discrepancies

The accident helicopter was manufactured in 1999 and had accumulated 2,496 hours of service. The report said that during the three months preceding the accident, four flight control discrepancies had been reported. The reports cited stiffness of the flight controls, excessive control inputs required for normal flight and unwarranted activations of the hydraulic system warning light and horn.

"The most recent write-up was one month prior to the accident," the report said. "The company maintenance department's corrective actions included cleaning the control system bearings, replacing the hydraulic system actuators and repairing damaged electrical wiring and cannon plugs."

Postaccident inspections and functional testing of the helicopter's hydraulic system components found no indication of preimpact failure or malfunction. "The hydraulic system accumulators were found to still have an unquantified amount of pressure," the report said.

Servo Transparency

The report said that NTSB investigators discussed the hydraulic servo transparency phenomenon with Eurocopter engineers and flight test pilots. The phenomenon, also called "control reversability," can occur during maneuvers that result in increased loading on the helicopter and rotor system. The load thresholds vary according to helicopter speed and gross weight, and atmospheric density altitude.

"As explained by Eurocopter, when the helicopter reaches a threshold

Eurocopter AS 350B3

© Sun Valley Aviation/Jetphotos.net

G-loading for the phenomenon onset, the hydraulic system does not have enough pressure available to move the main left lateral, right lateral and fore/aft servos against the dynamic forces being fed back from the rotor system into the controls," the report said. "At the onset of servo transparency, the flight controls essentially go from boosted to manual reversion, where they remain until the G-loads decrease below the onset threshold values."

Eurocopter's chief test pilot for the AS 350 program told the NTSB that when the phenomenon begins, the pilot typically feels the collective control moving down and the cyclic control moving right.

"Eurocopter personnel stated that the transparency phenomenon is nonviolent and transitory, lasting only 2 to 3 seconds, at most, due to the 'self-correcting actions of the pilots' to reduce the G loads and/or the natural static and dynamic stability response of the helicopter," the report said. "They also stated that the controls are fully operable throughout the entire transparency event; however, the force required to effect movement of the flight controls against the rotor system dynamic feedback loads would increase significantly."

Test Switch Guarded

The AS 350 has 36 backlighted, push-on/pull-off switches on its systems control pedestal. Among them is the hydraulic system test — "HYD TEST" — switch, which is located next to the landing light switch. "Depressing the switch shuts off the hydraulic pump for preflight system checks, in part to ensure that the pressure accumulators for the servo channels are pressurized and working," the report said.

The "HYD TEST" switch in the accident helicopter was found in the "OFF" position, which is the correct position for normal flight.

Postaccident test flights were conducted to determine the time intervals between selection of the "HYD TEST" switch to the "ON" position and loss of lateral hydraulic servo accumulator assistance to flight control inputs. The times varied from 45 seconds during a straight-in approach at 80 kt using excessive control inputs, to 3 minutes 30 seconds during a straight-in approach at 80 kt with minimal control inputs.

The report noted that after the accident, PHI designed, fabricated and installed guards over the "HYD TEST" switches in its fleet of Eurocopters. In November 2005, Eurocopter issued Service Bulletin 67.00.32, which presents procedures for installing a protection flap over the pedestal switches, and in January 2006 began incorporating the protection flap in production helicopters. ●

Note

1. U.S. National Transportation Safety Board accident report LAX05FA053.

The Underwriter's Perspective

© Carlos Santa Maria/Fotolia

Aviation insurers focus on airline safety practices that surpass baseline expectations.

BY WAYNE ROSENKRANS

Aviation insurers perceive the airline industry as one of the world's most highly regulated and safest, yet they still focus on each airline's risk-management orientation and its maturity within an industry sector and region, sometimes called its geosocial area, says Steve Doyle, global practice manager for Aon Aviation. Insurance brokers and underwriters also expect risk management by each airline to be the proactive side of the safety equation and aviation insurance to be the reactive side; so, when an airline handles risk management well, it is likely to elicit a favorable response from underwriters, Doyle said.

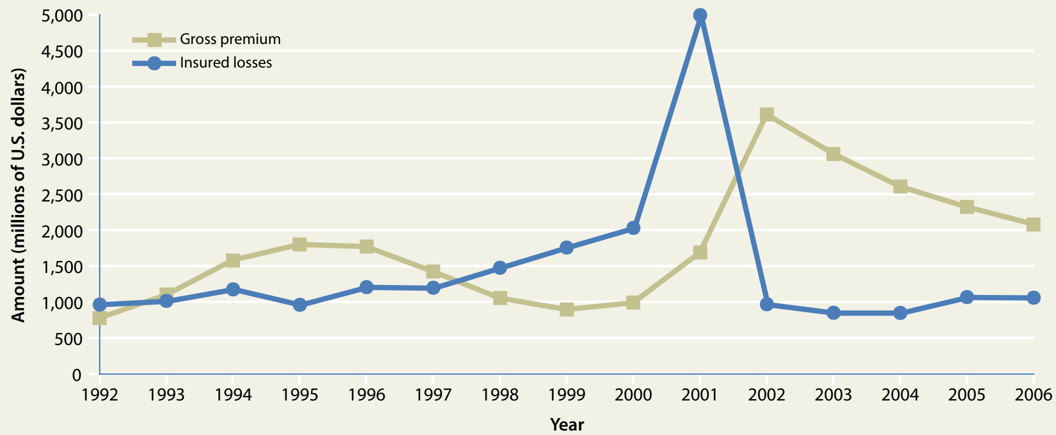
"From an aviation insurer's perspective, pricing — that is, catastrophe coverage limits for fairly low levels of premium — is reflective of the risk profile of a very safe industry," he said. "So, insurers today are reacting to the claims experience of the industry (Figure 1, p. 38) while, on the proactive side, the airlines are managing their risks to reduce the overall level of claims."

More than ever, insurers are attuned to collective efforts by the airline industry that demonstrate safety awareness and the capability to continue reducing the risk of accidents. In mid-2007, the International Air Transport Association (IATA) Operational Safety Audit (IOSA) program is a common interest.

"There is a baseline for the airline industry in IOSA, so it is only a question of 'How much better than the baseline are you?'" Doyle said, citing similarities between the interests of IOSA auditors and insurance underwriters. "The challenge is any airline's differentiation over and above that baseline — and over and above peers in terms of the adoption of technology, etc. If everybody or nearly everybody passes IOSA, it is a question of whether those not on the IOSA registry would be 'punished' by higher insurance premiums rather than whether those with IOSA would be credited. IOSA already is reflected much more in risk pricing than perhaps it was previously."

A Very Cyclic Aviation Insurance Market

Premium Versus Losses, 1992–2006



Note: The expected worldwide gross premium for aviation insurance is $1.5 billion for 2007, including an average $1.5 million per airline.

Source: Göran Forsberg

Figure 1

Spotlighting IOSA

Some observers consider the recognition of airlines' collective safety efforts by insurers to be mutually beneficial. "Clearly, the mandating of IOSA as a prerequisite for IATA membership is a force for good," said David Gasson, secretary general of the International Union of Aviation Insurers (IUAI). "It is also clear that passing an IOSA audit will carry some weight with an insurer. That said, insurers still require independent risk surveys of airlines when they believe circumstances merit it. In addition, the weight given to IOSA audits in risk evaluation will vary from underwriter to underwriter."

Giovanni Bisignani, director general and CEO of IATA, said in an April 2007 speech that the association recently has applied the IOSA concept, designed for airlines, to airport ground handling through a new program called the IATA Safety Audit for Ground Operations (ISAGO). "Standard[s] development is under way, and the first audits will take place in 2008," Bisignani said. Notably, the IUAI is providing advice on risk management and insurance while participating in the IATA steering group that is introducing ISAGO, Gasson said.

Carole Gates, IATA's director of risk management and insurance, also has seen aviation insurers taking into account IOSA participation and implementation of a safety management system (SMS) as they examine each airline's risk profile and determine the premium to be charged. "Insurers have been actively involved in maintaining … aviation liability insurance, which is key to airlines' ability to operate," Gates said. "Insurers and brokers work together to provide risk-management assistance to their clients — particularly if there are areas of concern or special issues to be addressed, such as a recent fatal accident."

IATA also has been promoting more effective interaction within airlines between operations risk managers and the corporate financial risk managers, who interact most frequently with the aviation insurance broker and the lead insurance underwriter. "The purpose of our Integrated Airline Management System guide is exactly that: to engage risk managers and operations personnel in the overall assessment and control of risk," Gates said. "This was our objective in combining the two audiences in Montreal at our April 2007 conference, which was attended by over 600."

When an airline proposes safety improvements during insurance negotiations, some insurers offer incentives or participate financially. "Aviation insurers make investments in airlines that wish them to do so, and generally make available funds built into placement slips — an amount of money set aside in the insurance purchase contract that can be used by the airline for risk-management activity — and that activity subsequently will be reflected in the risk pricing," Doyle said. Examples of safety improvements financed this way include comprehensive risk-management programs, consulting work by third-party specialists, programs for closer monitoring of daily operations, upgrading high-visibility clothing and procedures for placing safety cones around parked aircraft.

Similar Issues Long Ago

Observing the competition among several U.S. insurance groups to provide coverage to airlines in the late 1920s, Stephen Sweeney, an assistant professor of insurance at the University of Pennsylvania, told the 1928 meeting of the U.S. Casualty Actuarial Society (CAS) that although "the average operator does not know much about insurance," several developments were important. "Rates were materially reduced," Sweeney said. "Practically all aviation rates are the results of pure judgment. … As actuaries, you will probably be dissatisfied for some time to come with the aviation data available for rate-making purposes. … I think we might list [general considerations for coverage] as the pilot, the plane itself, the engine and the territory of operations. There have been attempts made to analyze these to determine their relative importance. Probably it is the consensus that the pilot is the most important element from the standpoint of the underwriter. … [An airline's] poor housekeeping, incomplete inspection routine, unsound financing, superficial experience in the case of those in charge of operations, undue pressure on pilots to take great chances — these are some of the things that must be watched for and guarded against most zealously by the underwriter who would survive."[1] Five years later, W.P. Comstock noted in a paper presented to the CAS, "Pilots are being educated to recognize that safety is as much dependent upon careful flying as upon structural design. … Casualty companies should point the way to safety in aviation and when necessary should establish their own safety standards."

After six more years, Barbara Woodward in a paper presented to the CAS meeting said, "For these reasons [that is, a wide range of airplane values and uses, and rapid changes in design and operating conditions], it can be seen that the time for placing aircraft insurance on an actuarial basis has not yet arrived. … A fundamental proposition for arriving at a proper rate is, however, followed by [two U.S. aviation insurance] groups in making rate quotations; namely, that the hazard in connection with any aviation risk is directly related to the amount of flying which is done." Commenting in 1939 on Woodward's paper, John A. Mills said, "The insurance companies are contributing their share towards promoting greater safety in flying through safety engineering. … Although statistics so far developed have been limited, they have nevertheless served a useful purpose in arriving at a base rate and also in judging the approximate proportion of the losses attributable to each of the major hazards connected with flying. Questions asked a prospective [airline] by aviation underwriters are designed to provide the underwriter with all data having an important bearing on the causes and circumstances surrounding airplane accidents. The underwriter knows the approximate part of the pure premium attributable to each of the factors on which information is required,

"When the Boeing 747 was introduced in the early 1970s [after its rollout ceremony below in September 1968], airlines paid so much more than they pay today to insure a 747," said Göran Forsberg, an aviation insurance manager based in Sweden.

Boeing Commercial Airplanes

and the final rate quoted recognizes within practical limits the extent to which the individual risk can be expected to vary from the average."

Where Credit Is Due

In 2007, insurers' perspectives of airline safety tend to differ from those within an airline primarily in terms of scale, according to Doyle. "Global aviation insurers write insurance coverage and accept financial risk from the global airline industry as a whole," he said. "The fundamental principle is that the losses of the few are paid for by the many (Table 1), so although your airline is part of the many and has had no losses, if the industry as a whole has had losses, then your part of the global premium 'pie' is going to increase. If your geographic region has had an experience of losses and your industry sector has had an experience of losses, then you are in a different position than airlines outside that region or outside that sector."

"As brokers … we take the view that increased exposure is not necessarily translating into increased claims."

One complication for operations risk managers who welcome insurers' influence (*ASW,* 3/07, p. 22) is that some factors still do not translate between the two domains. Insurers focus more on the claims levels, the average cost of awards by courts for passenger liability, the global loss experience by aircraft type, the compliance of infrastructure in the airline's areas of operation with standards of the International Civil Aviation Organization, and the degree of political stability, Doyle said. Professionals in both domains, however, pay attention to potential risks linked to the growth of airlines and air traffic.

"Insurers take the view that because the airlines are growing, their exposure is growing, and that is very true," he said. "As brokers, we emphasize the strengths in the overall risk profile of an airline and we take the view that increased exposure is not necessarily translating into increased claims — that claims levels today are no higher in actual dollar terms than they were in excess of 15 years ago, and are less than they were pre-9/11 [Sept. 11, 2001, when four U.S. commercial jets were destroyed in a terrorist attack]. So, while the airline industry has demonstrated massively increased exposures, the level of losses — one of the key factors that drives the market and insurance pricing — has not increased, but the potential has increased as award levels have increased."

Limiting Common Practices

Airlines logically may be expected to have different explanations for specific safety improvements. "This is especially true as no airline wants to be named in connection with an accident due to the reputational loss that may follow," Gasson said. "Risk surveys, inspections, meetings, discussions and conferences of airlines and underwriters are common in today's aviation market," he said. "Good examples are alliances and code-share agreements, where all involved airlines want to benefit and therefore put a further positive emphasis on safety."

From the insurers' perspective, the

Top 10 Aviation Disasters by Cost of Insured Loss to Aviation Insurers

Losses incurred[1] as of Feb. 22, 2007

Airline	Date	Location	Fatalities	Loss (U.S. Dollars)
American Airlines	Sept. 11, 2001	New York, New York, U.S.	2,911	1,500–1,900 million
United Airlines	Sept. 11, 2001	New York, New York, U.S.	65	1,650–1,800 million
American Airlines	Nov. 12, 2001	Queens, New York, U.S.	265	~ 700 million
Alaska Airlines	Jan. 31, 2000	Pacific Ocean, U.S.	88	~ 400 million
SriLankan Airlines	July 24, 2001	Sri Lanka	0	~ 400 million
Singapore Airlines	Oct. 31, 2000	Taipei, Taiwan, China	83	~ 380 million
EgyptAir	Oct. 31, 1999	International waters	217	~ 340 million
American Airlines	Sept. 11, 2001	Arlington, Virginia, U.S.	188	~ 270 million
American Airlines	June 1, 1999	Little Rock, Arkansas, U.S.	10	~ 230 million
SAS Scandinavian Airlines	Oct. 8, 2001	Milan, Italy	118	~ 200 million

~ = approximately

Note:

1. Aircraft hull, passenger liability and third-party liability.

Source: Göran Forsberg

Table 1

absence of conformity in many of these practices is by design. "Every underwriter needs to analyze and interpret the information available and decide if she/he wants to insure the risk and the premium to be charged," Gasson said. "There cannot be and must not be a common approach, bearing in mind antitrust rules and regulations. This is where the independent risk assessment may provide the final evidence to influence the underwriting decision. It must never be forgotten that the aviation insurance market is fiercely competitive. Loss frequency is decreasing while loss severity is increasing, and this makes the pricing process even more difficult."

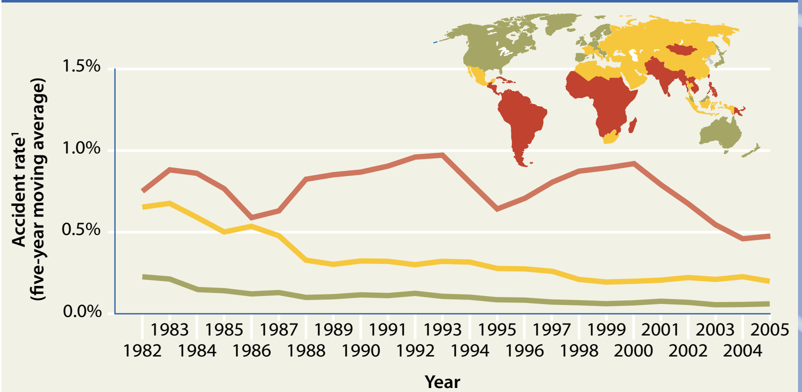
One actuarially oriented method used by underwriters is to assign airlines to geosocial areas (Figure 2) by accident rates, age of aircraft and onboard technology, regulatory oversight, infrastructure and various other factors, said Göran Forsberg, general manager, International Insurance Co. of Hannover Ltd. England Filial, and a member of the Flight Safety Foundation (FSF) European Advisory Committee. This practice also enables airlines to distinguish themselves from peers within a geosocial area, Forsberg said. Significant safety improvements can be easier to achieve, technically speaking, for airlines in the most challenging geosocial environments, he emphasized.

"From the passengers' point of view, the perception of the global airline industry would be affected very positively if operators in these geosocial areas improved their safety," he said. "To do that, they need a combination of modern technology of fourth-generation aircraft, an SMS, intense utilization of the FSF *Approach and Landing Accident Reduction Tool Kit,* etc. Not the least is auditing under IOSA, so the question we often ask airlines is 'Have you done the IOSA audit?'"

In contrast, one of the most difficult challenges is further safety improvement among airlines in geosocial areas that already have adopted best practices and achieved the world's lowest accident rates. In these areas, the costs of any accident to insurers are vastly higher because of the level of liability based on passenger demographics, jurisdiction and the typical awards/settlements for fatalities and injuries in

An Actuarial Perspective of Accidents by Geosocial Area

Worldwide Large Operators, 1982–2005



Note:

1. Large commercial jet total loss accidents as a percentage of the total fleet of these aircraft in each color-coded geosocial area.

Source: Göran Forsberg

Figure 2

some developed countries. "The costs of indemnification in these areas probably would be on the higher end of the scale," Forsberg said.

The lead insurer selected by the broker has the best opportunity to assess and influence an airline's risk-management efforts. "We are a lead insurer in the Nordic area so when we have a Nordic airline, we ask the questions from a checklist, discuss their attitudes toward audits and SMS, rate the particular exposures and set terms and conditions of the policy," he said. "We have our own actuarial approach to risk assessment, including a proprietary information technology–based rating tool." Aircraft generation, size of airline and geosocial area are three of the factors considered by the rating tool, he said.●

Notes

1. In proceedings of the annual meetings of the U.S. Casualty Actuarial Society: Sweeney, Stephen B. "Aircraft Insurance." 1928. Comstock, W.P. "Aviation Casualty Insurance." 1933. Woodward, Barbara H. "Aviation Insurance." 1938. Mills, John A. 1939.

2. Forsberg, Göran. "Aviation Insurance: The Way It Works." In proceedings of the Flight Safety Foundation European Aviation Safety Seminar, Amsterdam, March 13, 2007, and interview by Wayne Rosenkrans, April 4, 2007.

Faulty procedures were partly to blame for the failure to reinstall the center wing fuel tank purge door in a Boeing 777 after maintenance, the U.K. AAIB says.

© Ian Kirby/Airliners.net

The failure by maintenance personnel to reattach a fuel tank purge door inside the left main landing gear bay of a British Airways Boeing 777-200 was a causal factor in an incident in which a vapor trail of fuel streamed from the center wing tank after takeoff, the U.K. Air Accidents Investigation Branch (AAIB) said.

In its final report on the June 10, 2004, incident, which occurred on departure from London Heathrow Airport, the AAIB said that, after being told that a crew waiting at the runway holding point had seen a trail of smoke coming from their airplane, the flight crew of the Zimbabwe-bound 777 declared an emergency, determined that the "smoke" actually was leaking fuel, jettisoned enough fuel to reduce the airplane to maximum landing weight and returned to Heathrow for a normal landing. Although the report noted that the leak created "potential for a wheel-well fire," the airplane was not damaged and none of its 166 occupants was injured.

When a maintenance technician inspected the airplane after its arrival at the gate, he "noticed a few drips of fuel on the left main landing gear but none on the ground," the report said. "After opening the left inboard main gear door, he detected a distinct smell of fuel. An inspection inside the gear bay revealed that the center fuel tank purge door was not in place [Figure 1, page 44]. The purge door was hanging on a lanyard inside the fuel tank, and a plastic bag was attached to the purge door opening. The bag contained fuel

and the screws that would normally hold the purge door in place."

The report said that the plastic bag was the same type that was used at the British Airways maintenance facility at Heathrow and at British Airways Maintenance Cardiff (BAMC), the operator's subcontracted maintenance organization in Wales, where the airplane had undergone maintenance between May 2 and May 10, 2004.

The maintenance was a 2C check — conducted on British Airways 777s every 1,500 days or 8,000 cycles or 24,000 flight hours, whichever occurs first — that included two tasks requiring access to the center wing fuel tank: an internal inspection of the rear spar and a check of the bonding of the tank's float switches (Figure 2, page 45). Safe entry into a center wing fuel tank requires that all fuel first be removed and fuel vapors be purged.

The maintenance organization used a purging procedure discussed in the aircraft maintenance manual (AMM) that required removal of seven fuel tank access doors — but not the purge door.

A separate AMM entry — not cross-referenced in the discussion of the purging procedure — said that the purge door should be opened by attaching a lanyard to the door; unfastening the bolts, washers and clamp ring that hold the door in place; and using the lanyard to lower the door into the tank. Later, after a maintenance technician enters the fuel tank, he or she should remove the purge door from the airplane, the entry said.

The maintenance organization used job cards — also called certification cards — that contained instructions on how to complete specific maintenance procedures, such as draining the center wing tank. Each job card listed the tasks involved in the procedure; for each task listed, one box was stamped when the task was completed and a second box was stamped to certify that it had been completed correctly. The stamps were numbers that were assigned to each member of the maintenance staff to identify which one had performed a particular task. If any nonroutine action was taken — such as removal of the purge door as part of the job of purging fuel vapors from the center wing fuel tank — a licensed aircraft engineer (LAE) was required to produce relevant "defect cards" — such as one card for removal

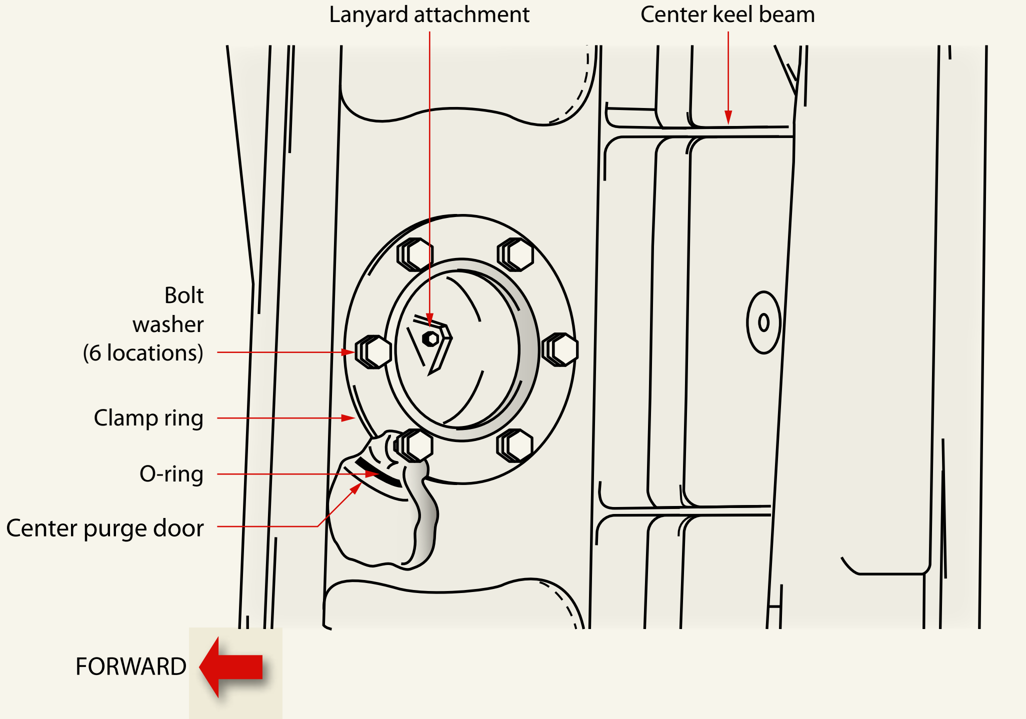
OPEN DOOR

BY LINDA WERFELMAN

© Steve Flint/Airliners.net

Leaking fuel trails the British Airways Boeing 777 after takeoff from London Heathrow Airport.

Boeing 777 Purge Door Installation



Source: U.K. Air Accidents Investigation Branch

Figure 1

of the purge door and a second card for its reinstallation.

In this instance, removal of the purge door was not recorded on a defect card, and there was no card for the door's reinstallation.

Unaware of the Purge Door

During the investigation, interviews with 10 maintenance personnel who had been working near the center wing tank revealed no one who remembered having removed the purge door or who was aware that anyone else had removed it. Seven of the 10 were even unaware that 777s have a purge door.

The technical team leader (TTL) who certified the completion of the draining and purging of the center wing tank had been promoted to TTL one month before the work was performed on the incident airplane. He had undergone training for the 777 technical type rating about 18 months before the incident but worked primarily on 747s, in which purge-door-removal procedures allowed for the purge door to remain hanging on a lanyard inside the tank and to be reinstalled by using the lanyard to pull it back into position. His team of two technicians and one mechanic also worked primarily on 747s.

A review of maintenance records revealed a previous instance in which a purge door was removed from the center wing tank of a 777 without an accompanying defect job card. In that instance, in February 2004, an experienced TTL observed the open purge door while he was conducting the rear spar inspection and ordered a defect card for its reinstallation.

'Confusing Diagram'

He also wrote a "query for engineering advice note" (QEAN), in which he questioned the rear spar inspection procedure outlined in the AMM and requested "clarification as to whether it was the front spar or the rear spar that needed inspecting," the report said.

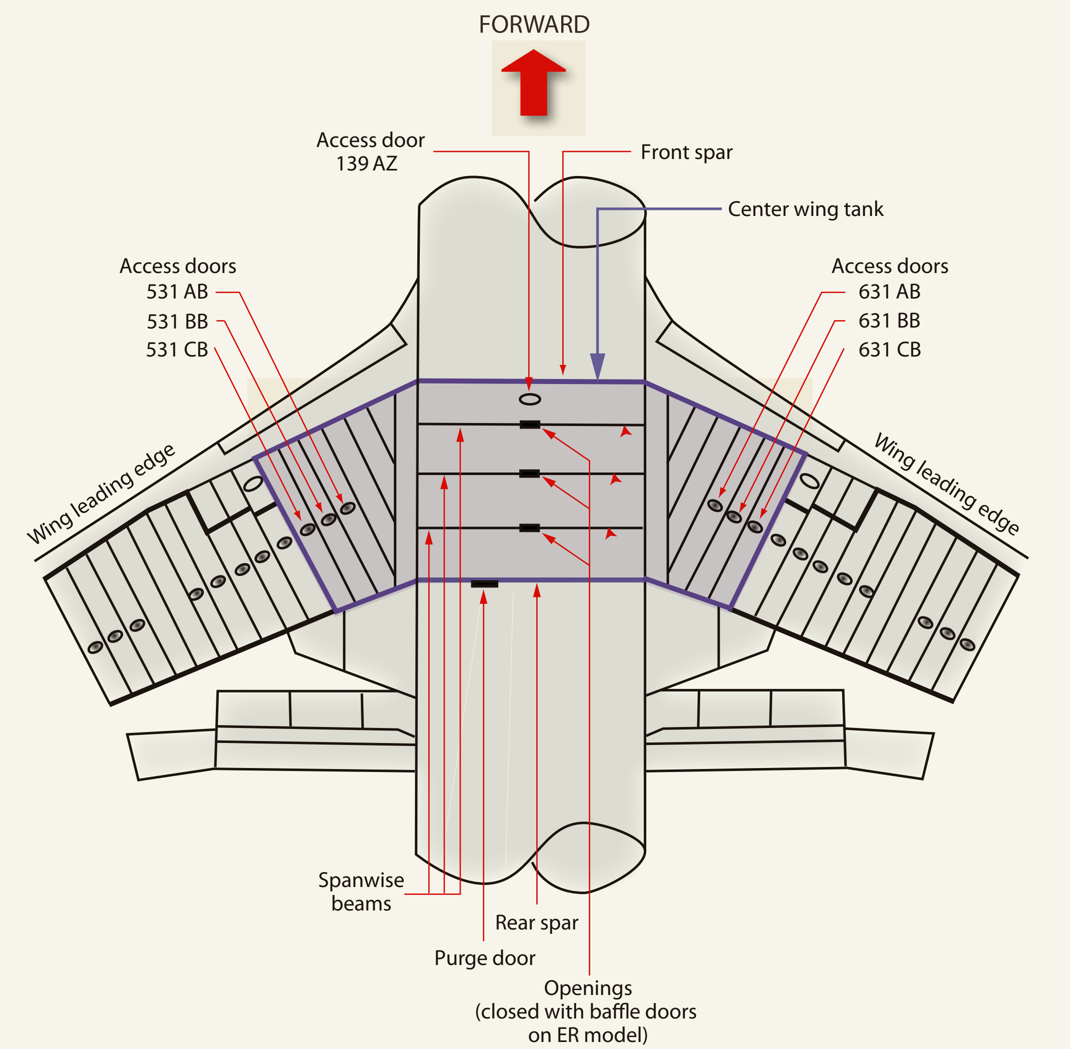
A technical services engineer responded the next day, saying that the rear spar required inspection and that he would contact Boeing to question a diagram on the Boeing task card, which "incorrectly showed the front spar … as the area to be inspected," the report said.

"No action was taken to withdraw the confusing diagram or to highlight its errors to other maintenance staff," the report said. "Also, no action was taken to determine if rear spar inspections on previous aircraft had been carried out correctly."

The technical services engineer sent a fax to the manufacturer on March 16, 2004, outlining problems with the rear spar inspection diagram; Boeing's first response, sent March 23, was lost and was sent again April 15, after a second query from the maintenance organization. The response confirmed that the rear spar was the area to be inspected and said that a corrected diagram would be issued. The correction was included in the May 5 revision of the AMM and the Boeing task cards, which were received by the operator on June 8 — one month after maintenance was performed on the incident airplane.

The maintenance technician who conducted the inspection on the incident airplane had

Boeing 777 Center Wing Fuel Tank Configuration



Source: U.K. Air Accidents Investigation Branch

Figure 2

"No action was taken to withdraw the confusing diagram or to highlight its errors to other maintenance staff."

never conducted a similar inspection and had never been inside a 777 center wing fuel tank. He complied with the incorrect illustration on the job card, and, as a result, he did not enter the rear section of the center wing tank where the purge door was located or remove three baffle doors, which were designed to limit rapid fuel movement within sections of the center wing fuel tank as a result of changes in the airplane's attitude and which should have been removed to perform the inspection.

"A potential opportunity to detect the open purge door was lost when the rear spar inspection was carried out in the wrong location because of an error in a diagram in the … AMM," the report said. "The maintenance organization was aware of the error in the AMM diagram and had notified the aircraft manufacturer, but no action was taken to communicate this fact to production staff."

In his query to Boeing, the technical services engineer also noted that the rear spar inspection procedure did not mention the need to remove the baffle doors, but he did not specifically ask for advice on what to do with them; the reply from Boeing did not mention the baffle door issue.

Recurring Question

The issue had been raised at the maintenance organization before — about two years before the incident, when a production engineer requested that routine job cards be produced for the removal and reinstallation of center wing tank baffle doors. A planning engineer prepared a QEAN about the absence of any reference to the baffle doors in the AMM; the response from Boeing indicated that the question had been misunderstood, but "technical services [at the maintenance organization] appeared to overlook this discrepancy and no further action was taken," the report said.

"Several routine procedures should have revealed the open purge door, but they all failed."

In June 2003, the planning engineer wrote another QEAN, restating his question. The report said that a technical services engineer responded that the question had been raised with the manufacturer and that "these changes will come, but at this present time, they are slow and we unfortunately cannot pressurize Boeing to speed up."

This response was incorrect, the report said. Boeing had closed the issue after responding to the question the previous year, and the maintenance organization had never resubmitted its question.

Although the maintenance organization had been aware of the missing baffle-door reference, routine job cards had never been created for removal and reinstallation of the baffle doors, the report said.

As a result, defect cards were required each time baffle doors were removed. On several occasions, however, they were removed but there were no corresponding defect cards; the report characterized this as "an unacceptable practice that may have contributed to the unrecorded removal of the purge door."

After the center wing fuel tank was closed, leak checks were conducted. The TTL who conducted the checks could not remember the specific amount of fuel used for the check, but the report said that it probably was the 40,000 kg (88,184 lb) "catch-all" amount that maintenance personnel typically used to ensure that all access doors were secure.

The AMM said that 30,900 kg (68,122 lb) of fuel was sufficient for a leak check of all center wing fuel tank access doors, but the "Fuel Leak Detection" procedure did not discuss the purge door. The separate purge door-removal procedure said that refueling the center wing fuel tank with at least 32,000 kg (70,547 lb) of fuel was required for a leak check of the purge door. However, after the incident, it was determined that 32,000 kg was not sufficient to reach the base of the purge door opening. The AMM subsequently was revised to include the correct figure — 52,163 kg (114,999 lb).

The report said, "Several routine procedures should have revealed the open purge door, but they all failed. Firstly, the paperwork failed because no defect card was raised indicating that the purge door had been opened. Secondly, tank inspection before its closure failed because the rear spar inspection was carried out in the wrong location and because the engineers closing the tank did not know the purge door existed. Thirdly, the 'safety net' leak checks failed because the job cards and the AMM [center wing tank] leak check procedure did not refer to the purge door. Moreover, the purge door leak check fuel quantity was incorrect, and the engineer carrying out the leak checks did not know about the purge door."

After the maintenance check, the airplane was flown 53 sectors before the incident flight. During that time, the highest recorded fuel load was 26,800 kg (59,083 lb) — about half the amount that would have been necessary for fuel to leak because of the missing purge door, the report said.[1]

There was no record of any maintenance that would have required opening the left main inboard gear door after the 2C check and before the incident flight. Without such maintenance, there was no opportunity to observe the missing purge door; the area where the door was located could not be seen from the ground when the left inboard main landing gear door was closed, the report said.

The maintenance organization had a system for the reporting of maintenance errors, but such errors were not routinely reported, the report said (see "Defining the Blame Boundary"). Since the incident, analysis of maintenance

Defining the Blame Boundary

A six-month review of British Airways Maintenance Cardiff (BAMC) quality discrepancy reports (QDRs) — which concerned items "of an airworthiness nature relating to aircraft maintenance operations/procedures" — revealed no reports of internal maintenance errors, the U.K. Air Accidents Investigation Branch (AAIB) said.

"However, it is known that maintenance errors were occurring because they were being reported by the operator once aircraft had returned to service," the AAIB said in its report on the incident involving the Boeing 777-200 fuel leak.

"The extent of the lack of internal maintenance error reporting could not be determined, but it was discovered that on at least one previous occasion [in February 2004], the purge door had been removed but not recorded as removed. This event was not reported at the time but was revealed during the investigation. Had it been reported and thoroughly investigated, the lessons learned could have prevented [this subsequent] incident."

The report cited several possible reasons that maintenance errors were not being reported under the QDR system, which required reporters to identify themselves. These reasons included the would-be reporter's fear of being blamed or fear that a colleague would be blamed, or a belief that "no effective action would be taken to prevent a recurrence," the report said.

The maintenance organization had a disciplinary policy designed to deal with cases of "misconduct" and "gross misconduct," but the policy did not discuss what types of maintenance errors would fall into each category, or what types of disciplinary action might be taken in case of a self-reported maintenance error, the report said. In addition, for some employees, it was unclear where the "blame boundary" lay.

"The company's disciplinary policy did not set clear boundaries, and it did not encourage uninhibited reporting," the report said. "The company did not have investigators who had been pre-identified … and the investigators, including the investigator of [this incident], did not receive any formal maintenance error investigation training. There was no formal feedback process following an incident investigation, and in cases where disciplinary action was taken, very limited information was made available."

— LW

Further Reading From FSF Publications

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

error data has begun in an effort to identify and prevent future errors.

Causal Factors

The investigation identified four causal factors:

- "The center wing tank was closed without ensuring that the purge door was in place;
- "When the purge door was removed, defect job cards should have been raised for removal and refitting of the door, but no such cards were raised;
- "The center wing tank leak check did not reveal the open purge door because the purge door was not mentioned within the AMM procedures for purging and leak-checking the center wing fuel tank; with no record of the purge door removal, the visual inspection for leaks did not include the purge door; [and] the fuel quantity required to leak check the purge door was incorrectly stated in the AMM; [and,]
- "Awareness of the existence of a purge door on the Boeing 777 was low among the production staff working on [the incident airplane,] due in part to an absence of cross references within the AMM."

As a result of the investigation, the AAIB issued safety recommendations calling on BAMC to — among other things — "actively encourage" personnel to inform managers of problems with procedures discussed in job cards and AMMs and promptly remedy the problems, and to "identify and publish clear disciplinary policies and boundaries relating to maintenance errors to encourage uninhibited internal reporting of maintenance errors." Other recommendations called for BAMC to ensure that its maintenance error management system complies with elements recommended by the CAA and to ensure that its TTLs adequately disseminate information from TTL meetings to personnel on their teams. Another recommendation said that British Airways should conduct a safety audit of BAMC after the maintenance organization had addressed other safety recommendations.

After the incident, both BAMC and Boeing took "significant safety action" to address the issues identified during the investigation, the AAIB said. BAMC, after an internal investigation, delivered presentations to employees on the risks of unrecorded work, developed new procedures for the identification and storage of temporarily removed parts, revised the job cards used for work involving center wing tanks and upgraded the QEAN system to ensure that issues would not be closed or forgotten before they were addressed.

Boeing published several documents discussing the purge door, including an all-operator message, and revised several sections of the AMM — including discussions of purge door removal and reinstallation, and rear spar inspection — and related task cards.

In addition, British Airways took several related actions, including an audit of BAMC job cards. Of 2,200 cards for a maintenance D check, 61 were identified with "highest-risk" deficiencies and about 500 with lower deficiencies; all were addressed by BAMC, the report said. ●

This article is based on AAIB accident report no. 2/2007, "Report on the Serious Incident to Boeing 777-236, G-YMME, on Departure From London Heathrow Airport on June 10, 2004."

Note

1. Fuel records showed that the last time before the incident that the center wing fuel tank contained more than 52,163 kg (114,999 lb) was on Feb. 10, 2003 — an indication that the purge door was in place on that date. Maintenance records showed no maintenance between Feb. 10, 2003, and the 2C check in May 2004.

MembershipUPDATE

Heating Up in Tucson

Last month's 52nd annual Corporate Aviation Safety Seminar (CASS) was a very hot ticket and the most successful CASS ever, with more than 443 registrants from 10 countries participating in the three days of events and presentations. Also setting new high water marks were the 35 exhibiting companies and the 19 sponsors.

Next year, the CASS will be at the Innisbrook Resort and Golf Club in Palm Harbor, Florida, April 29–May 1.

On the FSF Web Site

Established in November 1995, the FSF Web site has been a storehouse of valuable aviation safety information. Supported by our 1,080 individual members and organizations in 142 countries, the Web site continues to expand its content and services. Some of the current content improvements and service enhancements are highlighted here:

AeroSafety World

All published issues of *AeroSafety World* and its predecessor *Aviation Safety World* are available in Adobe portable document format (PDF) for download at no charge. Issues can be downloaded in their entirety or by individual articles. The seven publications superseded by *AeroSafety World* in July 2006 will remain available for download in PDF format.

E-mail Subscription Service

Sign up on the Web site home page to receive free e-mail notification of Flight Safety Foundation publications, including *AeroSafety World,* plus news releases, seminars and other special events. Provide your contact information and select your areas of interest. You will receive a direct link via e-mail each time an item in one of the selected interest areas is posted to our Web site.

Site Search

The FSF Web site is now using Google's Custom Search Engine — harnessing the power of this industry-leading search technology to return highly accurate results from users' queries.

Ground Accident Prevention (GAP)

In 2003, the Foundation launched the Ground Accident Prevention (GAP) program to develop information and products (GAP e-tools) to reduce the risk of accidents and incidents that occur on airport ramps and adjacent taxiways, and that directly affect airport operations and/or result in personnel injuries or damage to serviceable aircraft, facilities or ground-support equipment. Current GAP e-tools are: "Best Practices for Safely Towing Aircraft," Part One; "Best Practices for Safely Towing Aircraft," Part Two; GAP Cost Model; and GAP Leadership Tip Sheets. ●

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

Unsafe Acts

A study finds more similarities than differences in error patterns among crewmembers on accident aircraft in Australia and the United States.

BY LINDA WERFELMAN

A study of errors by flight crewmembers involved in aviation accidents in Australia and the United States found that the patterns of errors were "remarkably similar" and that skill-based errors — such as omitting a checklist item or fixating on a task — were the most common.[1]

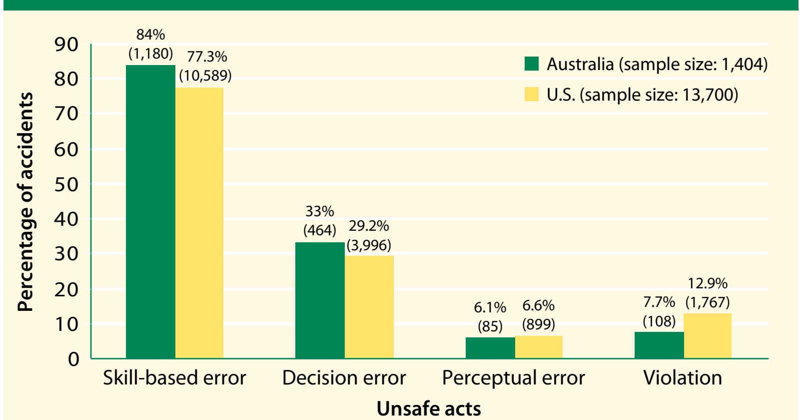
"The rationale behind comparing Australian and U.S. data is to discover whether there are similar trends in involvement of human factors in aviation accidents," said a report on the study by the Australian Transport Safety Bureau (ATSB). "If this is the case, it may be reasonable to assume that solutions to common problems developed in one country will be transferable to the other."

The study used the human factors analysis and classification system (HFACS) to examine and classify data from aircraft accidents that occurred during the 10-year period beginning in 1993. During that period, 69 percent of accidents in Australia and 72 percent of accidents in the United States involved at least one unsafe act by flight crewmembers, the report said (Figure 1).

The report said that "unsafe acts" include errors in doing, thinking and perceiving — known, respectively, as skill-based errors, decision errors and perceptual errors. Unsafe acts also include two types of violation, defined in the report as "a deliberate breach of the rules by an operator who knows they are breaking air law" — routine, small-scale violations and "exceptional" violations that deviate significantly from the rules.

For example, the report said skill-based errors recorded in Australian accidents included "landing errors, including problems with flare, alignment, touchdown point, descent rate and distance/altitude and speed; not maintaining

Percentage of Accidents Associated With Each Unsafe Act



Source: Australian Transport Safety Bureau

Figure 1

physical clearance or visual lookout; losing directional control on the ground; and not maintaining airspeed."

Decision errors included "selecting unsuitable terrain for landing/takeoff/taxiing, improper preflight planning; poor in-flight planning or decision, and performing a low-altitude flight maneuver," the report said.

The report cited perceptual errors such as "misjudging physical clearance, losing aircraft control, problems with visual/aural perception, and misjudging altitude/distance/speed."

The report also identified several violations: "not following procedures or directives (standard operating procedures), visual flight rules into instrument meteorological conditions, operating an aircraft without proper endorsement or certification [or] … outside its weight and balance limits, and performing low-altitude flight maneuvers."

A higher proportion of Australian accidents were associated with skill-based errors. A greater proportion of U.S. accidents involved violations. There were no significant differences between the proportions of Australian and U.S. accidents associated with decision errors or perceptual errors.

The examination of the distribution of errors by flight crewmembers found "an unexpectedly large number of errors and violations in Australian on-demand/commuter operations," the report said (Table 1). On-demand/commuter operations accounted for 26.9 percent of all violations in Australian accidents, 21.2 percent of perceptual errors, 20.4 percent of decision errors and 11.8 percent of skill-based errors.

By comparison, in the United States, on-demand/commuter operators accounted for between 3.5 percent and 8.7 percent of violations and errors (Table 2).

In both countries, general aviation accounted for the vast majority of errors and violations.

The study found that, of accidents involving at least one unsafe act, 11 percent of

Unsafe Acts Grouped by Type of Flight Operation, Australian Accidents

Flying Operation (Regulation Part)	Skill-based Error	Decision Error	Perceptual Error	Violation
General aviation (Part 91)	861 (73%)	298 (64.2%)	51 (60%)	73 (67.6%)
Air carrier (Part 121)	2 (0.2%)	1 (0.2%)	1 (1.2%)	1 (0.9%)
Large civil aircraft (Part 125)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Rotorcraft with external load (Part 133)	2 (0.2%)	3 (0.6%)	0 (0%)	2 (1.9%)
On-demand and commuter (Part 135)	139 (11.8%)	95 (20.4%)	18 (21.2%)	29 (26.9%)
Agricultural (Part 137)	162 (13.7%)	58 (12.5%)	13 (15.3%)	2 (1.9%)
Public use	14 (1.2%)	9 (1.9%)	2 (2.4%)	1 (0.9%)
Total	**1,180**	**464**	**85**	**108**

Source: Australian Transport Safety Bureau

Table 1

Unsafe Acts Grouped by Type of Flight Operation, U.S. Accidents

Flying Operation (Regulation Part)	Skill-based Error	Decision Error	Perceptual Error	Violation
General aviation (Part 91)	9,485 (89.6%)	3,542 (88.6%)	815 (90.7%)	1,530 (86.6%)
Air carrier (Part 121)	63 (0.6%)	52 (1.3%)	6 (0.7%)	19 (1.1%)
Large civil aircraft (Part 125)	1 (0%)	0 (0%)	1 (0.1%)	0 (0%)
Rotorcraft with external load (Part 133)	32 (0.3%)	18 (0.5%)	1 (0.1%)	8 (0.5%)
On-demand and commuter (Part 135)	369 (3.5%)	224 (5.6%)	38 (4.2%)	153 (8.7%)
Agricultural (Part 137)	593 (5.6%)	143 (3.6%)	34 (3.8%)	50 (2.8%)
Public use	46 (0.4%)	17 (0.4%)	4 (0.4%)	7 (0.4%)
Total	**10,589**	**3,996**	**899**	**1,767**

Source: Australian Transport Safety Bureau

Table 2

Comparison of Australian and U.S. Fatal Accidents by Unsafe Act

Unsafe Act	Australia	U.S.	Percent Difference	Lower 99% Confidence Interval	Upper 99% Confidence Interval
Skill–based error	120 (76.9)	2,201 (75.6)	1	–8	10
Decision error	67 (42.9)	850 (29.3)	14	3	24*
Perceptual error	21 (13.5)	249 (8.6)	5	–2	12
Violation	50 (32.1)	826 (28.4)	4	–6	14
Total	**156**	**2,912**			

*Denotes a statistically significant difference

Source: Australian Transport Safety Bureau

Table 3

Comparison of Australian and U.S. Non-Fatal Accidents by Unsafe Act

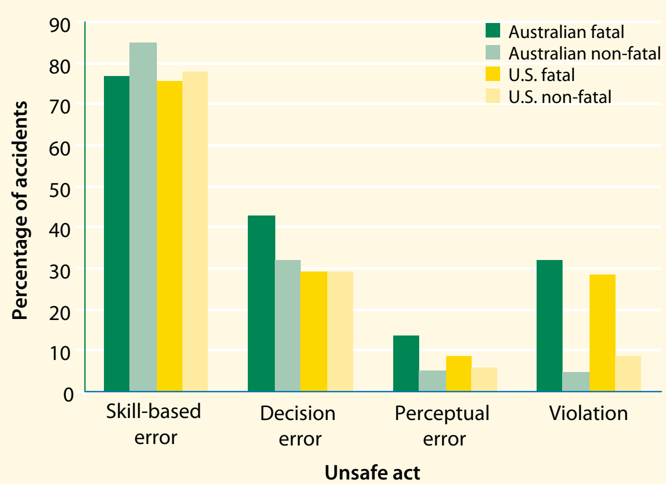
Unsafe Act	Australia	U.S.	Percentage Difference	Lower 99% Confidence Interval	Upper 99% Confidence Interval
Skill-based error	1060 (84.9)	8388 (77.8)	7	4	10
Decision error	397 (31.8)	3146 (29.2)	3	–1	6
Perceptual error	64 (5.1)	650 (6.0)	–1	–3	1
Violation	58 (4.6)	941 (8.7)	–4	–6	–2*
Total	**1,248**	**10,788**			

*Denotes a statistically significant difference

Source: Australian Transport Safety Bureau

Table 4

Comparison Of Australian and U.S. Fatal and Non-Fatal Accidents



Source: Australian Transport Safety Bureau

Figure 2

Australian accidents and 21 percent of U.S. accidents resulted in a fatality. Table 3 shows that the only statistically significant difference between fatal accidents in the two countries was that a greater percentage of Australian fatal accidents were associated with decision errors.

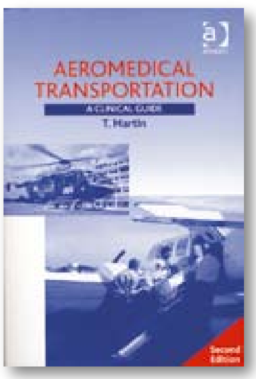
Table 4 and Figure 2 show that a higher percentage of nonfatal accidents in Australia were associated with skill-based errors, when compared with nonfatal U.S. accidents, and fewer nonfatal accidents in Australia were associated with violations.●

Note

1. Australian Transport Safety Bureau (ATSB). *Human Factors Analysis of Australian Aviation Accidents and Comparison With the United States*, Report no. 2004/0321. 2007.

Critical Care

A primer for aeromedical crewmembers.



BOOKS

Aeromedical Transportation: A Clinical Guide

Martin, T. Aldershot, England, and Burlington, Vermont, U.S.: Ashgate, 2006. Second edition. 312 pp. Figures, tables, glossary, references, index.

The preface to the first edition, published in 1996, dispelled the popular notion of aeromedical transportation as "the world of airborne cavalry coming to the rescue … to snatch life from the jaws of death." On the contrary, it said, "aeromedical practice usually comprises hours of tedium waiting for an assignment, interspersed with periods of sheer exhilaration and, just occasionally, moments of absolute terror."

Although on-demand pilots can relate to that definition, the intended readership is not pilots, but "medical, paramedical and nursing personnel, and those working in organizations whose duties include the transportation of the sick and injured by air," the publisher said.

In his preface to the second edition, the author says that much has changed in the decade since the first edition was published: "I could not have predicted the acceleration in interest and enthusiasm that was to take place. These years saw continued growth in aeromedical activities and an upsurge in publications which are starting to bring our specialty in from the cold."

Noting that the first edition has become the text for several aeromedical courses, the author said that the second edition has "more meat to each chapter," as well as two new chapters — one devoted to organizational and clinical issues in the transfer of intensive care patients between hospitals, the other addressing in-flight nursing of patients "within the harsh environment of an aircraft cabin." The author said, "One of my profoundest discoveries in the last decade of teaching was that flight physicians often escort patients alone and yet have little concept of nursing care."

The book is organized in five parts. The first provides a history and an overview of aeromedical transportation. The second discusses flight physics and physiology. The third addresses operational considerations, including equipment and crew composition. The fourth covers clinical considerations, such as the transport of patients with spinal injuries or burns. The fifth part discusses organizational and administrative aspects of aeromedical transportation.

The author said that the book "is intended as a basic primer for those who seek to work in transfer and retrieval medicine." He foresees the next decade as an "exciting time for the academic development of the subject" — one that will see "postgraduates with masters and doctorates in patient transportation."

REPORTS

The Outcome of ATC Message Complexity on Pilot Readback Performance

Prinzo, O. Veronika; Hendrix, Alfred M.; Hendrix, Ruby. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-06/25. Final report. November 2006. 36 pp. Figures, tables, references, appendixes. Available via the Internet at <www.faa.gov/library/reports> or from the National Technical Information Service.*

"Field data and laboratory studies conducted in the 1990s reported that the rate of pilot readback errors and communication problems increased as controller transmissions became more complex," the report says. "This resulted in the recommendation that controllers send shorter messages to reduce the memory load imposed on pilots by complex messages."

To find out if the situation has changed, FAA researchers studied 50 hours of pilot/controller communications recorded between October 2003 and February 2004 at five of the busiest approach control facilities in the United States. "This report contains detailed and comprehensive descriptions of routine air traffic control (ATC) communication, pilot readback performance, call sign usage, miscommunications, and the effects of ATC message complexity and message length on pilot readback performance," the FAA said.

Among improvements found by the researchers was an increase from 37 percent to 61 percent in full readbacks that included complete call signs. "Likewise, pilot/controller call sign mismatch has decreased from 0.8 percent to 0.3 percent," the report said.

As in the 1990s research, the study found that pilot readback errors increased as ATC message complexity increased, especially when pilots were conducting approaches as compared with departures.

Nonstandard phraseology continues to play a role in readback errors. For example, the study found a new trend in the use of the word "point" in readbacks of assigned airspeeds and altitudes, as in "two point seven on the speed" instead of "two seven zero knots" and "three point five" instead of "three thousand five hundred."

"To limit the occurrence of communication problems and misunderstandings, controllers should be encouraged to transmit shorter and less complex messages," the report said. "With increases in international travel, areas of concern related to English language proficiency and language production need to be addressed."

Index of International Publications in Aerospace Medicine

Antuñano, Melchor J.; Wade, Katherine. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-07/2. Final report, third edition. January 2007. 65 pp. Bibliography. Available via the Internet at <www.faa.gov/library/reports> or from the National Technical Information Service.*

"This manuscript contains a comprehensive listing of international publications in clinical aerospace medicine, operational aerospace medicine, aerospace physiology, environmental medicine/physiology, diving medicine/physiology, [and] aerospace human factors, as well as other important topics directly or indirectly related to aerospace medicine," the FAA says.

The primary objective was to provide information about books that comprehensively cover a general area of interest and serve as tools for structured learning and consultation. "On the other hand, article citations from periodical publications (journals, bulletins and newsletters) were kept to a minimum because their coverage is usually limited to specific issues," the FAA said. "For those colleagues interested in periodical publications, our guide includes a section containing general information on journals, bulletins and newsletters in aerospace medicine and aerospace human factors."

The guide also contains sections on the following:

- Publications in general aerospace medicine;
- Publications in other topics related to aerospace medicine and aerospace human factors;
- Proceedings from scientific meetings, conferences and symposiums in aerospace medicine and psychology; and,

- Online computerized databases containing bibliographic information in aerospace medicine and related disciplines.

"We believe this guide will be useful as a primary source of consultation for bibliographic information, especially to those colleagues who are in their formative years and to those who do not have easy access to computer-aided literature search systems," the FAA said.

REGULATORY MATERIALS

Guidance on the Design, Presentation and Use of Emergency and Abnormal Checklists

U.K. Civil Aviation Authority (CAA) Safety Regulation Group. Civil Aviation Publication (CAP) 676. Issue 3. Aug. 30, 2006. 76 pp. Figures, tables, glossary, references, appendixes. Available via the Internet at <www.caa.co.uk> or from The Stationery Office.**

This is the second revision of CAP 676, which initially was published in 1997 to "improve emergency and abnormal checklist usability in assisting the flight crew to manage and contain system faults and other situations that adversely affect flight safety." The U.K. CAA said that the guidance also is intended to "assist all stakeholders involved in the design, presentation and use of emergency and abnormal checklists to take account of best human factors principles within their processes."

Issue 3 contains improvements to the Checklist Assessment Tool (CHAT), which was developed "to allow regulators, manufacturers and operators to review checklists against these design principles and thus be able to recognize a potentially error-prone checklist," the CAA said, noting that the improvements were suggested by operational experience.

CHAT comprises several questions and comments about the physical characteristics, content, layout and format of the checklist being assessed. For example: "Do all captions and labels used in the drill correspond exactly to the labels used on the flight deck? It is essential that exact correspondence is achieved, and any differences must be corrected." Another example is memory items; the publication advises users to place no more than six memory items at the beginning of the checklist, clearly distinguished from other action items.

The publication also contains information on human performance issues associated with detecting and resolving problems, errors typically made when using checklists, processes for reviewing and revising checklists, and methods of training pilots in their use.

Separate chapters provide guidance for manufacturers, operators, pilots and instructors, as well as recommended checklist design attributes, including physical characteristics, content, layout and format. A list of recommended checklist contents is provided in an appendix. Other appendixes provide examples of incidents involving deficiencies in the design or use of checklists, and examples from actual checklists with comments on their specific strengths and weaknesses.

WEB SITES

La Direction Générale de l'Aviation Civile (DGAC), <www.aviation-civile.gouv.fr/publications.htm>

DGAC, the civil aviation authority of France, offers a number of publications online. In the publications section, readers will find the organization's *Aviation Civile Magazine*, DGAC seminar proceedings, organizational reports, air traffic statistics and reports and studies on aviation and safety issues.

The Web site contents are almost exclusively in French, the exceptions being reports of cabin safety and human factors studies in English. Documents are full-text and can be read, printed and downloaded at no charge.

Airport Fire — ARFF — Around the World, <www.airportfire.com/>

There are many sites on the Internet that offer resources, information, photographs and discussion about different aspects of aircraft rescue and fire fighting (ARFF). This Web site contains information about fire service organizations worldwide and their respective Internet sites. Information links are categorized by global regions, and within regions by countries and airports. Individual airport sites contain various amounts of information describing local ARFF services and equipment.

Fire and emergency services training programs, primarily U.S.-based, and course descriptions are listed. In the manufacturers category, there are lists (and links to) commercial sites. Most linking Web sites have colorful photographs of equipment, training and fire-related activities.

The Amsterdam (Netherlands) Airport Schiphol site offers six of its ARFF training films free online. Also free online are several aviation disaster movies from the National Geographic Channel.

Investigation Process Research Resources (IPRR), <www.iprr.org>

The IPRR Web site describes itself as "a pro bono site with hundreds of resources for … investigators." The site originated with several members of the International Society of Air Safety Investigators in 1996. While resources are not exclusively aviation, aviation is well represented.

Recognizing that the site is designed for investigators, there is information for safety professionals and others with an interest in safety and investigation. Among the resources are:

- A collection of accident and incident investigation manuals (e.g., International Civil Aviation Organization Annex 13) and guides, such as "Air Traffic Services: Guidance Notes for Investigators";
- A section on codes, standards and regulations relevant to accident investigation and investigators;
- Reports and monographs about quality control of investigation processes; and,
- A library of professional papers with downloadable full-text and audiovisual presentations.

IPRR also provides forums and discussion groups about accident investigation research processes and analysis. ●

Sources

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

** The Stationery Office
PO Box 29, Norwich NR3 1GN United Kingdom
Internet: <www.tso.co.uk/bookshop>.
E-mail: <book.orders@tso.co.uk>.

— *Patricia Setze and Mark Lacagnina*

Load Miscalculation

Aft CG causes pitch and steering problems.

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

Commander Did Not Notice Error

Boeing 747-400F. No damage. No injuries.

The center of gravity (CG) was 4.8 percent mean aerodynamic cord (MAC) behind the aft limit when the aircraft took off Sept. 21, 2004, from Oslo Airport in Gardermoen, Norway, with three crewmembers aboard for a cargo flight to Incheon International Airport in Seoul, South Korea. As a result of the imbalance, the aircraft began an uncommanded "autorotation" at a calibrated airspeed of 120 kt — 34 kt below the target rotation speed, said the report by the Accident Investigation Board of Norway.

The aircraft was relatively light and was accelerating rapidly. It became airborne at 165 kt, and pitch attitude increased from 11.5 degrees nose-up to 19.5 degrees. The commander used stabilizer trim to control the pitch attitude. Airspeed during initial climb was 158 kt — 18 kt below the target safety speed.

"[During cruise flight,] the commander realized that the aircraft balance was wrong due to the far forward trim setting," the report said. "The crew suspected a wrong CG location and contacted the company office through SATCOM [satellite communication]." The company advised the crew that the CG had been miscalculated and would be 10.7 percent MAC aft of the aft limit on landing in Seoul. "This could at best have caused a loss of control or a tail strike during landing," the report said.

The crew relocated some cargo pallets to shift weight forward; the CG was 7.2 percent MAC aft of the aft limit as the aircraft neared Seoul. "During the approach briefing, the landing configuration and performance parameters were discussed to reduce the possibility of a tail strike during touchdown and landing rollout," the report said. "Emergency equipment was requested to stand by."

The report said that the approach and landing went as planned. However, during the landing roll, the aircraft pitched nose-up at 60 kt; the nose landing gear strut extended, which caused the nosewheel-steering system to disengage. "The commander stopped the aircraft on the runway and shut down all engines," the report said. "The aircraft was subsequently towed to the parking stand."

The report said that the load master had made a mistake in calculations during load planning, and the loading resulted in a CG at 37.8 percent MAC; the aft CG limit is 33.0 percent MAC. The load manifest, however, indicated that the CG was at 27.0 percent MAC. The commander did not notice the mistake in the load master's calculations before he signed the load manifest. The report said, however, that the pilot operating manual did not contain aircraft-specific data that would have enabled the commander to check the load manifest. "In reality, the commander was merely checking that the [weight] and CG values were within limits for takeoff and landing," the report said.

The aircraft was equipped with an on-board weight and balance system that automatically computes and displays gross weight and CG. "At the time of the incident, the operating procedures of the aircraft's weight and balance system were not provided to the crew, and the crew was not trained for their use," the report said.

Misset Altimeter Results in Altitude Bust

Airbus A310. No damage. No injuries.

The aircraft was en route with 84 passengers from Tehran, Iran, to Birmingham (England) Airport the night of Nov. 24, 2006. Reported weather conditions at Birmingham included surface winds from 160 degrees at 10 kt, visibility greater than 10 km (6 mi) in light rain, few clouds at 1,600 ft and scattered clouds at 2,200 ft. QNH, the altimeter setting that results in a display of height above mean sea level, was 982 hPa.

"The operating procedures of the aircraft's weight and balance system were not provided to the crew."

The U.K. Air Accidents Investigation Branch (AAIB) report said that the copilot, the pilot monitoring, advised the approach controller on initial radio contact that they had received the automatic terminal information system (ATIS) information; he read back the reported altimeter setting of 982 hPa. However, the flight crew had not reset their altimeters from the cruise setting, 1013 hPa.

While providing radar vectors for the instrument landing system (ILS) approach to Runway 15, the controller cleared the crew to descend to 2,500 ft. The controller later observed on his radar display that the aircraft was descending through 2,500 ft and told the flight crew that they had been cleared to 2,500 ft. The copilot replied, "Two five hundred, two thousand five hundred."

The aircraft continued to descend, and the controller told the crew, "Yes, if you could climb back up to two thousand five hundred, please, and turn right now onto one two zero degrees." After a brief pause, the copilot acknowledged the instructions, but the aircraft continued to descend. The controller said, "You are still descending. Climb two thousand five hundred feet. Acknowledge." The copilot acknowledged the instructions; the aircraft continued to descend.

The controller then told the crew that there was a 1,358-ft television mast 4 nm (7 km) ahead of the aircraft and to climb immediately. Suspecting that the crew had misset their altimeters, the controller added, "QNH nine eight two. Confirm you are indicating one thousand five hundred feet."

"At this point, the crew realized that the altimeters were still set to the standard pressure setting of 1013 hPa and not the Birmingham QNH of 982 hPa," the report said. The commander initiated a climb, and both pilots set their altimeters to 982 hPa. The copilot told the controller, "Just got it now and climbing, reading two thousand feet." The controller cleared the crew to maintain 2,000 ft until intercepting the localizer and advised that the aircraft was clear of the television mast. The crew conducted the approach and landed without further incident.

"The crew could not recall any distractions or unusual flight deck activity at the point at which they would normally have adjusted the altimeter sub-scales," the report said. With the altimeters set at 1013 hPa, the indicated altitudes during approach were 930 ft higher than the aircraft's actual altitudes.

Elevator Trim Controls Rigged Incorrectly

Hawker 800 XP. No damage. No injuries.

After being repainted, the aircraft was departing from Peterborough, Ontario, Canada, for a positioning flight to Buffalo, New York, U.S., on June 2, 2005. As indicated airspeed neared 190 kt during initial climb, the pitch-trim system reached its nose-down limit, the Transportation Safety Board of Canada report said.

The flight crew maintained airspeed below 190 kt and diverted to Lester B. Pearson International Airport in Toronto. "During the approach to Toronto, the rudder began to vibrate and seize, and the flight crew declared an emergency," the report said. "The aircraft landed … without further incident. An inspection revealed that the elevator trim controls were incorrectly rigged."

The landing gear doors and flight control surfaces had been removed from the aircraft in preparation for repainting. "When the elevators were removed, the elevator trim control rods — two on each of the left and right horizontal stabilizers — were also removed," the report said. A maintenance engineer had marked the number of turns required to remove each rod on tags and attached the tags to the rods. After repainting, the rods were reinstalled using the same number of turns marked on the tags.

The rigging of the elevators was not checked, as required by the aircraft maintenance manual. "The rationale for this was that there were no reported flight control problems when the aircraft arrived, the aircraft was reassembled back to the way it was received, and the rigging should not have changed," the report said, noting that the company that performed the work did not have the equipment required to perform a rigging check.

Investigators found that the rigging of the elevator controls was such that "with full nose-down trim selected, the aircraft was rigged in a nose-up condition," the report said.

Smoke Prompts Emergency Landing

Avro 146-RJ100. No damage. No injuries.

Soon after departing from Zurich–Kloten (Switzerland) Airport for a scheduled flight to Brussels, Belgium, the morning of Dec. 5, 2005, the flight crew saw smoke emerge from the left console. The senior flight attendant advised the flight crew that smoke also was visible in the cabin, the Swiss Aircraft Accident Investigation Bureau report said.

The flight crew donned their oxygen masks, declared an emergency and requested and received clearance from air traffic control (ATC) to return to Zurich. The commander transferred control to the copilot and conducted the emergency checklist, which included deactivation of the air-conditioning packs. "During the approach, the smoke dissipated in the cockpit and cabin," the report said. "For safety reasons, the crew kept their oxygen masks on."

The commander told investigators that he was unable to stop the continuous flow of oxygen in his mask, which made communication with the copilot and ATC difficult. "As a result, during the approach, he also handed over to the copilot communication with ATC in addition to controlling the aircraft," the report said. After an otherwise uneventful approach and landing, the aircraft was taxied to the stand, where the 63 occupants deplaned normally.

Investigators found a defective oil seal in the no. 2 engine. "It is highly probable that this caused oil residues to evaporate, smoke to be generated and this smoke to enter the cockpit and cabin air-conditioning circuit," the report said.

Neglect of SOPs Leads to Ramp Damage

Boeing 767-300. Substantial damage. No injuries.

The airplane was at the gate, ready to be pushed back for departure from Washington Dulles International Airport on June 17, 2006. "A ramp employee, operating a tractor with a baggage cart in tow, was on the left side of the airplane when a pushback guideman on the right side of the airplane signaled that he needed hand wands for the pushback," said the U.S. National Transportation Safety Board (NTSB) report.

The tractor operator forgot that he had a baggage cart in tow when he drove under the airplane.

The tractor operator told company officials that he forgot that he had a baggage cart in tow and did not follow standard operating procedures (SOPs) when he drove under the airplane to reach the guideman. "In the process, the baggage cart impacted the underside of the fuselage about 25 ft [8 m] aft of the nose and 17 ft [5 m] in front of the wings," the report said.

NTSB said that the tractor operator's failure to follow SOPs was the probable cause of the accident and that a factor was his "diverted attention to an on-time departure."

TURBOPROPS

Lack of Training Cited in Tail Strike

ATR 72-200. Minor damage. No injuries.

The copilot was the pilot flying during the scheduled flight with 40 passengers from London Gatwick Airport to Guernsey, Channel Islands, the morning of May 23, 2006. The copilot conducted a visual approach using the correct approach speed and the runway's precision approach path indicator (PAPI) lights for glide path guidance, said the AAIB report. The aircraft bounced after touching down on the runway.

The commander said that the copilot had conducted a good approach and that the bounce was caused by "insufficient flare being applied before touchdown." Neither pilot believed that the bounce was sufficiently severe to warrant a go-around.

"In an attempt to cushion the second touchdown, the copilot … over-pitched the aircraft, resulting in the tail bumper making contact with the runway surface," the report said. The commander took control after the second bounce and landed the aircraft. The only repair required was repainting the steel skid-shoe at the base of the tail bumper.

"The copilot was relatively inexperienced, this being his first airline aircraft type, and he could not recall ever having received formal instruction in recovery techniques for bounced landings," the report said. "The company operating manuals contained no information on bounced landings. … There is no formal requirement in the United Kingdom for pilots to receive training in bounced landing recovery techniques at any stage in their training."

Based on the findings of the incident investigation, the AAIB recommended that the U.K. Civil Aviation Authority "require aircraft manufacturers, operators and training providers to issue appropriate guidance to pilots in the techniques for recovering from bounced landings."

Pilot Expedited Landing, With Gear Up

Piper Cheyenne. Substantial damage. No injuries.

The pilot was conducting a post-maintenance test flight in Fairbanks, Alaska, U.S., on July 8, 2006. The maintenance was not related to the landing gear, the NTSB report said. While returning to the airport, the pilot was asked by ATC to expedite his landing because of traffic.

The pilot told investigators that he extended the landing gear and that it collapsed on landing. The investigation determined, however, that the landing gear was retracted when the airplane touched down on the runway.

The company that employed the pilot recommended to NTSB that "the gear-unsafe horn should be wired through the audio panel, so as to be more easily heard by pilots wearing noise-attenuating headsets," the report said.

Distraction Blamed for Runway Incursion

de Havilland Twin Otter. No damage. No injuries.

Visual meteorological conditions (VMC) prevailed when the aircraft, with 16 passengers aboard, was landed on Runway 27 at Glasgow (Scotland) Airport the morning of Aug. 29, 2006. The airport tower controller told the crew to back-taxi on Runway 27, hold at the intersection of Runway 23 and cross Runway 23 after an Embraer 145 passed by after landing on Runway 23.

While holding at the intersection, the commander, who also was a training captain, began debriefing the copilot on topics that were not specified in the AAIB report. During the debriefing, the commander sketched illustrations on a piece of paper. "By being 'head down' on the flight deck, he became distracted and lost his sense of time and situational awareness regarding the landing Embraer 145," the report said.

After completing the debriefing, the commander perceived that the Twin Otter had been stationary for some time and, not having the 145 in sight, believed that it already had passed by. He began to slowly taxi the Twin Otter onto

Runway 23 but then saw the 145 about to touch down and used reverse thrust to back off the runway.

The airport's runway incursion monitoring and conflict alert system (RIMCAS) did not provide a warning because, after the Twin Otter was landed on Runway 27 to expedite its arrival, the system was set to the "VISUAL" mode, which caused it to monitor only the surface area of Runway 05/23. At the time, Runway 23 was the active runway. The report said that the system would have provided a warning if the "CROSS RUNWAY" mode had been selected to monitor the holding-point areas on Runway 09/27 as well as the surface area of Runway 05/23.

PISTON AIRCRAFT

Stall During Single-Engine Go-Around

Cessna 421C. Destroyed. Two minor injuries.

The left engine failed when the pilot reduced power about 600 ft above ground level while departing in VMC from Runway 06 at Palwaukee Municipal Airport near Chicago, Illinois, U.S., on Aug. 5, 2005. The pilot said that he confirmed that the landing gear and flaps were retracted, and then declared an emergency and told the airport tower controller that he was returning to land. The controller cleared the pilot to land on Runway 34, the NTSB report said.

The pilot said that although the operating engine was at idle power, the landing gear was extended and the flaps were extended to 45 degrees, he was unable to slow the airplane on short-final approach to the 5,000-ft (1,524-m) runway. "I crossed the fence at 118 kt," he said. "Because of the excessive airspeed, I overshot the runway."

The airplane was about halfway down the runway when the pilot attempted to go around. He brought the operating engine to full power and retracted the flaps to 15 degrees, but did not retract the landing gear. The airplane stalled, struck the roof of a building and then struck an embankment and trees about 0.5 nm (0.9 km) from the airport.

Inspection of the left engine revealed that the starter adapter shaft gear had failed. The report said that visual inspections of the starter adapter had not been performed in compliance with a service bulletin issued by the engine manufacturer. "The service bulletin contained a warning that stated, 'Compliance with this bulletin is required to prevent possible failure of the starter adapter shaft gear and/or crankshaft gear which can result in metal contamination and/or engine failure,'" the report said. Three months after the accident, the U.S. Federal Aviation Administration issued an airworthiness directive requiring compliance with the service bulletin.

Long Touchdown on a Short, Wet Runway

Beech 58 Baron. Substantial damage. No injuries.

A line of thunderstorms was approaching the airport from the northeast as the aircraft neared Denham Aerodrome in Uxbridge, Middlesex, England, on Aug. 13, 2006. The pilot believed that his first approach to Runway 06, which had an available landing distance of 706 m (2,316 ft), was too fast, and he conducted a go-around, said the AAIB report.

As the pilot maneuvered the Baron for another approach to Runway 06, rain began to fall heavily on the airport, and witnesses saw standing water on the runway. Several witnesses said that the second approach appeared to be faster than normal and that the aircraft touched down with about 470 m (1,542 ft) of runway remaining.

The pilot told investigators that he conducted a normal approach, but the aircraft floated as it crossed the runway threshold. "As the [pilot] applied the brakes, the aircraft began to slide, departing the left side of the runway and skidding with its right wing foremost through a hedge at the aerodrome boundary," the report said. "It came to rest on a public road just beyond this hedge. There was no fire." The six occupants deplaned without injury.

"Standing water can cause an aircraft to aquaplane or lose directional control, which may account for the aircraft sliding off the side of the runway," the report said.

Control Lost During Missed Approach

Piper Seneca III. Destroyed. Two fatalities.

During his preflight weather briefing the morning of Nov. 6, 2005, the pilot was told that overcast ceilings from 100 ft to 700 ft had been reported along the entire route from Fredericksburg, Texas, U.S., to Tomball, Texas. However, the destination airport, David Wayne Hooks Memorial Airport, reported a clear sky below 12,000 ft and 7 mi (11 km) visibility.

The NTSB report said that the pilot questioned the briefer about the reported ceiling at the destination airport. The briefer said, "That's what they are saying, but I kind of find it hard to believe that everyone around them is [reporting] one to three hundred overcast and they're clear below twelve thousand."

As the Seneca neared the destination, the pilot was cleared by ATC to conduct the localizer approach to Runway 17R. Reported weather conditions at the airport now included a 300-ft overcast and 3 mi (4,800 m) visibility with fog. The published minimum descent altitude for the localizer approach was 620 ft — 468 ft above the runway touchdown zone elevation — and the minimum visibility was 1 mi (1,600 m).

Recorded ATC radar data indicated that the airplane remained right of the inbound approach course and descended to about 300 ft above ground level (AGL). As the airplane descended, the airport tower controller issued a low-altitude alert and told the pilot to check his altitude. The pilot replied, "We're going to climb back up and go missed approach." The airplane began a right turn but remained at about 300 ft AGL. The published missed approach procedure calls for a climb to 1,000 ft and a climbing right turn to 1,800 ft.

About 40 seconds after reporting the missed approach, the pilot said, "I got the tower. Can I go ahead and land?" About this time, the airplane began a left turn. The controller cleared the pilot to land but received no response.

The airplane's height above the ground varied between 300 ft and 800 ft as the left turn was continued. The airplane then entered a continuous descent. Witnesses saw the Seneca emerge from the clouds at a high rate of descent and in a nose-low and a nearly vertical left-wing-low attitude. The airplane struck the roof of a truck parked near the airport boundary, a power line pole, a berm adjacent to a public road and a vehicle on the road, and came to rest in dense vegetation off the side of the road. The vehicle driver received minor injuries.

"A weather observation taken approximately two minutes after the accident included a visibility of 1 3/4 statute miles [2,800 m] with mist and an overcast ceiling of 300 feet," the report said.

HELICOPTERS

Loose Fuel Line Fitting Causes Power Loss

Bell 206L-1 LongRanger. Destroyed. Two fatalities, two minor injuries.

The helicopter lost power about five minutes after departing from an airport near Patterson, Louisiana, U.S., for a charter flight to an offshore platform in the Gulf of Mexico the morning of March 14, 2006. "The commercial helicopter pilot subsequently made a hard forced landing at an off-airport site comprised of tall vegetation and soft terrain," the NTSB report said.

The helicopter came to rest upright, and the two rear-seat passengers exited before it was engulfed in flames. The pilot and front-seat passenger were killed.

Examination of the engine revealed that the nut connecting the fuel line to the fuel nozzle was loose and had not been secured with a lock wire. A fuel-nozzle inspection, which was required every 50 hours, had been performed the evening before the accident occurred. "This inspection required the removal, disassembly, cleaning, inspection, reassembly and reinstallation of the fuel nozzle," the report said. "An interview with maintenance personnel revealed that fuel nozzle installation procedures found in the engine manufacturer's maintenance manual had not been followed."

Postaccident tests indicated that a loose fuel nozzle can cause a substantial loss of power and a flameout. "Testing further revealed that conditions would have been conducive for an in-flight fire," the report said. "Investigators could not determine if the fire originated in flight or during the ground impact."

Wind Shear Blamed for Hard Landing

Bolkow 105DB. Substantial damage. No injuries.

The helicopter was engaged in a public transport flight to resupply and maintain several lighthouses in Ireland on Dec. 13, 2006. Wind velocities in the area were 60 to 65 kt at 2,000 ft and 25 to 30 kt with gusts to 45 kt on the surface, said the Irish Air Accident Investigation Unit report.

The pilot expected to encounter turbulence on approach to the helipad at a lighthouse in Howth. He described the initial approach as relatively smooth. About 15 ft above the helipad, however, the helicopter began to descend rapidly, and application of power had no effect on reducing the rate of descent.

The helicopter landed hard and remained upright. The pilot shut down the engine, and he and his passenger exited the helicopter. Examination of the helicopter revealed substantial damage to the landing gear cross-tubes.

"Because of the strength of the gradient wind, there was certainly potential for localized significant wind shear and severe low-level mechanical turbulence," the report said. "These effects could have been exacerbated by mountain wave activity."

Adverse Weather Encountered in Box Canyon

Robinson R22 Beta. Destroyed. One fatality.

The pilot was among several pilots who were delivering helicopters from Torrance, California, U.S., to various locations on Sept. 20, 2005. The NTSB report said that all the flights "required a departure along the same easterly route, through a mountain pass and then over high desert terrain that included another line of mountains."

While waiting for weather conditions to improve sufficiently for departure, the pilot appeared to be anxious, and he said that he had to reach his destination — Las Vegas, Nevada — by 1600. Estimated flight time was between 2.6 and 3.0 hours. He departed from Torrance at 1425, flying the last helicopter in a group of four helicopters bound for Las Vegas and spaced about 15 minutes apart.

"While en route, other pilots in the group observed rain and lightning to the northeast of their track once they were east of the mountain pass and elected to [continue eastbound to] remain clear of the observed weather," the report said. After crossing the mountain pass, the accident pilot radioed another pilot that he was heading northeast.

"The helicopter was equipped with a GPS [global positioning system] navigation system, which had the capability to guide the pilot on a straight-line course to his destination, which could save about 17 minutes of flying time," the report said. "The pilot [likely] followed the GPS direct course and encountered restricted visibility, rain and moderate turbulence. He unintentionally flew into a box canyon and collided with rising terrain while attempting to reverse course out of the canyon." The accident occurred about 1600. The pilot had not filed a flight plan; the U.S. Civil Air Patrol located the wreckage at 3,370 ft on a 3,900-ft slope at 1100 the next day.

Engine Failure Traced to Fuel Control Unit

Eurocopter France EC120B. Destroyed. Two fatalities, one serious injury.

An overspeed and catastrophic failure of the engine occurred during a law enforcement patrol flight near Fair Oaks, California, U.S., on July 13, 2005. The pilot and front-seat observer were killed, and the observer-trainee was seriously injured when the helicopter struck terrain near the bottom of a steep hill.

NTSB said that the probable cause of the accident was the failure of a diaphragm in the engine fuel control unit that caused increased fuel flow. "The diaphragm's failure was the result of improper installation by the engine manufacturer," the report said. ●

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
April 1, 2007	Klagenfurt, Austria	Piper Seneca	destroyed	2 fatal
The aircraft reportedly broke up while cruising in visual meteorological conditions.				
April 1, 2007	Lake Germain, Quebec, Canada	Piper Chieftain	destroyed	1 fatal
The aircraft was en route from Sept-Îles, Quebec, to Wabush, Newfoundland, when it crashed on the frozen lake.				
April 1, 2007	Milwaukee, Wisconsin, U.S.	Bombardier CRJ	none	43 none
A horizontal stabilizer nose-down trim runaway occurred soon after departure. The flight crew declared an emergency and returned for a landing in Milwaukee. The preliminary report said that the aircraft was returned to service after the trim switches were lubricated and the horizontal stabilizer electronic control unit was replaced.				
April 2, 2007	Darwin, Northern Territory, Australia	IAI Westwind	none	NA none
The aircraft was climbing through Flight Level (FL) 340, en route to Alice Springs, when loud bangs were heard and cabin pressure was lost. The crew donned oxygen masks, descended to 10,000 ft and returned to Darwin.				
April 11, 2007	Wagga Wagga, New South Wales, Australia	de Havilland Canada Dash 8	none	NA none
Soon after departing from Wagga Wagga for a flight to Sydney, the left engine failed. The crew returned and landed the aircraft without further incident.				
April 11, 2007	Wheeling, Illinois, U.S.	Swearingen Merlin III	substantial	5 none
The aircraft had accelerated to about 75 kt on the takeoff roll when the left engine began to surge. The pilot could not maintain directional control and rejected the takeoff. The aircraft departed the left side of the 5,000-ft (1,524-m) runway.				
April 12, 2007	Traverse City, Michigan, U.S.	Bombardier CRJ200	substantial	52 none
Visibility was 1/2 mi (800 m) with snow when the aircraft overran the 6,501-ft (1,982-m) runway while landing at Cherry Capital Airport. The nose gear separated, and the aircraft came to a stop about 100 ft (30 m) beyond the runway.				
April 18, 2007	Abu Dhabi, United Arab Emirates	Airbus A300	destroyed	none
The aircraft was destroyed by a fire that erupted during maintenance.				
April 19, 2007	Kahuku, Hawaii, U.S.	Hughes 500	substantial	4 none
The pilot conducted a forced landing at Turtle Bay Resort after the engine failed.				
April 19, 2007	Chicago, Illinois, U.S.	McDonnell Douglas DC-9-30	minor	NA none
The roof of the tug struck the aircraft's radome during pushback from the gate.				
April 20, 2007	Jackson Bay, British Colombia, Canada	Beech D18S	destroyed	1 minor, 5 NA
The left engine lost power immediately after liftoff. The aircraft yawed left, and the floats separated on contact with the water. All six occupants exited with life vests before the aircraft sank; they were rescued about a half hour later.				
April 21, 2007	Changuinola, Panama	Bell 206	destroyed	2 fatal, 2 serious
The pilot reportedly lost control while landing the helicopter in a confined jungle clearing on the side of a mountain.				
April 23, 2007	Revelstoke, British Colombia, Canada	Piper Navajo	destroyed	2 NA
Returning from an aerial-photography flight, the pilot noticed an unsafe gear indication after turning final. He attempted to conduct a go-around, but the engines did not respond. The aircraft was landed gear-up beyond the end of the runway. Both occupants exited before the aircraft was consumed by fire.				
April 25, 2007	Kopinang, Guyana	Pilatus Britten-Norman Islander	destroyed	3 fatal, 2 NA
The aircraft was on a scheduled flight from Kato to Kopinang when it struck trees and crashed.				

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

IATA

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

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