AviationSafety WORLD

BUILDING AFRICAN SAFETY
Infrastructure development is key

WORKING TIRED
Preventing fatigue in aviation

AIRPORT CONSTRUCTION RISK
Planning preserves safety

AUTOPILOT BACKLASH
Metro III accident review

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FSF
THE JOURNAL OF FLIGHT SAFETY FOUNDATION
NOVEMBER 2006

AN Introduction

Hello to the readers of *Aviation Safety World* and supporters of Flight Safety Foundation!

As the new president and CEO of the Flight Safety Foundation, I get this space each month to speak my mind about safety and what the Foundation is doing. But for my first effort I thought it made sense to tell you a little about me and my initial plans at the helm of this organization.

I join the Foundation after spending many years at the U.S. Federal Aviation Administration and International Civil Aviation Organization. Over the years I have developed an appreciation for what can be achieved when industry partners and regulators combine efforts to improve aviation safety. Our aviation system has achieved some impressive safety goals – especially in the US, Western Europe, and parts of Asia.

But we cannot celebrate gains in some regions of the world while other regions continue to endure tragic losses. Aviation is fundamentally a global industry. A crash in Western Africa might involve a dry lease from a company in Florida, an airworthiness certificate from southern Africa, an airline based in the Middle East, pilots from Eastern Europe, and a bank from in the Mediterranean. The aircraft might carry passengers of a dozen different nationalities. Accidents today have global roots and have global impacts. We need to find global solutions.

The solutions we find must be systemic. Much of the burden for safety remains on the shoulders of the technical professionals, a burden that grows heavier as the demand for air travel outpaces the development of our workforce and infrastructure. We must continue the effort to spread the burden, the sense of responsibility for safety. The subject of safety must be approached with the same sense of urgency and ownership in the boardroom as it is on the flight line. It must continue to involve regulators, leasors, manufacturers, airlines, airports, insurance firms and more in concerted action. I believe one of Flight Safety Foundation's key roles is to drive the developing safety consciousness for all of these institutions, around the world, all of the time.

We already are working with many partners, including manufacturers, airport and pilot groups, airline associations and air traffic control providers, to develop a Safety Roadmap that will focus and coordinate our efforts.

Together we can achieve great things.

I deeply admire all the accomplishments of the Flight Safety Foundation. It's an awe-inspiring task to take over the running of this organization. It has a proud history and a well-earned reputation for technical competence and independence. I assure you that the pursuit of new global goals will not dilute the technical excellence that has been the hallmark of this institution.

I want to acknowledge Stuart Matthews, the outgoing president and CEO. He worked tirelessly to make the Flight Safety Foundation fiscally strong and internationally respected. Without his efforts over the years, the Foundation would not be in a position to spread the message of safety throughout the world with the effectiveness it has today. I look forward to continuing that work while we expand our efforts in all facets of the aviation industry.

William R. Voss
President and CEO
Flight Safety Foundation

AviationSafetyWORLD

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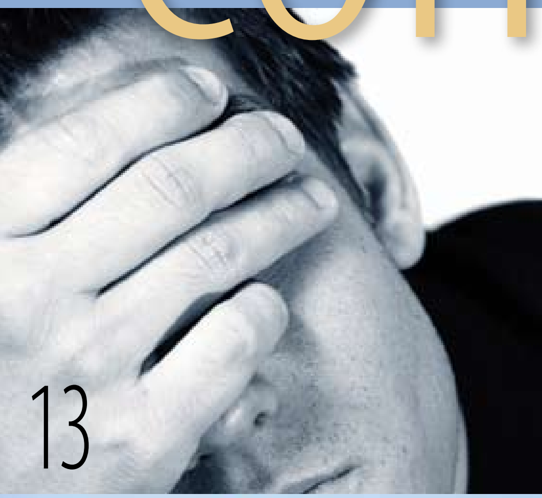

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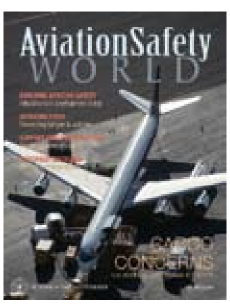

About the Cover
Cargo airline accident rates in the U.S. remain well above passenger airline rates.
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Share Your Knowledge

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

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

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Serving Aviation Safety Interests for More Than 50 Years

Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 900 member organizations in 142 countries.

Member**Guide**

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OPEN Minds

More than a century into the age of flight, we have learned a lot about aviation safety. Not only have we learned about things to do and not to do, we've also discovered a great deal about extracting valuable lessons from the accidents that still occasionally occur. And as the art of flying has developed and matured, lessons learned are compiled in that big book of "How Things Are Done," or not done, if you will.

Aviation professionals are by nature a conservative lot, prone to sticking to a successful course of action until overwhelming proof is presented in favor of a different course. It is hard to argue with success, and the vast majority of aviation practices and assumptions are inarguably successful. Therefore, with each passing day it becomes more difficult to set aside what works in favor of what might work better.

In this issue of *Aviation Safety World* we present new ways to look at fatigue that go beyond mere hours flown or hours served, the new philosophy addressing other elements that factor into mental fatigue. Breaking another barrier, the story also questions whether considerations of fatigue should be expanded beyond the groups currently having some degree of fatigue protection — usually pilots and air traffic controllers — to include other system participants.

Pilots are certain to welcome this new look at fatigue, having argued for years that even when regulatory mandates for hours of work, duty and rest are strictly followed, there are still times when they feel brain-dead at inopportune moments. Operators, however, diligently enforcing work and duty-time limits set through decades of experience and negotiation with workers on one side and national regulators on the other, likely will need more convincing. This is how it should be; new ideas should not become part of the fabric of aviation without first the exercise of rigorous diligence in seeking validation.

The idea of extending the discussion of fatigue-related limits to new groups of aviation system participants so far has not been embraced. Although this topic is still early in the discussion process, I expected more of a response than the simple "no" I received this summer when I asked the top two officials from the European Aviation Safety Agency if, having just adopted work rules for those who fly the aircraft, EASA staff was considering such a package for those who maintain the aircraft.

There has been dramatic change in the use of the expression "pilot error," seen as a sole causal factor much less frequently than several decades ago, when it was applied to numerous accidents without the "but why?" sort of questions that are asked today, drilling deeper in the causal search process. However, our current understanding of pilot error may not push the inquiry far enough, as a story being prepared for an upcoming issue of this publication will discuss, once again challenging long-held beliefs with a new vision.

We must allow ourselves, finally, to become persuaded by new ideas, if for no other reason than to adjust to changing circumstances and new technology. But our willingness to accept new views of the accident process and improve our ability to affect the elements in the chain of events leading to an accident must not get bogged down in satisfaction with our current state of success.

TAWS/EGPWS Misunderstandings

Congratulations to everyone involved with the recent approach and landing accident reduction (ALAR) workshops.

The risk of controlled flight into terrain (CFIT) remains high; data indicate a continuing threat from many CFIT near misses. There appear to be many misunderstandings about terrain awareness and warning system/Enhanced Ground Proximity Warning System (TAWS/EGPWS); pilots often retain inappropriate biases about nuisance warnings which are totally unfounded. Honeywell reports over 30 EGPWS saves. However, from my research the number is probably over 100; many flight operational quality assurance/flight data monitoring (FOQA/FDM) providers are "writing off" EGPWS warnings as faults without justification. In my experience, every EGPWS warning is valid until proven otherwise.

There are still vast gaps in crews' knowledge about EGPWS capability, the availability of software updates, database currency and the activation of the obstacle mode (already present in all EGPWS). The latter mode has proven its worth in one "save," a very-near miss involving a high-rise building.

The underlying factors in the EGPWS events are essentially the same as those identified in Flight Safety Foundation ALAR studies. Whereas fitting TAWS was and still is the main safety action, the operational emphasis needs to be refocused. Briefings are still important, but they do not necessarily identify chart errors or procedural misunderstandings. Use of an altitude versus range chart for all approaches will aid error detection — note the importance of checking altitude before range.

In most TAWS events, the crews did not identify the errors: both crewmembers suffered the same error at the same time, so there was no cross-monitoring. Monitoring can be improved with good standard operating procedures (SOPs). Altimeter-setting error is one critical issue (it also affects vertical navigation, or VNAV), so there need to be independent paths in obtaining and setting the pressure datum before cross-checking.

The main SOP item is where a pull-up procedure uses a conditional check — "*if* visual, *if* ground clearance has been established." This may not preclude errors — that is, errors of mis-set altimeter or visual illusion — that led to the warning in the first instance, enabling the crew to believe that they are safe. Thus, these conditional checks give the crew an incorrect and dangerous "opt out" of the pull-up procedure, or a reason to conclude that a nuisance warning has occurred, and could strengthen their false perception of an erroneous altimeter/visual scene. Four of 12 events that I studied had one or more of these issues as a factor.

None of the incidents that I reviewed were reported, and only a few have been subsequently investigated — an issue of safety culture?

Dan Gurney
FSF CFIT/ALAR Action Group

Editor's note: See the continuing series in Aviation Safety World, *beginning in the July 2006 issue, on approach-and-landing incidents that might have ended in CFIT if TAWS had not provided timely warnings. This month's incident discussion is on page 40.*

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

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

NOV. 23–24 ➤ EU–India Aviation Summit. Ministry of Civil Aviation of India and European Commission Directorate-General for Energy and Transport. New Delhi. Pallavi Agarwal, <pallavi@azure-events.com>, <www.euindaaviationsummit.com>, +91 11 26912513/14.

NOV. 27–29 ➤ Asia-Pacific Regional Conference. International Federation of Air Line Pilots' Associations. Auckland, New Zealand. Carole Couchman, <carolecouchman@ifalpa.org>, <www.ifalpa.org>, +44 (0)1932 571711.

NOV. 30–DEC. 1 ➤ International Aviation Industry Issues Seminar. Airports Council International–North America. Washington. Diane Peterson, <meetings@aci-na.aero>, <www.aci-na.org>, +1 202.293.8500.

DEC. 4–6 ➤ Airport NEPA (National Environmental Policy Act) Workshop. Airport Consultants Council and Airports Council International–North America. Irving, Texas, U.S. <www.acconline.org>, +1 703.683.5900.

DEC. 5–6 ➤ Airport, Port & Transport Security Europe. London. Sarah Kershaw, <skershaw@ibeltd.com>, <www.apts-expo.com>, +44 (0)1303 850259.

DEC. 6–7 ➤ Approach-and-Landing Accident Reduction (ALAR) Workshop. Flight Safety Foundation. Tokyo. James M. Burin, <burin@flightsafety.org>, +1 703.739.6700, ext. 106.

DEC. 7 ➤ Value Added by Independent Safety Assessment. London. Centre for Software Reliability. Bristol, England. Joan Atkinson, <joan.atkinson@ncl.ac.uk>, +44 (0)1912 227996.

FEB. 6–7 (HONG KONG), FEB. 9 (NAGOYA, JAPAN) ➤ Asian Business Aviation Conference & Exhibition (ABACE). National Business Aviation Organization. <convention@nbaa.org>, <www.abace.aero>, +1 202.783.9000.

FEB. 6–7 ➤ 2nd Annual Airline Engineering & Maintenance Conference for the Indian Sub-Continent. Aviation Industry Group. Mumbai, India. Daisy Munro, <daisym@aviation-industry.com>, <www.aviationindustrygroup.com>, +44 (0)20 7931 7072.

FEB. 13–15 ➤ ATC Maastricht 2007. CMP United Business Media. Maastricht, Netherlands. Sam Weller, <sweller@cmpi.biz>, <www.atcmaastricht.com>, +44 (0)20 7921 8544.

FEB. 13–15 ➤ Safety-Critical Systems Symposium 2007. Centre for Software Reliability. Bristol, England. Joan Atkinson, <joan.atkinson@ncl.ac.uk>, +44 (0)1912 227996.

FEB. 15–17 ➤ 18th Annual Women in Aviation Conference. Women in Aviation International. Orlando, Florida, U.S. Connie Lawrence, <www.wai.org>, +1 937.839.4647.

FEB. 21–22 ➤ 3rd Annual European Airline Engineering & Maintenance Conference. Aviation Industry Group. Zurich, Switzerland. Alice Macklin, <alicem@aviation-industry.com>, <www.aviationindustrygroup.com>, +44 (0)20 7931 7072.

MARCH 1–3 ➤ Heli-Expo 2007 Conference & Exhibition. Helicopter Association International. Orlando, Florida, U.S. Marilyn McKinnis, <marilynmckinnis@rotor.com>, <www.heliexpo.com>, +1 703.683.4646.

MARCH 12–14 ➤ 19th annual European Aviation Safety Seminar (EASS): "Staying Safe in Times of Change." Flight Safety Foundation and European Regions Airline Association. Amsterdam. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org>, +1 703.739.6700, ext. 101.

MARCH 13–14 ➤ 13th Annual Middle East Airline Engineering & Maintenance Conference. Aviation Industry Group. Abu Dhabi, United Arab Emirates. Daisy Munro, <daisym@aviation-industry.com>, <www.aviationindustrygroup.com>, +44 (0)20 7931 7072.

MARCH 20–25 ➤ Australian International Airshow. Aerospace Australia. Victoria, Australia. <expo@airshow.net.au>, +61 3.5282.0500.

MARCH 27–29 ➤ Aerospace Testing Expo 2007. UKIP Media and Events. Munich, Germany. Ben Drew, <bendrew@ukintpress.com>, <www.aerospacetesting-expo.com>, +44 (0)1306 743744.

APRIL 2–5 ➤ 58th Annual Avionics Maintenance Conference. ARINC. Phoenix, Arizona, U.S. Roger S. Goldberg, +1 410.266.2915.

APRIL 16–17 ➤ ACI–NA Public Safety & Security Spring Conference. Airports Council International–North America. Spokane, Washington, U.S. Amy Peters, <apeters@aci-na.aero>, <www.aci-na.org>, +1 202.293.8500.

APRIL 24–26 ➤ 9th Annual Canadian Airport Management Conference. Airports Council International–North America and Canadian Airports Council. Ottawa, Canada. <meetings@aci-na.aero>, <www.aci-na.org>, +1 202.293.8500.

MAY 7–9 ➤ 4th International Aircraft Rescue Fire Fighting Conference. *Aviation Fire Journal.* Las Vegas, Nevada, U.S. <www.aviationfirejournal.com/vegas/contact.htm>, +1 914.962.5185.

MAY 8–10 ➤ 52nd annual Corporate Aviation Safety Seminar: "The Foundation for Excellence." Flight Safety Foundation and National Business Aviation Association. Tucson, Arizona, U.S. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org>, +1 703.739.6700, ext. 101.

MAY 22–24 ➤ European Business Aviation Convention & Exhibition (EBACE 2007). National Business Aviation Association and European Business Aviation Association. Geneva. Kathleen Blouin, <kblouin@nbaa.org>, <www.ebace.aero>, +1 202.783.9364.

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

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

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

Safety News

ATC Language Change Sought

The U.S. National Transportation Safety Board (NTSB) has recommended that air traffic controllers use more precise language when advising flight crews of a change in the landing runway.

The recommendation says that, when amending a runway assignment, a controller should "provide a specific instruction to the pilot advising of the runway change; for example, 'UPS 1307, change to Runway 25L, cleared to land.'"

NTSB's Sept. 25, 2006, action follows its investigation of a Feb. 7, 2006, accident in which the crew of a United Parcel Service (UPS) Douglas DC-8-71F conducted an emergency landing on Runway 27R at Philadelphia International Airport after reporting a cargo smoke indication (see "FlightOps," page 28).

The crew had received a clearance for a visual approach to Runway 27R before the smoke indicator illuminated. After being told of the smoke indication, air traffic control (ATC) — acting in accordance with the airport's emergency procedures — changed the clearance to Runway 27L.

"Although the pilot acknowledged the change in landing clearance, he continued for Runway 27R," the recommendation said. "The controller ultimately cleared the flight to land on Runway 27R when it was apparent that the flight crew had not understood the change in landing clearance."

The recommendation said that, although the pilot read back the amended clearance for landing on Runway 27L, he was "in the midst of responding to emergency checklist items, and it appears that he did not recognize that the local controller had changed his landing runway."

The recommendation said that, to minimize misunderstanding, the controller could have asked the pilot "can you accept Runway 27L?" and then could have told the crew to "*change* to Runway 27L."

The three crewmembers received minor injuries in the accident, and the airplane was substantially damaged.

Canada to Increase Landing Visibility Requirements

Canadian aviation regulations have been modified to prohibit operators of commercial aircraft from beginning an approach when visibility is so poor that a successful landing is unlikely.

The regulations, which will take effect Dec. 1, 2006, will establish minimum visibility requirements of at least 1,600 ft/500 m, depending on factors involving the type of instrument approach, flight crew, aircraft and airport requirements.

"This new requirement, combined with existing safety measures and regulations, will help to enhance the safety of passengers and crew and help to prevent accidents," said Lawrence Cannon, minister of transport, infrastructure and communities.

The change will help Canadian regulations harmonize with international standards, he said.

Changes in Australian Airspace Management

Airspace classification and designation functions are being transferred to the Civil Aviation Safety Authority (CASA) of Australia from Airservices Australia in a move intended to "establish requirements for a single common risk-management framework and processes for assessing and implementing future changes, and make agencies more accountable for their regulatory decisions," said Warren Truss, minister for transport and regional services.

The change will place regulation of airspace in its "natural home" with the safety regulator, Truss said. He added that new technologies, including automatic dependent surveillance–broadcast for air traffic surveillance, will help provide for "better tracking of aircraft, less restrictive air traffic control separation standards and reduced fuel burn and travel time."

FAA Asked to Evaluate Safety Inspector Requirements

The U.S. Federal Aviation Administration (FAA) is being asked to develop a new computer model to evaluate the number of aviation safety inspectors required to adequately staff the FAA Flight Standards Service.

The recommendation from the U.S. National Research Council, a nonprofit institution that advises the U.S. government on research and technology, says that the current model does not provide adequate staffing.

FAA currently employs about 3,600 aviation safety inspectors — 95 percent of them in the Flight Standards Service — and the number has remained stable in recent years, even as the aviation industry has adopted more advanced technologies and new manufacturing tools and techniques, the council said. At the same time, FAA has relied more on designated nongovernment inspectors to perform some tasks previously handled by safety inspectors.

GPS Trial Extended

The U.K. Civil Aviation Authority (CAA) has extended its trial of global positioning system (GPS) approaches for general aviation aircraft at six airports. The trial will continue until Dec. 31, 2006.

The extension is intended to provide more time for pilots to participate in the trial, said Ron Elder, head of the CAA Safety Regulation Group's Licensing Standards Division. Of 1,700 pilots who could fly the approaches, 100 pilots have registered for the trial, 47 have flown the approaches and only 26 have provided feedback information, Elder said.

Those who have provided feedback have indicated that they are not sufficiently familiar with the equipment and that there is confusion about "procedure representation and distance to runway during the final approach," CAA said. "These comments have significant implications for the development of human factors issues and training guidance."

New Child Safety Restraint Gains FAA Approval

A new type of child safety restraint has been approved by the U.S. Federal Aviation Administration (FAA) for use on commercial flights. The device — the AmSafe Aviation CARES — is a smaller, lighter-weight alternative to forward-facing child safety seats and is designed for children who weigh between 22 and 44 lb (10 and 20 kg).

CARES uses an additional safety belt and a shoulder harness that encircles the airplane seat back and attaches to the passenger seat lap belt. It is not approved for use in motor vehicles.

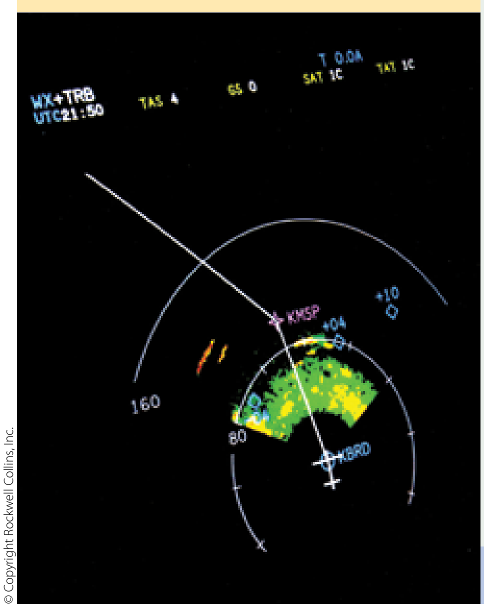
FAA Administrator Marion C. Blakey said that the device will "provide parents with options so they can make the right decision for their children when they travel by air." FAA regulations allow children younger than two years of age to sit on an adult's lap during flight, but use of an approved child safety device is recommended.

TCAS May Be Required in Canadian Aircraft

Transport Canada (TC) has proposed requiring the installation of collision avoidance equipment in all large commercial aircraft. The proposal, published in September, provides for a 30-day period for public comment, followed by TC's review of comments and publication of final regulations.

The proposal also calls for installation of traffic alert and collision avoidance systems (TCAS) in all recently manufactured aircraft, TC said.

"Ensuring Canadian aircraft have the additional tools to improve safety will help us maintain our enviable aviation safety record," said Lawrence Cannon, minister of transport, infrastructure and communities.



A380 Vortices Will Extend Takeoff Wait for Other Aircraft

Aircraft taking off or landing behind an Airbus A380 would have a longer wait than is now required to avoid wake vortices, according to a study by a panel of international aviation officials.

Airbus said that the study found that, on takeoff, large aircraft following an A380 would be required to wait two additional minutes; medium-sized and small aircraft would wait an additional three minutes. On approach to landing, crews of other aircraft would be required to increase their separation from an A380 preceding them by an additional 2 nm (4 km) for large aircraft, an additional 3 nm (6 km) for medium-sized aircraft and an additional 4 nm (7 km) for light aircraft.

The panel said that overall delays would be shorter than the wait times because there would be no constraints on A380s following other aircraft.

The panel's conclusions may be revised, based on further reviews.

In Other News …

Claire Tomlin, a Stanford (California, U.S.) University associate professor of aeronautics and astronautics, is one of 25 recipients of the 2006 "genius awards" from the MacArthur Foundation. Tomlin, an aviation engineer whose specialty is the development of methods for analyzing hybrid control systems and applying the results to practical problems, was notified in September that she will receive the MacArthur fellowship and an accompanying US$500,000 grant. … **George Ferito**, a member of the Flight Safety Foundation Corporate Advisory Committee, has been named director of business development for rotor wing aircraft at FlightSafety International. … **William O. McCabe** has formed The McCabe Group, an aviation consulting firm, in Newark, Delaware, U.S.; he is a member of the Flight Safety Foundation Board of Governors and the Board's Executive Committee, and a retired global managing director for aviation at DuPont Co. … Administrator **Marion C. Blakey** of the U.S. Federal Aviation Administration (FAA) has appointed a committee to develop recommendations on whether the United States should adopt a new international standard to allow pilots over age 60 to continue flying commercial airplanes. The International Civil Aviation Organization standard, effective in November, would increase the age limit from 60 to 65. The FAA Age 60 Aviation Rulemaking Committee is scheduled to complete its work before the end of November.

Tomlin

Ferito

Compiled and edited by Linda Werfelman.

Shaping the Future ATC System

BY BASIL J. BARIMO

1956 was a watershed year in shaping the future of our air traffic control (ATC) system. The sad fact is that a tragedy — the midair collision between two airliners over the Grand Canyon — had to occur before we took seriously the need for a more proactive approach to developing a safer ATC infrastructure.

Moving aggressively in the late 1950s — with the dawn of commercial jet operations — the United States led the world in deploying a state-of-the-art ATC system. Through innovation, and an unfailing commitment to safety on the part of both industry and government, new technologies continued to improve system performance and capacity. This innovation now includes technologies such as the traffic alert and collision avoidance system, which has proven to be highly effective. Similarly, the risk presented by controlled flight into terrain has been substantially reduced through the deployment of ground proximity warning system and terrain awareness and warning system technology. Wind shear detection and alerting systems, another breakthrough for aviation safety, continue to help pilots avoid dangerous weather.

Today, the result is, inarguably, the safest and the most reliable system of transportation.

However, the concept of operations in today's ATC system has not changed since the 1950s, and that presents us with a real problem. Why? Simply put, the basic design elements of the ATC system cannot be "grown" to meet increasing demand. Today's system relies on voice communication, radar surveillance and navigation over fixed points on the ground as its three core components. This effectively creates "one-lane roads" in the sky, where aircraft operate with verbal guidance from an air traffic controller monitoring them by radar. The system is straightforward but increasingly inefficient, as the limited nature of those one-lane roads combines with scarce radio frequencies and radar constraints to cause congestion. The ATC system that fueled dramatic economic growth in the U.S. now threatens to stifle it.

While the system remains incredibly safe, its design lacks the growth potential to meet burgeoning demand. This demand will grow from 45,000 flight operations per day to 61,000 daily flight operations by 2016. Increased congestion will become prevalent as new classes of aircraft — such as very light jets and unmanned aerial vehicles — are introduced into the system.

In the past, growth has been accommodated by adding more air traffic controllers and equipment and subdividing airspace. Adding more staffing to the system, however, is providing diminishing returns. As we run out of Band-Aid solutions, inefficiency increases. The situation is further complicated by an antiquated funding mechanism that divorces system use from system revenues and, as a result, has not kept pace with the investment needed to keep the ATC system up to date, let alone to undertake the modernization needed for next-generation technologies.

Basil J. Barimo is VP of operations and safety for the Air Transport Association.

Without question, the inadequacies of the current ATC system pose a significant challenge to maintaining the standards of safety and efficiency we expect from the aviation industry. But this crisis is not limited to the airlines; it is shared among all those who use the National Airspace System (NAS), including those in the business aviation and general aviation communities. We cannot afford to let delays and capacity limits become the safety margin of the future. This human-centric, maintenance-intensive, ground-based system must be transformed to avoid stifling economic growth, which is a direct result of a safe and vibrant air transportation system.

The time has come for us to set the course for the future of aviation growth. The wise choice — supported by empirical data and decades of analysis — is to begin at once the transition to an information-centric, satellite-driven, digital air traffic management system, taking full advantage of existing and developing technologies. Efficient growth in system capacity translates into even higher levels of safety, an expanding economy, environmental benefits and continuing world aviation leadership. It is the smart solution.

We cannot afford to let delays and capacity limits become the safety margin of the future.

By leveraging existing technologies and adopting improved procedures, we can facilitate growth and enable the economy to continue to benefit from an extensive air transport network. The transformation of the U.S. ATC system involves more than simply replacing old equipment and manual processes, however. A closer look reveals two distinct but equally important strategies: deploying technologies and replacing outdated and redundant infrastructure. There are three key principles to implementing these strategies:

- Reduce the cost of the current system through automation and productivity improvements. Consolidating redundant facilities, decommissioning obsolete equipment and procedures, and rationalizing the workforce will further free up funds for capacity investments. For example, today we rely on 21 en route centers and 168 terminal radar approach control facilities in the U.S. The fact is, those facilities could be easily consolidated into a handful of secure network-enabled operations centers, which would safely and smartly service the entire nation.
- Increase the capacity and efficiency of the current system by leveraging navigation equipment already aboard, transitioning to performance-based NAS, achieving visual arrival and departure rates during instrument conditions and rationally segregating different types of aircraft to optimize traffic flow. The Global Positioning System does not do much good if we are still limited to flying along the rigid highways in the skies.
- Build a system that enables growth through the deployment of modular technologies for a scalable, flexible architecture. Much of the technology envisioned for the future system has already been developed and tested.

Although addressing the shortcomings of our outdated ATC system seems an obvious choice in the face of mounting congestion, the process is fraught with challenges. The transition will require a new approach to the way funding and investment decisions are made, as well as systematic facility consolidation, innovative financing to accelerate technological deployment and a commitment by system users to pay for the services they consume. All of us must embrace change.

Maintaining the highest level of aviation safety and security continues to govern every decision as we plan for the next-generation system. A safer and more secure air transport system is what the public expects and what U.S. airlines will continue to deliver. Safety and security are not only the foundation of the airline industry — they are indeed the foundation of our future. Transforming our nation's air traffic control system is a formidable challenge. Bold change is needed and tough decisions must be made. When the dust settles, the flying public deserves a NAS that is safer, smarter and fairer. ●

If You Don't Snooze, You Lose

There's more to fighting on-the-job fatigue than simply limiting the number of hours worked.

BY LINDA WERFELMAN

Traditional methods of managing fatigue in the aviation workplace by limiting work hours are inadequate and should be replaced by comprehensive fatigue risk management systems (FRMSs) that help detect fatigue-related behavior and thereby prevent fatigue-related accidents, sleep researchers say.

"The traditional prescriptive HOS [hours of service] approach most likely derives from earlier regulatory models for managing physical, rather than mental, fatigue," Drew Dawson and Kirsty McCulloch of the University of South Australia Centre for Sleep Research said in remarks prepared for delivery at a worldwide aviation safety seminar in October in Paris.[1]

"While the application of prescriptive duty limitations may have been an appropriate control for physical fatigue, the same cannot be assumed for mental fatigue. … Regulatory models based only on shift duration are unlikely to produce congruence between what is safe and what is permitted and what is unsafe and not permitted."

Dawson and McCulloch's comments were included in one of four fatigue-related presentations that were part of a fatigue risk management session held during the joint meeting of the Flight Safety Foundation 59th annual International Air Safety Seminar (IASS), the International Federation of Airworthiness 36th annual International Conference and the International Air Transport Association.

Dawson and McCulloch said that recent research and policy initiatives in Australia, Canada, New Zealand and the United States have examined the "defenses-in-depth" method of fatigue management often used in the

military. This method, which includes fatigue management within the framework of a safety management system (SMS), provides a "more defensible conceptual and scientific basis for managing fatigue-related risk as well as the potential for greater operational flexibility," they said.

They said that within an SMS framework, five levels should be considered in managing fatigue risk: "sleep opportunity, or average sleep obtained across the organization, actual sleep obtained by individual employees, presence of fatigue-related behavior, occurrence of fatigue-related errors and occurrence of a fatigue-related accident and/or incident [Figure 1]."

In this context, a fatigue-related incident (FRI) is "merely the end point of a causal chain of events or error trajectory and is always preceded by a common sequence of event classifications that lead to the actual incident," Dawson and McCulloch said. "Thus, [an] FRI is always preceded by a fatigue-related error (FRE). Each FRE, in turn, will be associated with an individual in a fatigued state exhibiting fatigue-related symptomology or behaviors. The fatigued state in the individual will, in turn, be preceded by insufficient recovery sleep or excessive wakefulness, [which] will be caused by either insufficient recovery sleep during an adequate break … or by an inadequate break."

A fatigue-related incident … "is merely the end point of a causal chain of events or error trajectory."

An FRMS can be effective only if it addresses each of the five levels with organized defense systems, they said.

"Each of the four steps in the general error trajectory for [an] FRI provides the opportunity to identify potential incidents and, more importantly, the presence (or absence) of appropriate defenses in the system," they said. If such defenses are not developed, the overall system probably will not be protected against fatigue-related incidents, they said.

For example, limits on a crewmember's hours of service would be — according to Figure 1 — a Level 1 defense designed as an attempt to ensure that the crewmember had an opportunity for sufficient sleep. If the crewmember did not receive adequate sleep, the error trajectory would continue beyond Level 1; "thus, a system with little or no hazard controls at Level 2 or beyond may be quite poorly defended against FREs," the presentation said.

Dawson and McCulloch suggested that a determination could be made of the likely extent of a crewmember's fatigue by calculating the amount of sleep received during the 48-hour period immediately prior to beginning work and the length of time from the last wake-up until the end of the shift. If the time awake, as of the end of the shift, exceeds the amount of sleep obtained in the 48 hours before beginning work, there is "a significant increase in the likelihood of a fatigue-related error, and the organization should implement appropriate hazard-control procedures for the individual," the presentation said.

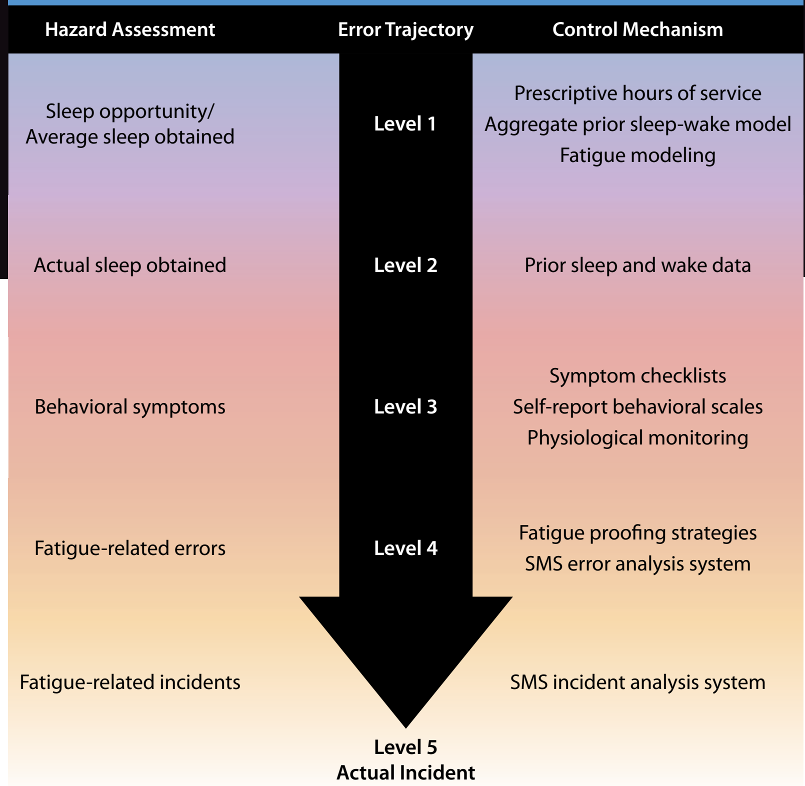
Diminishing Fatigue's Impact

In recent years, Transport Canada has examined similar fatigue issues in the Canadian aviation industry, where — as in most countries — flight and duty time limits apply to flight crewmembers but not to aviation maintenance personnel, Transport Canada officials said in a presentation prepared for the IASS (see "Maintenance Concerns Yield Plan to Fight On-the-Job Fatigue," page 16).[2]

"The main drive to address the fatigue issue in Canadian aviation came initially from the aircraft maintenance side of civil aviation," the Transport Canada presentation said. After a study found that "fatigue and excessive periods of work may be present in the work force," Transport Canada developed an FRMS toolbox, designed to aid in implementation of an FRMS — in both flight operations and maintenance — as a mandatory component of an operator's SMS. The next step will be a 12- to 18-month FRMS implementation trial involving flight and maintenance personnel at a medium-size Canadian airline.

"Transport Canada believes that the implementation of an FRMS as an integral part of [an] SMS will provide the various operators with a flexible and company-specific approach to managing workplace fatigue," the presentation said. "In the long term, it is expected that well-implemented FRMSs will diminish the impact of fatigue problems and therefore contribute to reducing the number of fatigue-related incidents and accidents, as well as improving productivity and work-related satisfaction."

Defenses-in-Depth Approach to Managing Fatigue



SMS = Safety management system

Source: Dawson, Drew; McCulloch, Kirsty. "Managing Fatigue: Defenses in Depth." In *Enhancing Safety Worldwide: Proceedings of the 59th Annual International Air Safety Seminar.* Alexandria, Virginia, U.S.: Flight Safety Foundation, 2006.

Figure 1

Scheduling Changes

An FRMS already is in place at easyJet, which in April 2005 received an "alleviation" from U.K. Civil Aviation Authority (CAA) flight time limitations, representatives of the airline said in a presentation prepared for delivery at the IASS.[3]

The alleviation followed a six-month trial at two easyJet bases, which eliminated a

Maintenance Concerns Yield Plan to Fight On-the-Job Fatigue

Concern about fatigue among aviation maintenance personnel — whose duty time often has been unregulated — was a primary impetus behind the search for measures to address fatigue in the Canadian aviation industry, Transport Canada (TC) officials say.[1]

In a presentation prepared for delivery at the joint meeting of the Flight Safety Foundation 59th annual International Air Safety Seminar (IASS), the International Federation of Airworthiness 36th annual International Conference and the International Air Transport Association, the TC officials cited past research that found that "maintenance tasks involving planning, documenting, communicating, supervising, troubleshooting and inspecting can be severely affected by fatigue."

One of the officials who produced the presentation said, in earlier writings on fatigue, that the association of fatigue and maintenance error has never been as clear as the association of fatigue and pilot error.

"This is in spite of the fact that the physiological challenges are still the same: shift work, night work and long working periods," said Jacqueline Booth-Bourdeau, chief of technical and national programs of the Aircraft Maintenance and Manufacturing Branch of the TC Civil Aviation Directorate.[2] "The link between fatigue and performance impairment is somehow perceived as less critical because the maintainer is not seen as being on the 'front line.'

"The fact remains, however, that many maintenance tasks are performed in the middle of the night when the propensity for human performance error is at its greatest."

— LW

Notes

1. Marcil, Isabelle; Booth-Bourdeau, Jacqueline; Laurence, Mark; Dawson, Drew. "Fatigue Risk Management in the Canadian Aviation Industry." In *Enhancing Safety Worldwide: Proceedings of the 59th* Annual International Air Safety Seminar. Alexandria, Virginia, U.S.: Flight Safety Foundation, 2006.

2. Booth-Bourdeau, Jacqueline. "Fatigue and Performance Degradation." *Aircraft Maintenance Technology*, March 2001.

"6/3" work roster (three days with early duties, three days with late duties and three days off) and replaced it with a "5/2/5/4" work roster (five days with early duties, two days off, five days with late duties and four days off).

"The 5/2/5/4 roster was predicted to reduce fatigue by decreasing the number of days worked consecutively and increasing the amount of time off provided for the changeover from early to late duties," the presentation said.

Monitoring of crew performance found that 1.8 percent of duties on the 6/3 roster were associated with a fatigue risk described as "high or very high," compared with 0.7 percent on the 5/2/5/4 roster. In addition, line operations safety audit (LOSA) observers found a mean error rate of 5.2 per sector on the 6/3 roster, compared with 2.6 per sector on the 5/2/5/4 roster.

The presentation said that these and other data supported the April 2005 switch to a 5/2/5/4 roster at all 14 easyJet bases. In the months following adoption of the new roster, flight data monitoring found that serious events, such as 500-foot altitude deviations, decreased to about one-third the rate that had been reported one year earlier; however, at the same time, crewmembers' complaints of fatigue increased.

The airline responded with crew workshops designed to produce a better understanding of the sources of fatigue and their effects on performance, and the work schedule subsequently shifted to a 5/3/5/4 pattern, with an additional day off "as a risk-mitigation step between early and late sequence duties," the presentation said.

"The experience of developing a safety case to work outside [flight time limitations] ... has enabled the company to develop a sophisticated FRMS," the presentation said.

The FRMS has been included within a broader risk-management system, which is intended to evaluate overall system risk and implement measures to mitigate those risks, the presentation said.

Degraded Crew Performance

A separate study of international long-haul flight crews found that fatigue was associated with degraded crew performance, especially in areas of increased mismanagement of operational threats, increased rates of error occurrence and increased mismanagement of errors that were detected by the crew, researchers from the Centre for Sleep Research at the University of South Australia said in a presentation prepared for delivery to the IASS.[4] A reduction in sleep during the 24 hours preceding flight was the fatigue-related variable most consistently associated with changes in crew performance, they said.

"Crews take longer to make decisions if they have obtained a small opportunity to sleep, based on recent duty history; have obtained a small amount of sleep in the prior 24 hours; are experiencing high levels of subjective fatigue; and/or have slow response times," the presentation said. "Taking longer to make decisions may have negative implications for operational safety, as this could lead to greater time pressures, which may enhance the risk of errors during the later stages of flight."

The study also found several areas, such as improved cross-checking, in which fatigue was associated with improved performance, perhaps because fatigued crews anticipated errors and "devoted more cognitive resources and targeted behavioral strategies towards the detection of fatigue-related error."

Nevertheless, the researchers said that their study "reinforced the conventional wisdom that fatigue is a real issue within commercial flight operations, with significant implications for the operational performance of flight crew and the overall safety of flight operations." ●

Notes

1. Dawson, Drew; McCulloch, Kirsty. "Managing Fatigue: Defenses in Depth." In *Enhancing Safety Worldwide: Proceedings of the 59th Annual International Air Safety Seminar (IASS)*. Alexandria, Virginia, U.S.: Flight Safety Foundation, 2006.

2. Marcil, Isabelle; Booth-Bourdeau, Jacqueline; Laurence, Mark; Dawson, Drew. "Fatigue Risk Management in the Canadian Aviation Industry." In *Enhancing Safety Worldwide: Proceedings of the 59th Annual IASS*. Alexandria, Virginia, U.S.: Flight Safety Foundation, 2006.

3. Stewart, Simon; Holmes, Alexandra; Jackson, Paul; Abboud, Rafeef. "An Integrated System for Managing Fatigue Risk Within a Low-Cost Carrier." In *Enhancing Safety Worldwide: Proceedings of the 59th Annual IASS*. Alexandria, Virginia, U.S.: Flight Safety Foundation, 2006.

4. Thomas, Matthew J.W.; Petrilli, Renée M.; Lamond, Nicole; Dawson, Drew; Roach, Gregory D. "Australian Long Haul Fatigue Study." In *Enhancing Safety Worldwide: Proceedings of the 59th Annual IASS*. Alexandria, Virginia, U.S.: Flight Safety Foundation, 2006.

Further Reading From FSF Publications

FSF Editorial Staff. "Fatigue Evaluation Indicates Most Aviation Maintenance Personnel Obtain Insufficient Sleep." *Aviation Mechanics Bulletin* Volume 49 (November–December 2001).

Hobbs, Alan; Williamson, Ann. "Survey Assesses Safety Attitudes of Aviation Maintenance Personnel in Australia." *Aviation Mechanics Bulletin* Volume 48 (November–December 2000).

Caldwell, J. Lynn. "Managing Sleep for Night Shifts Requires Personal Strategies." *Human Factors & Aviation Medicine* Volume 46 (March–April 1999).

FSF Editorial Staff. "Overcoming Effects of Stress Offers Greatest Opportunity to Sleep Well." *Human Factors & Aviation Medicine* Volume 45 (July–August 1998).

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

A reduction in sleep during the 24 hours preceding flight was the fatigue-related variable most consistently associated with changes in crew performance.

BASIC NEEDS

Sub-Saharan Africa cannot afford to delay air transport infrastructure upgrades.

BY WAYNE ROSENKRANS

High accident rates are the most visible consequence of Sub-Saharan Africa's challenged aviation system, where physical infrastructure shortcomings and failures of political will have some nations' air transport systems locked into a downward spiral. Without interventions, their airlines risk more accidents and blacklisting by other regions, and may even have difficulty leasing, financing and insuring newer and safer commercial jets. However, new programs to finance the physical and institutional assets needed for improved safety, backed by international pressure to comply with world air transport safety standards, are building hope in the region.

The concept of aviation infrastructure used by the World Bank includes not only physical assets such as airports, but also elements such as laws and safety oversight. Sound governance and the political will to competently, strictly and transparently conduct safety oversight are essential elements, many specialists agree.

Disparity of safety levels around the world was driven home by six major airline accidents in fall 2005. The accidents provided "timely reminders that systemic deficiencies identified

Left: Sir Seewoosagur Ramgoolam International Airport, Mauritius, supports tourism. Above: The control tower is a freestanding structure at Banjul, The Gambia.

under the Universal Safety Oversight Audit Program [USOAP] since 1999 were still present," said Dr. Assad Kotaite, then-president of the Council of the International Civil Aviation Organization (ICAO) in early 2006. Follow-up USOAP visits during 2001–2004 revealed that a significant number of the 162 countries had not prepared or implemented corrective action plans after the 1999–2001 USOAP audits.

"We collectively own the world safety record," said Paul Lamy, chief of the ICAO Flight Safety Section, during the May 2006 ICAO–Air Transport Action Group (ATAG)–World Bank Development Forum. "It is in everyone's best interest to support effective assistance programs."

Where help is needed most is obvious: The Africa operator region had only 3 percent of the world's flights yet 21 percent of the fatal accidents in the 1995–2004 period, according to a 2006 U.K. Civil Aviation Authority (CAA) aviation safety review of passenger and cargo operations flown by large jets and turboprop aircraft. The rate of fatal accidents — 4.5 per million flight hours — was higher in this region than any other.

The Nigerian CAA reported that African airlines had 14 fatal accidents in 2005, with 359 fatalities. Twelve of these aircraft were Eastern-built types. The International Air Transport Association (IATA) reckoned that 18 percent of all 2005 accidents involved airlines domiciled in its Africa region; 45 percent were fatal accidents and 70 percent were hull losses, said Martin Maurino, IATA's manager, safety analysis. The same data showed a hull-loss rate for Western-built large commercial jets of 9.21 per million sectors flown for Africa versus 0.76 worldwide.

IATA identified the most significant accident factors as "intentional noncompliance, 25 percent; flight crew training deficiencies, 25 percent; standards and checking, 25 percent; deficient flight crew communication, 20 percent; inadequate safety management, 15 percent; and poor regulatory oversight, 15 percent."

The main deficiencies reported by the ICAO Africa and Indian Ocean Planning and Implementation Regional Group in 2005 included failure to implement ICAO airport certification standards; no preparation for a safety management system (SMS); unstable primary electrical power and unreliable secondary power for navaids and lighting; lack of bird hazard programs; missing emergency plans and equipment; inadequate airport fencing and/or perimeter roads; insufficient or unavailable aircraft rescue and fire fighting; and inadequate pavement maintenance. Additional problems found included the lack of emergency drills, unserviceable airfield lighting and approach/runway lighting, faded and/or nonstandard markings, and excessive rubber deposits on runways.

Uncorrected problems included a lack of air traffic control (ATC) service, failure to implement current nonradar procedures for aircraft separation, inadequate coordination between air traffic control units, failure to publish current ICAO airport and airport obstacle charts, outdated geographic coordinates of ground facilities, and irregular issuance of notices to airmen. Nevertheless, progress was reported: In 2005 about 50 percent of deficiencies noted in air traffic services in 2003 had been corrected, as had 75 percent of aeronautical information services deficiencies.

Air transport infrastructure often gets lower priority than water, food, health, power, roads, education and social welfare, but the irony is that traveler confidence in aviation safety helps address all these by facilitating tourism, business travel, exports and investment. Serious safety concerns can mean that a manufacturing plant or product outlet will not be built, says Charles Schlumberger, principal air transport specialist in the Transport Division of the World Bank.

Airline passengers do not want to be any more concerned about arriving safely than they are about stepping into an elevator in a high-rise office building, he said.

Solutions underway include closely coordinating the efforts of ICAO, states, industry and development institutions to assist developing states; establishing regional safety oversight organizations; and promoting SMS. In extreme cases, ICAO said that the states should hand over safety oversight responsibility to a competent authority.[1]

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Deficiencies in the control tower cab on the roof of the airport terminal at Pemba, Tanzania, were reported in October 2005.

Reform within some CAAs and airlines has occurred only in response to international rewards or sanctions, Schlumberger said. "The 'stick' could be the European Commission [EC] aviation blacklist and/or canceling loans by the World Bank because of the state of safety oversight in certain countries," he said. "The 'carrot' could be our US$14.5 million grant to Cameroon for security and safety improvements at the airports and CAA. Experience shows that political will is the first issue to address — pleasant theoretical discussions and training achieve very little."

ICAO promotes regional safety initiatives such as cooperative development of operational safety and continuing airworthiness programs (COSCAPs); provides assistance and guidance for 200 projects in 100 states through its technical cooperation program; operates the Flight Safety Information Exchange Web site; pays for some country-level corrective actions and regional safety oversight projects through its International Financial Facility for Aviation Safety funding mechanism; and arranges assistance from development institutions and industry through its Unified Strategy Program.

Roadmap Part 2

As *Aviation Safety World* went to press, release was imminent of Part 2 of the Global Aviation Safety Roadmap developed for ICAO by the Industry Safety Strategy Group (ISSG).[2] Part 1, issued in March 2006, outlined why states, regions and industry should address 12 problem areas, including these linked to infrastructure: inconsistent implementation of international standards, inconsistent regulatory oversight, barriers to the reporting of errors and incidents, and ineffective accident and incident investigation. Part 2 sets priorities based on an awareness of all world regions, said Robert Vandel, Flight Safety Foundation executive vice president and the FSF representative to ISSG.

The roadmap first targets Sub-Saharan Africa. "In 2006, there has been a near-universal agreement among international safety organizations to support improvements in Africa," Vandel said.

African safety specialists influenced safety initiatives launched in the 1980s and 1990s. For example, the FSF *Approach-and-Landing Accident Reduction (ALAR) Tool Kit* encourages proven interventions with or without advanced technologies. But some ALAR principles are made irrelevant by infrastructure deficiencies in Africa, said Capt. David Carbaugh, chief pilot, Flight Operations Safety, Boeing Commercial Airplanes.

"For example, we advocate flying approaches as published to improve safety," Carbaugh said. "Crews of at least one airline I know in Africa fly approaches using approach plates published in the 1970s because they got bootleg copies from another airline. In some areas, there are no navaids so crews use handheld global positioning system (GPS) receivers and basically make up approach procedures. Obviously, it's tough to follow Tool Kit advice there."

The effects of infrastructure deficiencies in Africa have not been as clear as, for example, the causes of approach and landing accidents worldwide. South African Transport Minister Jeff Radebe said, "One of the challenges … is the lack of detailed data. … Decisions on solutions and effective allocation of resources will continue to be difficult."

The effects of inadequate maintenance and the number of aging aircraft in Africa have been assumed to a degree. "As far as I know, a concentrated, in-depth study of infrastructure effects on the accidents in African countries has not been done," Carbaugh said. "While poor [aircraft] maintenance is part of the problem, it is rarely directly a cause. However, I believe that it is indirectly a cause of many of the accidents. Crews often have multiple inoperative equipment issues to deal with on every flight. Unfortunately, many of the accident reports do not go into this kind of depth."

Competing Values

Shaping development assistance worldwide are eight Millennium Development Goals of the United Nations — which have a target date of 2015. A committee of 19 African states representing the African Union also has laid out an agenda called the New Partnership for Africa's Development. The agenda partly seeks "to increase air passenger and freight linkages across Africa's subregions" and to "promote private-public partnerships in the rationalization of the airline industry and build capacity for ATC."

The Group of Eight major industrialized democracies and the European Union have agreed to increase development assistance in Africa by $25 billion a year by 2010 to support the objectives of the New Partnership for Africa's Development. Progress is scheduled to be reported by the end of 2006 by the Africa Partnership Forum, and reviewed at the G8 summit in Germany in July 2007. In 2005, G8 leaders pledged to cancel the debt of the world's most indebted countries, mostly in Africa, providing about $37 billion of debt relief over 40 years, the World Bank said.

Radebe described what is at stake using data developed for ATAG by Oxford Economic Forecasting when he told a national aviation safety seminar in February 2006, "Air transport … generates about 470,000 direct and indirect jobs across Africa, contributing over $11.3 billion to African gross domestic product. If we add sectors such as tourism that owe their existence to the air transport sector, then the number of jobs increases to about 3.1 million and the contribution to African gross domestic product reaches some $55.5 billion."

Tourism-fueled economic growth requires safe flights from both outside of Africa and on intra-African routes. "Tourism is a driving force in a number of African countries, including Kenya, Mauritius, Morocco, Tunisia, Egypt, Ghana, Senegal and Tanzania, and is assuming an ever-increasing importance in South Africa and Namibia as well," Radebe said. "An amazing 20 percent of all tourism jobs [about 675,000] in Africa are directly related to airborne tourists. … I assume the figures do not count the increasing number of African tourists traveling within the continent."

African and non-African airlines often are hobbled by infrastructure deficiencies, preventing, for example, the substitution of large jets for turboprop aircraft on internal African routes, Radebe said. Infrastructure improvements also can amplify the competitive disparities among airlines.

Christian Folly-Kossi, secretary general of the African Airlines Association (AFRAA), in a May 2006 speech said that African airlines are struggling to compete. "African air transport is in deep crisis," Folly-Kossi said. "The African market currently represents 4.5 percent of the global traffic. Out of this, foreign airlines operate more than 70 percent of the traffic and a small portion is left for Africans. … The global liberalization that was precipitated on the market, [without] control and safeguards, [had] a devastating impact on many African countries."

The runway was in "very poor condition" at Arusha, Tanzania, but ability to compete with Kilimanjaro International Airport influences redevelopment.

Travel between capitals of some African states still requires a connection in Europe thanks to slow implementation of the continent's open skies agreement, the Yamoussoukro Decision, ratified in 2000. "The domestic continental market should be built, liberalized and controlled by carriers of the continent," Folly-Kossi said. "As prescribed by the Yamoussoukro Decision, Africa as a whole should … be a single airspace."

Ethiopian officials told a 2006 forum that the Yamoussoukro Decision "remains the single most important air transport reform policy initiative by African governments to date" to develop intra-Africa air services and attract private capital. Africa's domestic airline industry has been at an impasse, however, given problems such as managing the change from traditional bilateral route agreements between states and inexperience regulating airline competition. Abdoulie Janneh, under-secretary-general and executive secretary of the U.N. Economic Commission for Africa, said, "Unfortunately, some African countries are reluctant to fully implement the Yamoussoukro Decision because of their local aviation industry's fear of competition from foreign airlines." Competitors include companies in other African states and non-African airlines that invest in them.

World Bank Angle

Among several governments and large development institutions concentrating on Africa, the World Bank provides $251 billion in worldwide loan commitments, with about $32 billion (12.7 percent) allocated to the transport sector, primarily for roads. Only around $1 billion of that $32 billion has been allocated for air transport, including infrastructure. "With African institutions led by the African Union and ICAO, we are preparing a multi-donor facility [loans and grants] for 2007," Schlumberger said. "This Africa project, our first on a large scale, will be operational in 2007–2010."

State priorities include road construction in Nigeria and malaria treatment by Médecins Sans Frontières staff in Burundi. A community rally on the airport apron at Bukoba, Tanzania, coincided with a World Bank visit.

Schlumberger

The project includes elements to analyze and report on economic, legal and social benefits of liberalized air transport in Africa, the current state of infrastructure and aircraft operators, policy and institutional capacity of countries, assessing regulatory oversight of safety (i.e., through USOAP) and security and liberalization of air transport services; creation of an implementation strategy tool kit based on regional inputs; and coordinating all financial and technical assistance from several donors and partners.

One model project is in Tanzania, involving commitments of $20 million for runways and $10 million for automatic dependent surveillance–broadcast (ADS-B).[3] "In Tanzania, there is one radar in Dar es Salaam and … the country is huge," Schlumberger said.

Another model project is in Cape Verde, where TACV–Cabo Verde Airlines now operates weekly service between the national capital Praia and Boston using Boeing 757-200ERs. "Cape Verde received Category 1 [meets ICAO standards] from the U.S. Federal Aviation Administration [FAA] International Aviation Safety Assessment program after we had supported the country with a $1.2 million loan for capacity building and regulatory reform," he said. "There is a new law and a well-formed CAA staff. This is the dream we want our clients to achieve. Operating to the United States brings economic development."

The World Bank also has a $150 million project to help 23 West and Central African CAAs comply with ICAO safety and security standards, and enhance security of their main international airports. In the first phase, Burkina Faso received $6.46 million and Mali received $5.51 million in International Development Association (IDA) credits; Cameroon received $14.5 million and Mali received $7.1 million in IDA grants. Safety-related elements of the financing include technical assistance for safety oversight and autonomy; basic communications and aircraft inspection equipment; and replacing navaids at the primary airports.

Another project is a $44 million IDA grant to Sierra Leone partly for airport infrastructure and for improved airport authority management.

Whether revenues from aviation alone can pay for infrastructure depends on local factors. For example, the Tanzanian CAA raised $10.3 million for its infrastructure in fiscal year 2005–2006 by imposing an $8 airline ticket safety surcharge for international passengers. Mongolia, in North Asia, distributes about 30 percent of $40 million received annually from overflight fees to air transport infrastructure, regulation and safety oversight, Schlumberger said.

Sometimes infrastructure benefits the whole continent. An example is IATA's technical assistance for ATC communications in Angola, Ghana and Sudan, and for ATC surveillance in Democratic Republic of Congo (DRC), Nigeria, Sudan and Tanzania.

"IATA assistance [in DRC] has resulted in the deployment of the VSAT [very small aperture terminal, fixed satellite terminals that provide interactive or receive-only voice/data communication] network," Maurino said. "The Régie des Voies Aériennes (RVA), the Congolese air navigation service provider, has established a special investment fund derived from RVA en route charges collected by IATA. Without the extended VHF coverage in western DRC, two new international RNAV/RNP10 [area navigation/required navigation performance] routes could not have been opened to traffic in May 2006."

VSAT now provides many aeronautical fixed telecommunication network links, correcting a deficiency that lasted for decades. "This set of [telecommunication] networks will provide a robust backbone for the improvement of both fixed and mobile communications," he said.

FAA initiatives in African states have included technical advice on GPS navigation, law making and rule making. "Our Safe Skies for Africa program is engaged in 'invisible infrastructure' — not concrete and steel," said Hank Price, an FAA spokesman. The program and IATA jointly provide flight inspection services for satellite-based systems and related procedures in 14 states.

"ICAO's Model Civil Aviation Safety Act and Model Civil Aviation Regulations [MCARs] and associated guidance materials have been adapted to meet [states'] own needs and requirements," he said. "Cape Verde, The Gambia, Ghana, Liberia, Nigeria and Senegal have used the MCARs. With FAA assistance and financial support, Kenya, Tanzania and Uganda have used the MCARs as a basis to revise and harmonize their regulations for use under a proposed regional safety oversight organization."

Jumping Ahead

Advanced technologies could allow some nations to jump ahead of inadequate legacy infrastructure, and often will be "scalable for free," according to Boeing Commercial Airplanes.[4] Major safety-enhancing technologies include ADS-B, satellite-based navigation, airborne collision avoidance system, terrain awareness and warning system and flight data monitoring.

Schlumberger advocates rapid adoption of satellite-based instrument approaches. "At the 2002 ICAO air navigation conference, I said that developed countries should start financing standalone GPS approaches in Africa," but the proposal met opposition from those seeking an even bigger technological leap, he said, while "Africa has air carriers … flying into mountains every week or every month."

Years later, the EC, European Space Agency and Eurocontrol are preparing to augment GPS and Galileo satellite navigation system signals in Europe and Africa with the European Geostationary Navigation Overlay Service (EGNOS); EGNOS certifications for air navigation with GPS signals and Galileo signals are scheduled for 2007 and 2008, respectively.

"If I want to fix the problem today, I take what works," Schlumberger said. "We are losing lives, so we should finance what is available today to reduce accidents. The World Bank budgets about $100,000 to $150,000 to conduct a WGS 84 airport site survey [for a GPS approach with vertical guidance] that enables descent to 250 ft above the highest obstacle, typically a minimum descent altitude of 400 to 500 ft."

Satellite-based navigation for Africa comparable to the level established in the U.S. already is on the horizon. "The implementation of RNAV procedures at selected African international airports will set examples for the use of RNAV procedures at secondary airports where ground aids do not exist," Maurino said. Ten reference and integrity monitoring systems soon will complete preoperational trials for EGNOS, which will provide ICAO's APV-1 performance level, 20 m [66 ft] vertical accuracy. Four additional reference and integrity monitoring systems will be required to enable APV-1 approaches throughout Africa.

The World Bank favors ADS-B for African states for ATC surveillance. "We can implement a dual system GPS-based or flight management system-based Mode S extended squitter [ADS-B 1090 MHz data link] for air carriers and a GPS-based Universal Access Transceiver (UAT) ADS-B data link for general aviation [in Tanzania]," he said. IATA's position favoring ADS-B as the surveillance tool — but suggesting multilateration as an interim solution — has been accepted by African states, Maurino said. Pending implementation of ADS-B, multilateration could enable ATC to track aircraft equipped with the Mode S extended squitter or ADS-B UAT or Mode S radio frequency data link (ACAS/ACAS II) or basic Mode A/C transponder replies.[5]

African leaders have considered ADS-B trials in light of ICAO's endorsement of the Mode S extended squitter; the avionics in new Airbus and Boeing airplanes; and Australia's experience. Airservices Australia in 2007 is scheduled to be first to implement ADS-B across a state's entire upper-level airspace, providing radar-like surveillance throughout domestic airspace above 30,000 ft with 28 ground receivers and upgrades to its air traffic management systems.[6]

Worldwide auditing prompts action to fix infrastructure, and African CAAs have taken strong interest in the IATA Operational Safety Audit (IOSA). "USOAP for states has led to COSCAP projects and to the joint safety oversight project of the East African Community's Africa and Indian Ocean office," Maurino said. "A total of 104 airlines and 32 states have participated in IOSA seminars, and 19 gap audits [pre-audit assessments of where standards are not met] have been conducted in developing countries worldwide, with another 29 scheduled in 2007. Seven of the 19 airlines have already progressed to a full IOSA audit. Madagascar and Nigeria have mandated IOSA."

Ultimately, perpetuating the current safety level can mean that the only passenger airlines capable of profitably serving Africa will be a few non-African carriers such as Air France and British Airways and a few African operators such as Ethiopian Airlines, Kenya Airways and South African Airways, Schlumberger said. "I don't think the world will give up on safer aviation in Africa, but we can't just wait another 20 or 30 years," he said. ●

Notes

1. International Civil Aviation Organization (ICAO). *Report: Directors General of Civil Aviation Conference on a Global Strategy for Aviation Safety.* March 20–22, 2006.

2. The Industry Safety Strategy Group comprises Airbus, Airports Council International, The Boeing Co., Civil Air Navigation Services Organization, Flight Safety Foundation, International Air Transport Association and the International Federation of Air Line Pilots' Associations.

3. The U.S. Federal Aviation Administration has announced that initial implementation of automatic dependent surveillance-broadcast (ADS-B) for all U.S. airspace will begin in fiscal year 2007; the full evolution is expected to take 20 years. ADS-B equipment aboard an aircraft downlinks data, including its three-dimensional position, once per second.

4. Lewis, Michael. "Challenges and Opportunities of a Next Generation Air Transport System." A presentation to the ICAO-ATAG-World Bank Development Forum, May 2006.

5. Wide-area multilateration uses "time difference of arrival" techniques that enable an air traffic control central processor on the ground to triangulate three-dimensional aircraft positions from basic aircraft transponder replies or other data downlinked to a network of low-cost ground receivers that later can be used for ADS-B.

6. Airservices Australia. "Airservices and SITA Undertake ADS-B Trial in Indonesia." Media release, Feb. 15, 2006.

Listen Up!

A study seeks to model — and improve — passenger attention to safety briefings.

BY RICK DARBY

Passengers do not pay as much attention to cabin safety briefings as they should, and airlines need to consider new strategies to motivate them, according to a recently published report by the Australian Transport Safety Bureau.[1] The report offers 13 suggested actions for engaging passengers' attention, as well as a model of factors influencing passenger responses, or lack of them, to safety announcements.

The report, based on a study that comprised a literature review, industry consultation, interviews of passengers following flights and passenger focus groups, concludes that the overall effectiveness of cabin safety communication is "generally weak." Although the study results are based on data from Australia, the level of attention to safety communication is "similar … to that of other countries, a level that has been regarded almost universally by cabin safety experts as too low to maintain good passenger safety," says the report.

"Perceived relevance" of safety information is one key to passenger attitudes, the study says. Although it seems axiomatic that passengers would be interested in facts that might help keep them alive in an accident, negative assumptions — such as skepticism about the likelihood of surviving — could stand in the way. As one respondent said, "If there is going to be a problem, I think all hell is going to break loose, so [safety information] is not going to make any difference."

Other factors influencing passengers' attention to safety communications included:

- **Overconfidence.** "Results showed that passenger ability to recognize messages presented during safety communication is high," the report says. "This is endorsed by high levels of passenger agreement with 'having seen all the content in the briefing before' and 'knowing all the information I need.'"

- **Social norms in the aircraft cabin.** The report says, "Passengers associated those who pay attention to safety communications with undesirable stereotypes, such as the nervous or inexperienced, and identified peer group behaviors that tend not to favor paying attention. … The impact of such norms appears to be greatest on infrequent and younger travelers."

- **Repetition.** "Most respondents believed they had heard all the content in the briefing before," the report says. "Ten percent provided unprompted feedback that they considered the briefing too boring, and 29 percent agreed, when prompted, that the briefing was boring. Feedback from focus groups supported this notion to an even greater extent."

- **Confusion between recognition and recall.** Passengers tended to believe that recognizing a standard safety message meant they understood or could remember it. "However, the results also suggested that ability to recall safety information and perform safety actions when required may be lower than passengers expect," says the report.

Planned Behavior Model

The study showed that "passengers recognize the importance of cabin safety and are aware of behaviors expected of them; however, the perceptions and actual behaviors do not reflect this recognition." The report offers a framework for understanding the dissonance between perceived and actual behaviors.

Icek Azjen, currently head of the Division of Personality & Social Psychology, University of Massachusetts at Amherst (U.S.), formulated the theory of planned behavior (TPB).[2] The theory "has been a significant and influential social-psychological model used in the determination of consumer decision making and attitudes toward behaviors for some time," the report says.

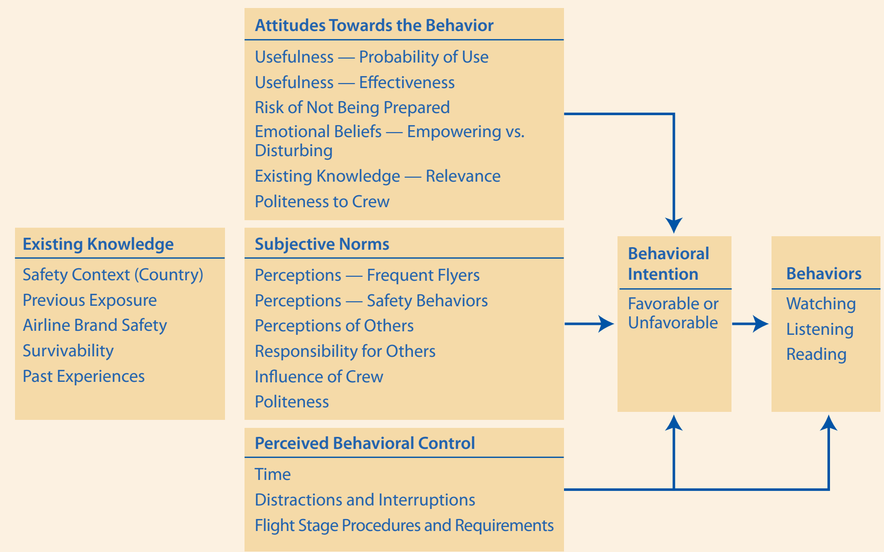
According to the TPB model, human behavior is driven by intentional and motivational factors that influence "how hard an individual is willing to try or how much effort they are planning to exert in order to plan the behavior." The individual's existing knowledge, the starting point or context, is influenced by three independent variables, described by the report as follows:

- **"Attitudes towards the behavior** — the degree to which a person has a favorable or unfavorable … appraisal of the behavior in question, including behavioral outcomes;
- **"Subjective norms** — the perceived social pressure to perform or not to perform the behavior, including motivation to comply with others' expectations; and,
- **"Perceived behavioral control** — the perceived ease or difficulty of performing the behavior, reflecting past experience, as well as anticipated impediments and obstacles."

The TPB is shown schematically in Figure 1.

The report considers how each component of the TPB plays out in cabin safety communication.

Theory of Planned Behavior: Attention to Cabin Safety Communication



Source: Australian Transport Safety Bureau

Figure 1

Attitudes Towards the Behavior

The report says that attitudes that could contribute to inattention to cabin safety communication include the perception that needing to apply the information is improbable; the discomfort that safety information produces in some or, conversely, the reassurance it offers others; the perception that the passenger recognizes the message and considers his or her safety knowledge to be good; and the perception that safety information may not be effective in an emergency.

Subjective Norms

The report says, "In establishing what subjective norms could contribute to low levels of attention to cabin safety communications, this study has identified that some passengers consider paying attention socially undesirable; consider peer group compliance to pay attention is low; observe a lack of flight attendant enthusiasm; [and] do not perceive an inter-dependence on other passengers should an emergency arise."

Perceived Behavioral Control

Perceived behavioral control measures, in effect, how much pressure a person experiences to perform a task. The more pressure, the lower the perceived behavioral (self-)control. A high level of perceived behavioral control means the person feels in control.

Generally, perceived behavioral control among passengers is high because nothing particularly demanding is required to pay attention, the report says.

"To a limited extent, perceived behavioral control may influence passengers through the distractions of other tasks," the report says. "This may arise by the perceived priority of other tasks relative to the priority given to in-flight safety (communicating with other passengers, sorting personal possessions, etc.). Perceptions of the availability of time to perform these tasks during this stage of flight may also be a contributing factor."

The 13 suggested actions (Table 1) are in some cases designed to counteract factors described in terms of the TPB. Because the perceived behavioral control in connection with cabin safety communication is typically high, it can be inferred that attitudes towards the behavior and subjective norms offer the best opportunities to improve passengers' attitudes and behavior.

For example, the "I've heard it all a hundred times before" attitude of many frequent flyers might be countered by Action no. 1: "Airlines should develop tailored cabin safety communication strategies for frequent flyers that account for the unique challenges of effectively delivering safety messages to such passengers." Action no. 6, "Content variation," might also be helpful in reaching this audience.

The perception that flight attendants are unconvincingly delivering the safety briefing by rote is addressed by Action no. 7, "Flight attendant briefings," designed to encourage better flight attendant performance through training and observation. Distraction factors can be minimized, Action no. 8 suggests, by airlines refraining from providing newspapers and magazines, amenities and nonessential information — "regardless of class of travel" — until after the safety communication or even until after takeoff. ●

Notes

1. Australian Transport Safety Bureau (ATSB). *Public Attitudes, Perceptions and Behaviours Towards Cabin Safety Communications.* ATSB Research and Analysis Report B2004/0238. Final Report. June 2006.

2. Azjen, Icek. "The Theory of Planned Behaviour." *Organisational Behaviour and Human Decision Processes* Volume 50 (1991), 179–211.

Suggested Actions for Improving Passenger Attention to Cabin Safety Briefings

Title	Action No.	Suggested Action
Frequent flyers	1	Airlines should develop tailored cabin safety communication strategies for frequent flyers that account for the unique challenges of effectively delivering safety messages to such passengers.
Passenger information	2	Additional factual safety information and resources about air travel and cabin safety should be made available to passengers at airports by airlines and safety authorities.
Escape slides	3	Additional detailed information and/or emphasis regarding the operation and use of escape slides should be provided to passengers during safety briefings.
Brace position explanation	4	Carriers should be encouraged to detail the brace position during safety briefings. Where a video-based briefing with visuals of the required brace positions is not provided, carriers should be required to provide a detailed verbal explanation of brace positions in the safety briefing/demonstration.
Brace position understanding	5	Further investigation should be made into methods of improving passenger understanding of the brace position, particularly where the safety card is the primary means of information delivery.
Content variation	6	Carriers should vary the content or creative format of safety briefings on a regular basis, notwithstanding regulatory requirements, to increase passenger attention. Such variation should not result in dilution of, or cause confusion in regard to, core safety messages.
Flight attendant briefings	7	Carriers should monitor and enhance the ongoing performance of cabin crew in relation to delivery of the safety briefing. This may be achieved within existing crew management processes through training and observation.
Passenger distraction	8	Carriers should refrain from providing passengers with reading materials (such as newspapers and magazines), amenities and nonessential information, regardless of class of travel, until the conclusion of the safety briefing and, where possible, after takeoff.
Safety cards	9	The safety regulator, the civil aviation safety authority, should implement guidelines and approval processes for testing of the effectiveness and comprehension of airline passenger safety cards.
Interaction effects	10	Beyond the extent of current requirements, passengers should be provided with an explicit direction that additional information exists in the safety card that is not contained in the briefing and that the card should be read.
Safety disposition	11	Carriers should seek to understand the unique safety disposition of their passengers (versus that of other airlines) and tailor their safety communication strategies to suit.
Safety media development	12	Airlines should utilize the resources of professionals experienced in consumer psychology and/or communication disciplines when designing future safety communications and associated media.
Theory of planned behavior	13	Additional research should be initiated to investigate and validate the dimensions of the theory of planned behavior model presented in this study.

Source: Australian Transport Safety Bureau

Table 1

The accident rate in U.S. airline all-cargo operations is two to five times higher than the accident rate in passenger and combined passenger/cargo, "combi," operations, according to a recent study by the Commercial Aviation Safety Team. The larger estimate results from eliminating relatively low-risk events such as ramp accidents and turbulence encounters from the equation.

Moreover, a study conducted by the National Aerospace Laboratory–Netherlands (NLR) and the U.K. Civil Aviation Authority (CAA) in 2000 indicates that there are 2.5 accidents per million large cargo airplane flights in North America, which is nearly five times higher than the accident rate for passenger flights in North America and more than twice as high as the accident rate for cargo flights in Europe.[1]

Nevertheless, the U.S. Federal Aviation Administration (FAA) says that accidents involving U.S. cargo aircraft are decreasing and that recently published guidelines for air carrier operators will contribute to the trend.

National Transportation Safety Board (NTSB) records show that in 1996 through 2005, 63 (14 percent) of the 449 accidents that occurred in U.S. Federal Aviation Regulations Part 121 air carrier operations involved cargo aircraft (Figure 1, page 30). Cargo aircraft were involved in five (21 percent) of the 24 fatal accidents during the period.

Of the 742 accidents in Part 135 air taxi operations during the 10-year period, 282 (38 percent) involved cargo aircraft (Figure 2, page 31). The total included 183 fatal accidents, of which 85 (46 percent) occurred in cargo operations. Part 135 applies, in part, to cargo operations conducted in airplanes with payload capacities of 7,500 lb (3,402 kg) or less, or in helicopters.

Balancing

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Cargo Safety

The United States grapples with a relatively high accident rate in freight operations.

BY MARK LACAGNINA

Inconsistencies

Citing regulations that are less stringent for cargo operations than passenger/combi operations, the Air Line Pilots Association, International (ALPA) says that cargo operations never will match the safety of passenger operations until regulatory inconsistencies are eliminated to ensure "one level of safety."

Among examples discussed at an NTSB forum on air cargo safety in 2005 were exemptions from requirements for escape slides and active fire-suppression systems on the main decks of transport category cargo airplanes. Airport-certification rules do not require aircraft rescue and fire fighting (ARFF) facilities at airports served by cargo aircraft, which frequently carry hazardous materials.

An accident early this year that nearly destroyed a Douglas DC-8 freighter highlights the reason for concern about less-stringent regulations applied to cargo operations. The airplane was en route from Atlanta to Philadelphia on Feb. 7, 2006, when the flight crew detected an odor but could not determine the source. The odor dissipated, and, because the airplane was near Philadelphia, the crew decided to continue to the destination. The odor became detectable again during approach, and a smoke-warning light and then the lower-cargo-fire-warning light illuminated. Smoke began to enter the flight deck, and the crew donned their oxygen masks. The flight engineer told investigators that the smoke became so dense by the time the airplane was stopped on the runway that he could not see his hand in front of him. The DC-8 was substantially damaged by the fire, and the crew received minor injuries.

NTSB had not completed its investigation of the accident at press time, but preliminary information indicated that the fire-damaged cargo included laptop computers and cellular telephones with lithium batteries. These items were not required to be documented, marked and handled as hazardous materials because the lithium content of the batteries was below the specified minimum.

The Department of Transportation (DOT) called lithium batteries "an immediate threat to the flying public" when it outlawed their carriage in the cargo holds of passenger aircraft in 2004. The DOT action responded in part to an incident at Los Angeles International Airport in April 1999, when two cargo pallets containing 120,000 lithium batteries caught fire after they were damaged while being unloaded from a passenger aircraft. It took 30 minutes to extinguish the fire, and NTSB found signs that the batteries had burst and melted. FAA subsequently conducted flammability tests and concluded that "the presence of primary [nonrechargeable] lithium batteries can significantly increase the severity of an in-flight cargo-compartment fire."

Nevertheless, DOT exempted cargo aircraft from the prohibition against carrying lithium batteries because, it said, "the risk to public safety is much lower."

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Back of the Clock

More than half of cargo operations are conducted at night, while only about one-fifth of passenger and combi operations take place at night. Cargo pilots typically function on "the back of the clock" and rely on daytime sleep, which has been shown to be inferior to nighttime sleep.

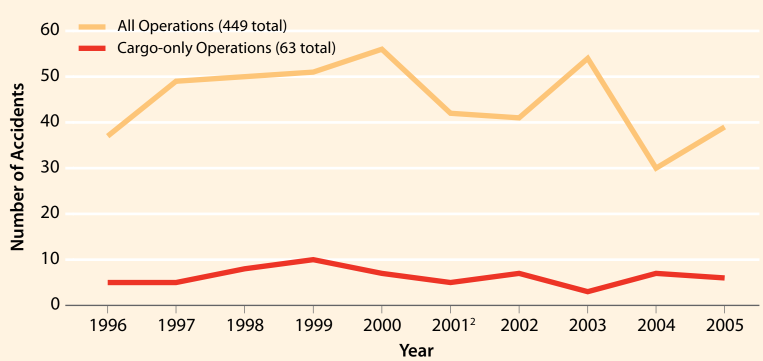
According to Mark Rosekind, Ph.D., Alertness Solutions' president and chief scientist, complete circadian adaptation to night work rarely occurs. ALPA said that studies by the U.S. National Aeronautics and Space Administration have shown that night-cargo pilots lose an average of two hours of sleep per day, resulting in an accumulated sleep deficit of eight hours or more by the end of the week.

Yet, cargo-airline pilots can be scheduled to fly more hours than other Part 121 pilots. Cargo flights typically are conducted as "supplemental" operations under Part 121, and the regulations allow cargo pilots to fly up to 48 hours per week. The weekly flight time limit set by Part 121 for pilots in domestic passenger/combi operations is 30 hours, and the weekly limit for pilots in "flag," or international, passenger/combi operations, is 32 hours.

ALPA says that the rules applied to supplemental operations were developed about 50 years ago for unscheduled freight operations conducted in unpressurized piston airplanes and that an attempt begun by FAA in 1995 to modernize flight time/duty time regulations has stalled for various reasons.

The pilots' union also has cited inconsistencies in the establishment by airlines of modern safety programs. For example, of the 12 airlines with flight operational quality assurance (FOQA) programs in 2005, one was a cargo airline. Of the 32 aviation safety action programs in use, four were at cargo airlines. Line operations safety audits were being conducted by 16 airlines, none of which was a cargo airline.

U.S. Air Carrier Accidents[1]



	Fatal Accidents		Fatalities	
Year	**All Operations**	**Cargo-only**	**All Operations**	**Cargo-only**
1996	5	2	380	38
1997	4	1	8	5
1998	1	0	1	0
1999	2	0	12	0
2000	3	1	92	3
2001[2]	2	0	266	0
2002	0	0	0	0
2003	2	0	22	0
2004	2	1	14	1
2005	3	0	22	0
Total	**24**	**5**	**817**	**47**

1. Aircraft operated under U.S. Federal Aviation Regulations Part 121, *Operating Requirements: Domestic, Flag and Supplemental Operations*.
2. Does not include the hijackings of four air carrier aircraft that were flown into buildings and the ground, with 265 fatalities, on Sept. 11, 2001.

Source: U.S. National Transportation Safety Board

Figure 1

Aging Aircraft

Aging-aircraft problems are not unique to the cargo industry, but they are more pronounced as economic factors drive cargo airlines to operate less expensive equipment. ALPA says that the average age of aircraft in the U.S. cargo fleet is 28 years, while the average for the passenger fleet is seven years. Outdated technology, higher maintenance requirements, lack of spare parts availability and the decline or absence of manufacturers' support are among the issues associated with aging aircraft. Many passenger aircraft have been converted to cargo aircraft by companies no longer in business.

Older aircraft typically do not incorporate safety improvements developed after their original certification. An example is the Emery Worldwide Airlines DC-8-71F that crashed in an automobile salvage yard while returning to land at Sacramento (California) Mather Airport on Feb. 16, 2000. The airplane entered an uncommanded nose-high attitude before reaching take-off rotation speed. The pitch attitude continued to increase despite forward movement of the control column and application of nose-down stabilizer trim by the pilot flying. "The airplane rolled and pitched and climbed and descended as the pilots tried different combinations of flight control inputs and engine power settings to counter the airplane's uncommanded pitch-up while they attempted to maneuver back to the runway," the NTSB report said. The airplane was being turned onto base leg when it struck terrain.

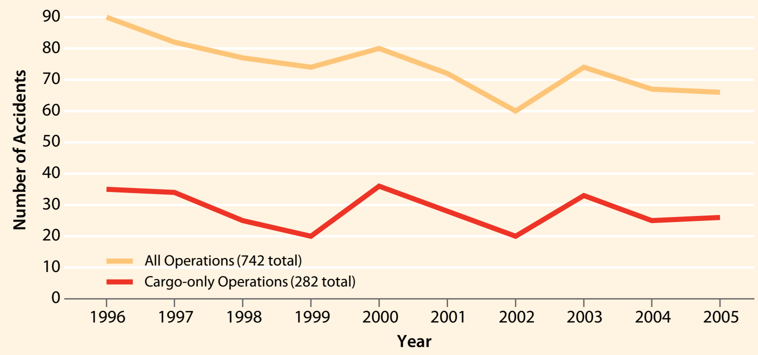
DC-8 elevators are driven by control tabs on the trailing edges. NTSB determined that the bolt attaching the pushrod to the control tab on the right elevator had been improperly secured and inspected during recent maintenance. The bolt migrated from its fitting, and the disconnected control tab moved to a trailing-edge-up position, creating aerodynamic forces that caused an extreme nose-up pitch attitude that the pilots were unable to correct.

The accident airplane had been manufactured in 1968 and converted to a freighter in 1993. The DC-8 was certified in 1959 under the transport category airplane airworthiness standards of Civil Aeronautics Manual 4b, which did not require two separate locking devices on critical fasteners in flight-control systems. The current standards in Part 25 require dual-locking devices at critical flight-control attachments.

Load Verification

There are no license requirements for cargo-handling companies and personnel. "Cargo preparation and loading personnel are frequently not

U.S. Air Taxi Accidents[1]



	Fatal Accidents		Fatalities	
Year	All Operations	Cargo-only	All Operations	Cargo-only
1996	29	13	63	16
1997	15	7	39	9
1998	17	9	45	10
1999	12	5	38	6
2000	22	11	71	12
2001	18	10	60	14
2002	18	7	35	7
2003	18	8	42	9
2004	23	10	64	12
2005	11	5	18	5
Total	**183**	**85**	**475**	**100**

1. Aircraft operated under U.S. Federal Aviation Regulations Part 135, *Operating Requirements: Commuter and On-Demand Operations*.

Source: U.S. National Transportation Safety Board

Figure 2

extensively trained, and, in many cases, these jobs are minimum-wage, high-turnover positions," said ALPA's Terry McVenes and William McReynolds at the NTSB forum. "Many cargo loaders perform their jobs in adverse and demanding physical conditions, under schedule-driven pressure. These circumstances increase the likelihood of errors."

Ultimate responsibility for proper loading rests with the flight crew, but cargo pilots often have no practical way to verify the aircraft's weight and balance before takeoff, the NLR/CAA study said.

FAA data show that a disproportionate percentage of Part 121 cargo aircraft hull loss and fatal accidents involve loss of control on takeoff (Figure 3, page 33). An example was the Aug. 7, 1997, crash of a Fine Air DC-8 at Miami International Airport. The airplane entered an extreme nose-up pitch attitude on takeoff, stalled and struck the ground, killing the three flight crewmembers, a security guard aboard the airplane and one person on the ground. The crew had trimmed the horizontal stabilizer according to the center of gravity (CG) shown on the load sheet. However, the cargo had not been loaded according to the airline's instructions; the CG was aft of the location indicated on the load sheet. The NTSB report said that the trim set by the crew likely caused a greater-than-expected pitching moment that was exacerbated by the lighter control-column forces resulting from the aft CG location. NTSB said that the accident might have been avoided if the crew had an independent method for verifying the aircraft's weight and balance.

FAA said that Advisory Circular (AC) 120-85, *Air Cargo Operations*, was published in June 2005 in direct response to safety recommendations by NTSB based on its investigation of the Fine Air accident.

The AC includes recommended procedures for cargo loading and unloading, operational control of the procedures, designation of trained load supervisors to oversee and verify the procedures, use and calibration of scales for measuring cargo weight, maintenance of cargo-restraint devices, and training cargo personnel and flight crews. The guidelines are specific to Part 121 cargo operations and are not mandatory.

Part 135 Accidents

NTSB at press time had completed the investigations of 74 of the 85 fatal Part 135 cargo accidents that occurred in 1996 through 2005. The aircraft included nine twin-turboprop airplanes (12 percent); 10 single-engine turboprops (14 percent), all of which were Cessna 208 Caravans; 32 piston twins (43 percent); and 20 single-engine piston airplanes (27 percent). There also was one jet — a Learjet 25 that struck terrain when the first officer, the pilot flying, became disoriented during a takeoff in nighttime instrument meteorological conditions (IMC) — and two helicopters that crashed in the Gulf of Mexico while transporting cargo to offshore platforms.

U.S. National Transportation Safety Board

Investigators are probing the role that lithium batteries played in a cargo fire that nearly destroyed a DC-8 freighter in February 2006.

The final reports on 40 fatal accidents that occurred in 2001 through 2005 classify 19 (48 percent) as loss-of-control accidents. Several reports cite the pilots' failure to maintain adequate airspeed. A Britten-Norman Islander entered an uncontrolled descent after being flown into thunderstorms. The pilot of a Piper Lance became spatially disoriented after the pneumatic pump failed, rendering the attitude and direction indicators inoperative in nighttime IMC. An elevator trim tab actuator was not properly secured during maintenance of a Cessna 402's elevator; the tab jammed, causing an excessive nose-down pitch moment when the airplane was on final approach.

Fatigue was cited as a cause of two fatal accidents. The pilot of a Piper Aerostar had been on duty more than 14 hours when the airplane struck terrain during a missed instrument landing system (ILS) approach. The report on a Piper Seneca that struck a mountain said that the pilot had made several requests for someone to accompany him on the flight because he was tired.

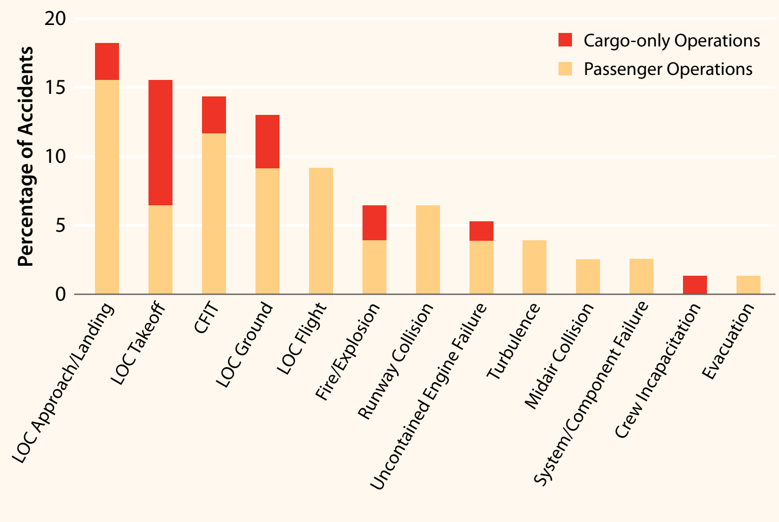
Fifty-three (19 percent) of the 282 Part 135 cargo aircraft accidents in 1996 through 2005 and 11 (13 percent) of the 85 fatal accidents during the 10-year period occurred in Alaska. The risks to flight operations in the vast state are amplified by rough terrain, variable weather conditions and the lack of weather-reporting stations and navigational aids.[2] Aircraft, primarily single-engine airplanes operated by single pilots under visual flight rules, serve as the main link between regional hubs and widely scattered villages, many of which have unlighted gravel or dirt airstrips.

The state and the FAA have launched several initiatives to improve safety in Alaska. The Capstone Program, for example, includes development of global positioning system (GPS) approach procedures and dissemination of weather information and surveillance of traffic via the automatic dependent surveillance–broadcast (ADS-B) system.

Wait and See

FAA currently is deferring any rule-making action affecting air cargo operations while it gauges voluntary acceptance and implementation of the recommendations in AC 120-85.

U.S. Air Carrier Hull Loss and Fatal Accidents, 1987–2000



CFIT = Controlled flight into terrain LOC = Loss of control

Source: U.S. Federal Aviation Administration

Figure 3

Testifying at a congressional hearing on FAA safety programs in September 2006, Nicholas Sabatini, the agency's associate administrator for aviation safety, said that the hull loss accident rate for cargo aircraft in Part 121 operations has consistently improved and currently is about one-third of what it was in 1990.

Similar data are not available for Part 135 cargo operations, but Sabatini said that the total number of accidents in 2005 was about one-half of the total in 1990. "In both types of operations, the accident rates are declining," he said. "The trends are coming down." ●

Notes

1. Roelen, A.L.C.; Pikaar, A.J.; Ovaa, W. "An Analysis of the Safety Performance of Air Cargo Operators." *Flight Safety Digest* Volume 20 (July 2001).

2. Bailey, Larry L.; Peterson, Linda M.; Williams, Kevin W.; Thompson, Richard C. "Controlled Flight Into Terrain; A Study of Pilot Perspectives in Alaska." *Flight Safety Digest* Volume 20 (November–December 2001).

Rebuilding Airport Safety

Airport managers and pilots must take precautions so that changes in taxiway and runway configuration during construction and maintenance do not create a hazard.

BY GERHARD GRUBER

Airports, like aircraft, periodically undergo maintenance and overhaul. Unlike aircraft, which can be temporarily taken out of service, airports typically must keep operating even while they are being repaired and expanded — and while parts of movement areas are excluded from normal use. Consequently, safety threats arise both for airports and aircraft operators.

Airports are obliged to provide an infrastructure that will cope with increasing capacity demand for aircraft and passenger movements. To meet these goals, airport managers must arrange for construction of extensions of the ground facilities. Maintenance (scheduled and unscheduled) is an additional ongoing process.

Equipment and buildings everywhere have a service life. Those within an airport are no exception. Runways, taxiways, aprons and navigational aids (including mechanical and electrical parts) require regular servicing. They eventually will be replaced or renewed when their service life has expired or when new technology is adopted.

The work required for keeping the airport up to the International Civil Aviation Organization (ICAO) standards may include resurfacing, repainting, extension or construction of any airside surface; the installation, testing or calibration of electrical equipment; and the demolition or construction of buildings.

Airside facilities are exposed to extreme conditions. At many airports, the temperature can vary as much as 65

© Gerhard Gruber

When maintenance work is arranged in different phases, ground personnel and pilots must pay close attention.

degrees C (117 degrees F) during the year, such as minus 25 degrees C to 40 degrees C or minus 13 degrees F to 104 degrees F. These environmental changes eventually take their toll on all exposed materials and equipment. An asphalt or concrete surface expands and contracts with temperature variation, resulting in cracks or buckles.

Weather exposure and ultraviolet light cause fading of surface markings and signs, requiring their repair or replacement. Tire material deposits from landing aircraft obscure the surface markings. Rain, snow and anti-icing chemicals accelerate the aging of paved surfaces and ground installations.

Water seeping into cracked surfaces can erode the underlying road base, creating depressions or "potholes," which make an uneven or fragile surface. When water freezes between layers of road base material or in cracks, it expands, producing damage. When pavement breaks down, the surface material becomes loose and can break off.

Loose asphalt or bits of concrete create a serious threat of foreign object damage, or FOD, to aircraft because these materials can be sucked into the aircraft's turbines, or damage tires or the aircraft structure. Repairing such damage may mean an expensive out-of-service period for the aircraft.

The airport operations staff, therefore, performs frequent checks of the surface of the movement areas to ensure an environment free of foreign objects.

Closing Time

Closure of some movement areas typically cannot be avoided when maintenance is necessary. In former times, this was an easy task for many airports. When capacity demand was low, single-runway operation of a dual-runway airport did not create much restriction. The construction/maintenance site and aircraft operation could be well separated. No crossing of an active movement area by ground vehicles was necessary. All the work could be done during daytime.

As traffic increases year by year, however, many airports are running at maximum capacity. Extending the infrastructure often is restricted because of environmental considerations. Building an additional runway is hardly possible for many airports, and even where feasible, it usually takes far more time than expected because of the complex approval process. This, combined with traffic growth, can put considerable pressure on airport infrastructure.

Any maintenance of movement areas (especially taxiways or runways) affects capacity. A capacity restriction must be avoided as much as possible. Therefore, construction often must be performed during nighttime, in different phases (stages), section by section and quite often close to the minimum safe distances from aircraft operations. The re-opening of movement areas after nighttime maintenance is also a big challenge for the airport operations staff.

Any required crossings of movement areas by ground vehicles require special precautions and specific staff training. The coordination of all tasks is complicated and must be carefully scheduled.

When maintenance work is arranged in different phases, ground personnel and pilots must pay close attention, since this will result in frequent closure and re-opening of parts of the movement areas. Consequently, procedures such as taxi routing, wingspan restrictions and approach procedures are changed accordingly. All ground and flight personnel must be informed about the situation by maps, taxi diagrams, instructions, notices to airmen (NOTAMs), automatic terminal information system (ATIS) and other means in time for them to adjust.

Constant Change

Heraclitus, the Greek philosopher, said that it is impossible to step into the same river twice. Airports, thanks to their need for upkeep and growth, are also in a state of constant change. Pilots should never assume that the airport is

in the same condition as it was the previous day or even earlier the same day. It is extremely important that they check NOTAMs and ATIS prior to every arrival and departure for possible restrictions prompted by maintenance or construction.

Special precautions, such as temporary surface markings, marshaller service and physical barriers, must be applied in complicated situations to maintain the safety level and to help prevent errors by pilots and ground staff. Visual aids must be converted or added to avoid false guidance of aircraft into closed areas and to provide alternative taxi routings.

When temporary centerlines need to be introduced, two methods are applicable: either painting or pasting. For both methods the surface must be dry before application.

Pasting a temporary centerline by using adhesive reflecting material has the advantage that it is highly visible, even during marginal light conditions. It can be removed easily, causing no damage to the surface. The disadvantage of this method is that the marking is susceptible to damage by the traction of ground vehicles.

Painting a temporary surface marking is quite inexpensive. The disadvantage of this method is its removal, which can only be done by using high pressure water or mechanical methods, and this can damage the surface.

To prevent such damage, usually the painting method is used to cover existing centerlines leading into construction areas. Caution is necessary, because under certain conditions — glare from the sun or other light sources — it might appear that the covered line still exists, particularly when the surface is wet.

Centerline lights and electrical circuits must be reconfigured to prevent guidance of pilots or vehicle drivers into closed areas. Temporary vehicle access roads or taxiways also may be necessary to re-route traffic around construction areas. Every displacement needs careful planning to provide the obstacle clearances required by ICAO.

Some construction and repair work can only be carried out within a specified range of meteorological conditions. Certain phases of projects may have to be completed in a specific sequence. For example, all equipment must be removed from the sensitive areas when conducting calibration flights for an instrument landing system (ILS); paving the surface must be done in favorable weather and must be completed before surface markings are applied. Changing financial conditions may alter the start date and duration of construction projects.

Considering all these factors, plans should assume that congestion and delays during peak airport operating hours may occur from time to time during construction or repair work.

Displaced Thresholds

One major threat is the temporary displacement of a runway threshold, which is required during runway extension and other construction work near the threshold. It has been shown in the past that accidents and incidents involving displaced thresholds are a serious threat. A pilot may be influenced by habit to use the original threshold, ignoring a temporarily installed precision approach path indicator, even though all its lights are red and all other visual aids — surface markings, threshold lights, etc. — indicate the displaced threshold. Aircraft landing short may collide with the elevated approach and threshold lights.

Experience with displaced thresholds shows that even the publication of an instrument approach procedure involving a localizer and distance measuring equipment is no guarantee against landing short of a temporary displaced threshold. It is much safer when the electronic glideslope is displaced to compensate for the temporary threshold. This practice usually results in a considerable amount of expensive work, such as building a concrete basement for the ILS transmitter, the relocation of all electric equipment and recalibration of the localizer.

Signage

The signage system also needs to be adapted to any new routing situation. Taxi signs and lighting that are, for

A Grim Lesson in the Risks of Airport Construction

On Oct. 31, 2000, a Singapore Airlines Boeing 747-400 began a takeoff roll on Runway 05R at Chiang Kai-Shek International Airport, Taiwan. Heavy rain and strong winds from a typhoon were moving toward Taiwan and visibility was low.

On Aug. 31, the Civil Aeronautics Administration of Taiwan (CAA) had issued a notice to airmen that part of Runway 05R was closed because of construction work, and would remain so until Nov. 22. The 747 flight crewmembers were aware of the partial closure of Runway 05R, and believed they were taxiing to the assigned runway, 05L. But instead of passing the threshold marking for Runway 05R and continuing to Runway 05L, they turned the aircraft onto Runway 05R and began the takeoff.

The airplane struck concrete barriers, runway construction pits and construction equipment. Four cabin crewmembers and 79 passengers were killed; four cabin crewmembers and 35 passengers received serious injuries. The 747 was destroyed by impact forces and a post-accident fire.

The accident report by the Aviation Safety Council of Taiwan said that Runway 05R "was not available for landing, but pilots were able to request its use for takeoff." According to the CAA, the report said, there was no runway-closed indication near the Runway 05R threshold because that portion of the runway was still being used for taxi operations on the night of the accident.

"In addition, given the inbound typhoon, it was not safe to erect mobile runway-closure signs, which may have been blown into taxiing aircraft," the report said. "There were warning signs demarcating the construction area on Runway 05R but the distance from the 05R threshold to the construction area precluded the pilots from seeing those lights."

— Rick Darby

the time, incorrect must be covered or clearly crossed out so that is obvious that the taxiway is no longer in use. Crossing out the taxiway signs instead of fully painting over or erasing them has the advantage that pilots or vehicle drivers can still use them for orientation.

In case of a runway or taxiway closure, physical barriers and signs must be erected to indicate the closure and to prevent inadvertent entries into the closed area. Runway or taxiway closure lighting will be required during nighttime.

© Gerhard Gruber

The safety assessment for every construction area and phase will need to be performed in accordance with the safety management system described in ICAO Annex 14. This includes consideration of jet blast into construction areas.

When tools or other loose equipment is not secured safely, jet blast can easily blow them away. Therefore, the specified safe distances must be kept between construction activity and aircraft operations. Some situations even require temporary blast fences.

Paying Attention

Airport managers and pilots can take away from this discussion two key concepts:

- Situational awareness is extremely important to every operation in the dynamic airport environment, especially during airside construction and maintenance operations, to prevent disorientation and maintain critical obstacle clearance.
- Keep up to date with NOTAMs and ATIS, and always pay close attention to changes in familiar surroundings.

The ICAO safety management system and guidance from Airports Council International are both necessary when planning construction areas with the required level of safety in the interest of the airlines, passengers and construction or maintenance personnel. ●

Gerhard Gruber is manager, rescue and airport operations, at Vienna (Austria) International Airport.

AUDITING Management

BY DAROL HOLSMAN

Safety management systems (SMS), which for many years were referred to as Safety Programs by Flight Safety Foundation (FSF) and most other aviation safety organizations, were found lacking at some operations visited by the FSF Audit Team.

As stated in the International Standard for Business Aircraft Operations Audit Procedures Manual, "A Safety Management System is a process to explicitly identify, manage and measure the safety risks that inevitably occur in all aviation operations." U.S. Federal Aviation Administration Advisory Circular 120-92 describes an SMS as, "essentially a quality management approach to controlling risk." It also provides the organizational framework to support a sound safety culture. There is not much difference between the two organizations' descriptions of what an SMS should be and what it should do. For more than 25 years, FSF Audit Teams have promoted the concept of a safety program in all types and sizes of flight operations. Safety programs included the creation of an advocate position as an integral part of the leadership team, usually with the title safety manager or safety coordinator. With the advent of the SMS, the integration of risk management has elevated safety programs in flight operations to an even higher level of attention. An effective SMS should be an essential ingredient in all flight departments.

An effective safety management system should be an essential ingredient in all flight departments.

The data for this study were compiled during the 20 audits FSF Audit Teams conducted in 2004. In 12 of those audits, or 60 percent, the team found that aircraft "hands-on" emergency evacuation and equipment training was not provided for executive management personnel. In an ideal situation, a corporate operator provides "hands-on" training for key passengers in the use and operation of aircraft safety and emergency equipment and evacuation procedures. The audit team strongly recommends this practice, and a number of major corporations have been able to adopt such programs. This is particularly important for operators that do not assign flight attendants to their flight crews.

While hands-on training is very difficult to accomplish because of the busy schedules of the company executives, the audit teams recommend that operators strive to secure a commitment and direction from the CEO to support a hands-on familiarization and demonstration program for key executives and management passengers who are frequent travelers on company aircraft. A reasonable alternative for many corporations is to assign crewmembers to conduct a thorough emergency briefing — hands-on, or as hands-on as practicable — for each of the key passengers once each year.

Operators also should develop an intranet-based emergency procedures video that can be viewed on the company Web site by all passengers, particularly executive management. The management scheduling and passenger information data system can be utilized to track and monitor the completion of this emergency briefing annually, either face-to-face or via the intranet.

This article extends the discussion of the aviation department problems mostly frequently found by the FSF Audit Team, based on the final reports submitted to clients that contracted for operational safety audits during 2004, detailing the observations, findings and recommendations identified during the review (Aviation Safety World, Sept. 2006, page 46). Observations are documented policies, procedures and practices that exceed the industry best practices; findings identify areas in which the team advises the client to adopt better policies, procedures or practices to parallel industry best practices; and recommendations describe actions that could be taken by the client to meet industry best practices. The recommendations cited in this story are in response to the findings identified in the Administration and Organization topic area, and are the opinions of the FSF Audit Team.

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In 10 of the audits — 50 percent of the total — no documented SMS was found. A documented SMS is essential for the implementation of an effective risk management program. A written program provides a "safety roadmap" for the organization, which each year identifies specific goals and tracks progress in attaining those goals.

A written SMS should be developed and incorporated in the flight operations manual or as a separate document that will establish a working relationship with the company safety, loss prevention and risk management personnel, as appropriate. An operator should integrate its corporate safety goals and objectives into the flight operations SMS.

When the SMS documentation is completed, all personnel should receive a safety indoctrination training session; a similar orientation session should become mandatory for all new personnel.

Also in 10 audits it was found that the responsible party — the SMS manager, pilot or coordinator — lacked formal training. The audit team recommended that operators consider sending the responsible party for formal training in safety program management at the University of Southern California, George Washington University, Embry-Riddle Aeronautical University or other appropriate training institutions.

The best overall preparation course for a newly assigned safety manager is an aviation safety program management course, which typically is available at safety training institutions. The operator also should permit the safety manager, pilot or coordinator to attend the annual FSF Corporate Aviation Safety Seminar and the annual Bombardier/National Business Aviation Association Safety Standdown.

Ten audits found no system for keeping records of accidents, incidents or near-midair anomalies. To provide a meaningful file of safety-related reports and enable a follow-up of identified safety concerns, a system of organized reports and resultant mitigation actions must be identified. Without this documentation, factual data on previous safety issues fades with individual memories and the details are lost.

Every accident, incident or operational anomaly, no matter how insignificant, should be documented and investigated. Further, operators should establish an anomaly-reporting form with follow-up procedures, and include this information in the SMS documentation, and develop a permanent reference source for future safety managers and department personnel on accidents and incidents experienced with their aircraft and facilities.

Finally, operators should review industry data and publications to identify accidents, incidents or operational anomalies experienced by other operators that have similar equipment or operational practices and include those events in the internal documentation. The operator does not have to experience an accident or incident to benefit from the lessons learned.●

The data used in this article have been de-identified. Questions about this article should be sent to Darol Holsman, manager, Aviation Safety Audits, Flight Safety Foundation at dvhjkh@sbcglobal.net or +1 618.345.7449 (office phone) or +1 202.258.2523 (cell phone).

Tricks of Light

Learning From Experience
Incident No. 5

Fifth in a series focusing on approach and landing incidents that might have resulted in controlled flight into terrain but for timely warnings by TAWS.

BY DAN GURNEY

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Limited visibility and a pattern of street lights similar to the approach lights that the flight crew expected to see are possible factors in a close encounter with tall buildings that occurred during a nighttime nonprecision approach to an airport in a major metropolitan area.

The incident involved a modern, "heavy" air carrier aircraft that was being flown on a localizer approach in instrument meteorological conditions. Visibility was limited by fog when the crew descended below 600 ft, the minimum descent altitude (MDA). The aircraft was 2.2 nm (4.1 km) from the runway threshold and descending at 600 fpm through 480 ft when the terrain awareness and warning system (TAWS) generated an "OBSTACLE, OBSTACLE, PULL UP" warning.[1] The crew began the escape maneuver within two seconds (Figure 1).

The "obstacle" was several multistory buildings 340 ft high and 1.8 nm (3.3 km) from the runway threshold. The buildings were at the edge of the obstacle-free zone protecting the instrument approach glide path.[2]

The aircraft's flight path on final approach was equivalent to a constant-angle — 2.99-degree — descent that began approximately 1.0 nm (1.8 km) before reaching the final approach fix (FAF), defined by distance from the localizer. The localizer is offset 0.8 nm (1.5 km) beyond the runway's approach threshold. It is possible that the crew began the premature descent based on the EFIS (electronic flight information system) display of distance from a VNAV (vertical navigation) waypoint on the runway threshold that had been entered in the flight management system for a constant-angle approach.

There was no altitude/range table on the approach chart, and there is no indication that the crew used or even had an independently prepared altitude/range table. Without this monitoring guidance, any error in commencing the descent likely would not have been identified during the final approach.

Beyond the FAF, the approach chart provided only one check altitude, at a step-down fix 2.7 nm (5.0 km) from the localizer, about 2.0 nm (3.7 km) from the threshold. Beyond that, the crew was dependent on the protection provided by conducting a missed approach at the MDA or by establishing visual contact with the runway environment.

The author's analysis of the incident, which was reviewed by a select group of aviation professionals including airline pilots, did not establish a likely reason for the aircraft's low approach. Regardless of the cause, the error apparently enabled the crew to gain visual contact with the ground at an earlier point than the conditions normally would have allowed. When the TAWS warning was generated, the aircraft was below the MDA; the crew likely believed that they had the approach lights in sight and continued the approach visually, in the foggy conditions.

It is possible that the crew mistook a pattern of street lights for the approach lights. Near the approach end of the runway are street lights aligned both longitudinally and laterally, resembling the centerline and crossbars of an approach light system. There are also light patterns resembling a PAPI (precision approach path indicator).

Lessons to Be Learned

This incident is believed to be the first "save" by the TAWS obstacle mode. All operators should retrofit this mode in their TAWS equipment or activate the obstacle mode in equipment in which it already is available. The obstacle mode is built into every Honeywell EGPWS; activation of the mode may require a minor modification — a wire-strapping change. The aircraft involved in the incident was the first and, at the time, the only aircraft in the operator's fleet to have been modified with the obstacle mode. The mode is active in the EGPWS equipment in most newly manufactured air carrier aircraft.

When conducting a nonprecision instrument approach, it is essential for the flight crew to identify the correct descent point for the final approach and calculate the required approach timing and vertical speed. Accurate descent rate and airspeed control are required to avoid large deviations in the flight path.

Beware of incorrectly identifying lighting features in low-visibility conditions. Take time to confirm what has been seen, and avoid the tendency to "see" what is expected. Cross-checking the visual scene by the pilot flying and the pilot monitoring is difficult when ground contact is first established. Both pilots could be susceptible to the same perceptual error. It is essential that the monitoring function be based on independent information that can confirm the aircraft's continuing safe flight path below MDA. Altitude/range checks, together with track and airspeed information, are vital elements of a monitoring scan.●

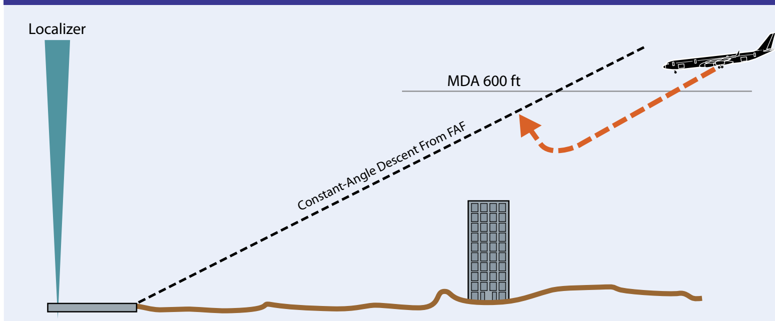
[This series, which began in the July issue of *Aviation Safety World*, is adapted from the author's presentation, "Celebrating TAWS Saves, But Lessons Still to Be Learned," at the 2006 European Aviation Safety Seminar and the 2006 Corporate Aviation Safety Seminar.]

Dan Gurney served in the British Royal Air Force as a fighter pilot, instructor and experimental test pilot. He is a co-author of several research papers on all-weather landings. Gurney joined BAE Systems in 1980 and was involved in the development and production of the HS125 and BAe 146, and was the project test pilot for the Avro RJ. In 1998, he was appointed head of flight safety for BAE Systems. Gurney is a member of the FSF CFIT/ALAR Action Group, the FSF European Advisory Committee and the FSF steering team developing the "Operators Guide to Human Factors in Aviation."

Notes

1. *Terrain awareness and warning system* (*TAWS*) is the term used by the International Civil Aviation Organization to describe ground-proximity warning system (GPWS) equipment that provides predictive terrain-hazard warnings; *enhanced GPWS* (*EGPWS*) and *ground collision avoidance system* (*GCAS*) are other terms used to describe TAWS equipment.
2. U.S. Federal Aviation Administration *Terminal Instrument Procedures*, paragraph 954, "Obstacle Clearance," states, "The transitional surfaces in localizer-only type approaches begin at a height not less than 250 feet below the MDA [minimum descent altitude]."

Aircraft Flight Path



Not to Scale

FAF = Final approach fix   MDA = Minimum descent altitude

Source: Dan Gurney

Figure 1

SHUTTING Out

Pilots on the flight deck need to hear what they want to hear as much as they need to be protected from what they don't want to hear. While visual information is predominant on flight decks, complete reception and comprehension of spoken words from air traffic controllers and other crewmembers and audio signals from electronic systems are vital to flight safety. Aviation headsets — especially with recent advances in noise reduction and sound attenuation — can enhance a pilot's ability to hear those words and signals throughout flight while also protecting hearing.

Consequences of Noise

Flight deck noise affects both the performance and safety of flight crewmembers, and can induce hearing loss.

Noise on the flight deck affects communication by masking important audio signals. Masking is a process in which one of two simultaneous sounds renders the other impossible to hear. Low frequency noise — the sound produced by the slipstream, for example — masks higher frequency sounds such as an instruction from air traffic control, a crewmember's instructions or an audio warning.

Task performance may be affected by the presence of noise, especially loud noise. Studies suggest that noise reduces a person's overall accuracy and negatively affects the completion of complex tasks[1] — tasks that require attention to a large number of cues presented concurrently or in succession.[2]

Noise can produce a host of reactions in humans. These can be physiological, such as headache, fatigue, nausea and insomnia; psychological, such as irritability, anger and anxiety; or cognitive, such as impaired concentration and decreased ability to estimate elapsed time.

Among the worst consequences of high levels of noise is hearing loss. Noise-induced hearing loss can be either temporary or permanent. A temporary hearing loss is a brief shift in the auditory threshold that occurs after a relatively short exposure to excessive noise — more than 90 decibels (dB). Normal hearing recovers fairly quickly after the noise stops. However, if the noise level is sufficient to damage the tiny hairs in the cochlea — the part of the inner ear that is responsible for transforming sound waves into the electrical signals that go to the brain — the threshold shift can be irreversible, resulting in permanent partial or total hearing loss.

Three Components

On the flight deck, headsets — a considerable improvement over hand microphones and speakers once widely used by pilots — protect hearing and reduce ambient noise while enhancing critical communications.

Nathaniel Baldwin is credited with developing the first basic radio headset

Technological advances have resulted in headsets that enhance communication and protect pilots' hearing.

BY CLARENCE E. RASH

the NOISE

while he was a student at Stanford University in California, U.S., and patenting it in 1910. There was little interest in the device until the eve of World War I, when the U.S. Navy ordered 100 headsets.[3]

Nearly all headsets have three basic components: a microphone, ear cups or earplugs, and a harness or headband. Most current aviation headsets are classified as either "heavyweights" — which clamp over the user's head, covering both ears — or "lightweights," which resemble personal music earphones. Lightweights, while designed to be more comfortable, typically do not perform as well as heavyweights in blocking out aircraft noise.

Another method of classification is based on the hearing-protection technology incorporated into the headset. The two types of technology currently used are passive noise reduction — or attenuation — and active noise reduction (ANR) — also called electronic noise cancellation.

Conventional passive noise reduction consists of putting something — such as earplugs or earmuffs — in or over the ears to block noise. Properly inserted, standard earplugs typically provide about 30 to 35 dB of protection across the entire noise spectrum. Most modern passive over-the-ears headsets use soft and flexible cushions to form a good seal, preventing ambient noise from directly entering the ear and providing 20 to 30 dB of protection, which is most effective at higher frequencies. Anything that interferes with the seal, such as sunglass or eyeglass temples, compromises the noise-protection level. Sounds are conducted toward the ear when sound waves — such as the relatively high-frequency sound waves produced by voices or audio signals — hit the outer ear cup and cause the cup to vibrate; this, in turn, causes the air inside the cup to vibrate. Low-frequency sound waves such as those produced by the slipstream do not have enough energy to make the cup vibrate and therefore are not heard.

ANR, first conceived in the 1930s and refined in the 1950s, did not become prevalent in aviation until the 1990s.[4] In conventional ANR headsets, the frequency and amplitude of the sound inside the headset cavity are measured by a small microphone, and a 180-degree out-of-phase copy is produced and fed back into the headset; the two signals superimpose and cancel each other.

Regardless of the type of feedback loop used, in order for ANR headsets to perform their task, they require electrical power from either a battery pack or the aircraft. The ANR technology is generally effective only at lower frequencies. A protection level of 20 dB over this lower frequency range is typical. This makes this type of headset most effective in environments such as aviation, where the noise spectrum consists of mostly lower frequency

sounds.[5] ANR headsets also provide signal-to-noise improvement — clear sounds — by reducing the masking effects of low-frequency noise.

However, ANR is not a one-size-fits-all system. Every pilot has a different hearing response. Therefore, the perceived performance of a selected ANR headset varies from pilot to pilot. Ultimately, the best method of evaluating the effectiveness of an ANR device is for the pilot who plans to use it to try it out in the aircraft that he or she usually flies.

ANR aviation headsets were developed to cancel the lower frequency sounds produced by piston engines and propellers. Because turbine engines typically produce sounds in the mid- to high-frequency ranges, ANR headsets designed for use in piston aircraft will be less effective in turbine aircraft. Ideally, a detailed knowledge of the noise spectrum of the specific aircraft, compared with the performance of the ANR headset, will allow each pilot to choose the ANR device that is best for him. Unfortunately, the noise spectrum pattern produced by a specific aircraft is rarely available.[6]

The U.S. Federal Aviation Administration (FAA), as well as many hearing-protection organizations, recommend a dual protection approach, using both earplugs and a headset.[7] However, the use of earplugs under a headset is somewhat counter-productive; the earplugs impede a pilot's ability to hear headset communications. An approach that provides the extra protection of the earplug without compromising communication is the communication earplug (CEP).

The CEP, which initially was developed for use in U.S. Army helicopters, provides the high-quality hearing protection of an expanding foam earplug while allowing clear passage of speech communication to the ear. A miniature speaker and foam earplug are coupled to yield a lightweight communications device that can be used alone or in combination with over-the-ear hearing protection. The CEP, when worn in combination with other hearing protection, reduces noise exposure to minimal levels.

Tests conducted by the Army showed reductions of "more than 30 dB for the low frequency noise spectra that are prevalent in helicopters," said Ben Mozo of Communications and Ear Protection Inc., developer of the device.

Selection Criteria

A quick survey of the market reveals more than 25 manufacturers offering more than 100 different aviation headset models that range in price from about US$100 to more than $1,000.

In addition to price, headset selection criteria can be separated into performance, comfort and added features.

For performance, the first decision is active or passive noise reduction. At about twice the cost, ANR headsets are considered superior to passive noise reduction systems. Nevertheless, performance depends greatly on the ability of the headset ear cups to seal over the ear. A label should disclose the headset's protection level — a noise reduction rating of at least 24 dB is recommended (see "Rating Systems").

Although the FAA does not regulate headsets, it does provide specification guidance in two technical standard orders (TSOs).[8,9] Many of the specifications discuss construction and environmental criteria for the manufacturer rather than operating and protection performance criteria for the user. Nevertheless, headsets that meet these specifications bear the applicable TSO marking — and this should be a factor in the selection process.

Another performance factor is how a headset receives its power. A headset that can be operated with either battery power or aircraft power is a plus.

In addition to active/passive technology, overall comfort should be considered. Weight and "feel" — that is, clamping pressure and headband/strap design — determine how comfortable a headset will be, especially after several hours of flight. Headset weights typically are about 12 to 18 ounces (340 to 510 grams); a difference of a few ounces may not seem worth worrying about, but over a long period, the extra weight can induce neck strain and headache.

From left, Lightspeed Aviation's LightFlight Mach 1 Headset, Lightspeed's Twenty 3G, Communications and Ear Protection's communications earplug, Lightspeed's QFRXCc and David Clark Co.'s X11.

Clamping pressure and the headband/strap mechanism also are important considerations. All headsets of reasonably good quality have some type of adjustment to permit expansion or tightening of the ear cups. The amount of padding on the ear cups and headband/strap is a strong indicator of how comfortable the headset will be.

Finally, if possible, the pilot should test the headset in the aircraft that he or she usually flies.

Most headsets offer additional features. One option is a choice of ear seals made of foam plastic or newer surgical gels, which manufacturers say are more effective in distributing the pressure of the ear seals against the head. Another is a choice of stereo or monaural speakers, or individualized speaker controls on each headset ear cup to allow for independent adjustment of the volume for each ear. However, the stereo option is useless if the aircraft's audio system does not support stereo outputs.

As with most electronic equipment, keeping a headset in good working order requires regular preventive maintenance. Exterior parts should be cleaned regularly with mild soap and water, and dried well before use. Periodic inspections should be conducted to check for cracks on ear cup seals and missing parts, and to ensure that headband tension is sufficient. Parts that have hardened or cracked and those that cannot be cleaned should be replaced. ●

Rating Systems

One method of rating the protection level provided by hearing protection devices is the noise reduction rating (NRR) system specified by the U.S. Environmental Protection Agency. It is the measure, in decibels (dB), of how well a hearing protector reduces noise; the higher the number, the greater the noise reduction.

When dual protectors are used, the combined NRR is usually accepted as 5 dB more than the higher rating of the two devices. For example, if a pair of earplugs with an NRR of 25 dB is worn under earmuffs with an NRR of 23 dB, the NRR of the combination is 30 dB (25 dB + 5 dB = 30 dB).

Additional protection rating numbers are in use throughout the world. These include the single number rating (SNR) system defined by International Organization for Standardization in ISO/DIS 4869-2.2.

— CER

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Notes

1. Miller, J.D. "Effects of Noise on People." *Journal of the Acoustical Society of America* Volume 56 (1974): 729–762.
2. Kahneman, D. *Attention and Effort*. Englewood Cliffs, N.J., U.S.: Prentice Hall, 1973.
3. SKC Communication Products. *A Brief History of Headsets*. <www.plantronics.com>.
4. Tennyson, E.A. "How to Buy a Headset: A Guide to Get You Started." *AOPA Flight Training*. April 2001.
5. Gauger, D. "Should You Consider ANR for Hearing Protection?" *The Newsletter for the Council for Accreditation in Occupational Hearing Conservation,* Volume 15 (2000).
6. Kernstock, N.C. "Headsets, Helmets and Communications: A Buyer's Market." *Rotor and Wing*. May 2001.
7. U.S. Federal Aviation Administration (FAA). Pilot Safety Brochure AM-400-98/3, *Hearing and Noise in Aviation*. 1998.
8. FAA. Technical Standard Order (TSO) TSO-C57a, *Headsets and Speakers*. 1983.
9. FAA. TSO-C139, *Aircraft Audio Systems and Equipment*. 2005.

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Cross-Control Upset

The Metro's autopilot was engaged when the pilots induced a sideslip to balance fuel. When the autopilot reached its control limits and disengaged, the aircraft rolled and entered a spiral dive.

BY MARK LACAGNINA

Last year's upset and in-flight breakup of a Fairchild Metro III in New Zealand has prompted investigators to call for the development of a standard procedure for balancing fuel in the aircraft while in flight and for a warning that the autopilot must be disengaged during the procedure. The Metro's flight crew was using rudder trim to place the aircraft in a sideslip while balancing fuel in the wing tanks and lost control when the autopilot disengaged and the aircraft abruptly rolled and dived.

The fatal accident occurred during a scheduled cargo flight from Auckland to Blenheim the night of May 3, 2005. In its final report, the New Zealand Transport Accident Investigation Commission (TAIC) said that the upset probably would not have occurred if the crew had hand-flown the aircraft while balancing the fuel.

The aircraft was scheduled to depart at 2100 local time, but the loading of the cargo was not completed until 2115. The flight crew then ordered about 1,000 lb (454 kg) of additional fuel and told the fueler to put all of it into the left wing tank. "This was probably to expedite their departure after the delayed loading," the report said. The crew took action to balance the fuel, and the wing tanks likely were within the 200-lb (91-kg) maximum differential specified by the aircraft flight manual (AFM) for takeoff.

The aircraft departed from Auckland at 2136. The captain, 43, had 6,500 flight hours, including 2,750 flight hours in type, and was a Metro line-training captain for the operator, Airwork (NZ) Limited. The first officer, the pilot flying (PF), 41, had 2,345 flight hours, including 70 flight hours in type. Both pilots held Metro type ratings. They had flown together once previously, five days before the accident flight. "The operator's records showed that both pilots had been trained in autopilot use and in fuel-transfer procedures," the report said.

The crew flew the aircraft to Flight Level (FL) 180 (approximately 18,000 ft), where they likely encountered instrument meteorological conditions and moderate turbulence. The crew requested, and received, clearance to climb to

FL 220. After reaching that flight level, the crew maintained climb power for about 15 minutes to make up some of the delay in departure. The report said that the aircraft likely was above the clouds and in smooth air at FL 220.

Unpublished Technique

The Metro's fuel system comprises two wing tanks that supply fuel to their respective engines. The tanks are connected by a crossflow tube containing a valve that can be opened to balance fuel between the tanks or, if one engine is inoperative, to make the fuel in both tanks available to the operative engine. "The gravity-crossflow fuel system was unusual and probably confined to the SA 226/227 [Merlin/Metro] family of aircraft," the report said. "Other types had either a pumped crossfeed system or a pumped crossflow system."

Annunciator lights indicate when the crossflow-valve switch is selected to "OPEN" and when the crossflow valve is not fully closed. Several checklists, including the "Before Starting Engines" and the "Before Takeoff" checklists, require the crossflow valve to be closed.

Airwork told investigators that it believed a fuel imbalance was unlikely to develop during a typical flight duration with both engines operating normally and with the crossflow valve closed. However, other Metro operators said that they had observed fuel imbalances as great as 120 lb (54 kg) per hour "between engines that were at the opposite ends of the overhaul period." The overhaul period for the Metro III's Honeywell TPE331 engines is 7,000 hours. The left engine on the accident aircraft had accumulated 710 hours since its last overhaul; the right engine had accumulated 3,491 hours since overhaul.

Airwork did not have a written procedure for balancing fuel, and the AFM provided no detailed procedure, the report said.

"The operator's usual but unpublished technique to balance the fuel in flight, if necessary, was to open the crossflow valve and fly with the fuller wing held just higher than wings-level attitude," the report said. "Slight opposite rudder, or 'cross-control,' was necessary to maintain the desired heading. The operator considered that this method was adequate and balanced the fuel quickly. Information obtained from pilots with Metro experience with several operators confirmed that this method was used [and that] it required minimal rudder-control input and was efficient. Some pilots reported that they would apply a small amount of rudder trim while the aircraft was flying on autopilot to achieve this."

After the crew completed the "Cruise" checklist about 2212, the captain decided to transfer fuel from the left wing tank to the right wing tank. "There was no evidence of how much imbalance he was responding to," the report said. The imbalance likely resulted from the asymmetric fueling rather than a difference in the engines' fuel consumption. "The engine with the longer time since overhaul was still only halfway through the overhaul period, and the flight time since [the aircraft] left Auckland was probably insufficient to develop much fuel imbalance," the report said. "The imbalance may have been within AFM limits [200 lb] for the upcoming landing but was sufficient for the captain to want to tidy up while the aircraft was in cruise."

The captain told the first officer, "We'll just open the crossflow [valve] again. … Sit on left ball and trim it accordingly." The report said that the captain then clarified the instruction: "Step on the left pedal and just trim it to take the pressure off," he said. "Get the ball out to the right as far as you can … and just trim it."

The first officer said, "I was being a bit cautious." The report said that this comment likely indicated that the first officer was concerned that the rudder input commanded by the captain was excessive.

"Don't be cautious, mate," the captain said. "It'll do it good."

The first officer asked, "How's that?" The captain replied, "That's good. Should come right. Hopefully, it's coming right."

'You'd Better Grab It'

The report said that the autopilot likely was maintaining the selected altitude and the selected heading or course. "When left rudder was applied, the aircraft would have yawed left and tried to roll left as a result of normal aerodynamic yaw/roll coupling," the report said. "The autopilot would have applied right aileron control to counter this rolling tendency and would also have tried to maintain the heading (or course) by applying more right aileron so that the aircraft flew right-wing-down in a straight sideslip to the right."

The crew did not increase power from the cruise setting, and airspeed began to decrease. Air traffic control (ATC) radar data and flight data recorder (FDR) data indicated that the aircraft began a gradual left turn. The turn rate then increased, and the aircraft began to descend.

The captain said, "Doesn't like that one, mate. You'd better grab it." The aircraft's ground-proximity warning system (GPWS) then generated an aural "bank angle" warning. The report said that this warning is provided when bank angle exceeds 40 degrees and is repeated every three seconds until bank angle decreases below 40 degrees.

Soon after the first "bank angle" warning, the cockpit voice recorder (CVR) recorded a chime, which probably indicated a deviation from the selected altitude, the report said. During the next 23 seconds, the CVR recorded seven more "bank angle" warnings.

New Zealand Transport Accident Investigation Commission

"The probable explanation for the bank angle excursion and the altitude loss is that the autopilot had disengaged automatically as a result of a servo reaching its torque limit," the report said. "With the autopilot constraint removed, the aircraft abruptly responded to the trimmed rudder input by rolling left and starting to yaw its nose down into a steeply banked diving attitude."

The captain asked the first officer to confirm that the autopilot was disengaged. Soon after the first officer confirmed that the autopilot was disengaged at 2213, the CVR recording ended. ATC radar contact was lost a few seconds later, as the aircraft descended through 19,900 ft.

Airspeed and wing loading increased rapidly. Twelve seconds after the captain told the first officer to "grab it" — take manual control of the aircraft — maximum operating airspeed, 227 kt, was exceeded. Wing loading increased beyond the limit load of +3.02 g, or 3.02 times standard gravitational acceleration.

"Over the last 20 seconds of recorded data, the airspeed increased from 175 [kt] to almost 300 kt, the vertical acceleration increased from about +1.5 g to +4.2 g," the report said. "These data characterize a rapidly developing spiral dive."

Trim Likely Thwarted Recovery

The left-rudder trim that had been applied to balance the fuel likely contributed to the crew's inability to regain control of the aircraft. "The FDR did not record control positions, so it is not possible to determine exactly what the crew did to try to return the aircraft to a normal attitude," the report said. "The normal recovery action sequence for a spiral dive is:

- "Reduce power to minimize airspeed increase;
- "Roll the aircraft to wings-level; then,
- "Pitch the aircraft up to the horizon."

The report said, "This action needs to be taken promptly, positively and smoothly, and in that order, so that flight-envelope limitations are not exceeded."

The CVR recorded the sounds of power reduction about seven seconds before the recording ceased. "This was late in the development of the spiral dive, and the delay would have exacerbated the situation," the report said.

Compression buckling in both wings indicated that the crew applied substantial right-wing-down aileron-control input. "This indicated that appropriate control input was being made to try to roll the aircraft to the right, towards wings-level, as the aircraft wing structure became loaded towards failure," the report said. "The reason why the applied right aileron control was not effective in rolling the aircraft towards wings-level was not conclusively determined, but it was likely to have been a direct result of the left rudder trim which had been applied, and which probably remained applied throughout."

Increasing aerodynamic loads recorded by the FDR indicated that substantial up-elevator control input also was applied. "This elevator input would have been ineffective in pitching the aircraft up towards the horizon, however, because of the steeply banked attitude," the report said. "It could only have further tightened the turn, escalating the spiral dive. The bank attitude needed to be reduced towards wings-level before the elevator control could raise the nose of the aircraft."

The report said that a fire erupted when both wings folded upward and separated from the aircraft. Several witnesses described an intense and unusual noise, and orange-yellow lights or fireballs falling through broken layers of cloud. The left wing was on fire as it fell. The flight deck, which had been struck by the left propeller when the wing folded, also separated in flight. Most of the wreckage was found at about 700 ft on hilly farmland 7.0 km (3.8 nm) northeast of Stratford, which is near the western coast of New Zealand's North Island.

Similar Events

The report cited an incident in Australia and a fatal accident in the United States in which fuel imbalances and upsets likely occurred in similar aircraft.

Fairchild SA-227AC Metro III

© Steve Lake

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, regional airline derivative, the Metro, have had Garrett, now Honeywell, TPE331 engines. The Metro III, introduced in 1981, has longer wings, a greater useful load and more powerful engines than the preceding Metro models.

The aircraft accommodates two pilots and 20 cabin occupants. Maximum takeoff weight is 14,500 lb (6,577 kg). Maximum fuel weight is 4,342 lb (1,970 kg). Maximum rates of climb are 2,370 fpm with two engines and 690 fpm with an engine out. Maximum cruise speed at 25,000 ft and at 12,500 lb (5,670 kg) is 263 kt. Stall speeds are 98 kt clean and 87 kt in landing configuration.

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

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

The incident involved a Fairchild Merlin III that was on a charter flight in New South Wales on Aug. 30, 2004.[1] The fuel systems in the Merlin and the Metro are essentially the same. The pilot said that after reaching cruise altitude, FL 160, he observed that the aircraft was in a slightly right-wing-low attitude. He used left-rudder trim to level the wings and engaged the autopilot. About 2.5 minutes later, the autopilot disengaged, and the aircraft rolled right and entered a spiral dive. The pilot regained control about 50 seconds later, at 5,200 ft. Neither he nor his seven passengers were injured. The pilot told investigators that, after regaining control, he noticed that the fuel gauges showed 772 lb (350 kg) more fuel in the right tank than in the left tank. The final report

“The amount of control-wheel displacement by the autopilot would not have been readily apparent on a dark flight deck at night.”

on the incident by the Australian Transport Safety Bureau said that the fuel imbalance likely occurred because the crossflow valve either was open when the flight began or was inadvertently opened during the flight.

The U.S. National Transportation Safety Board investigation of the Feb. 8, 2006, accident in Paris, Tennessee, was continuing at press time. A preliminary report said that during a cargo flight from Ohio to Texas at 16,000 ft, the pilot of a Swearingen Metro II conducted 360-degree turns to the left and right, and then requested radar vectors to the nearest airport.[2] After issuing a heading to the nearest airport, the air traffic controller asked the pilot if he had an emergency. The pilot replied that he had an asymmetric fuel condition. “About a minute later, the pilot transmitted ‘mayday’ six times, and shortly after this, radar and radio contact with the flight was lost,” the preliminary report said. “The airplane was heard and then seen descending at a high rate of speed in a near-vertical attitude.”

Tactile Feedback

The TAIC report said that by flying the aircraft with the autopilot engaged, the first officer received no tactile feedback of the control forces that were being applied during the sideslip maneuver.

“If the autopilot had not been engaged, the PF would have had to apply right aileron manually in coordination with the left rudder input to achieve the same result,” the report said. “In manual flight, the PF would have received continuous tactile feedback from the controls to indicate the control forces and displacements he was producing, and would have had to monitor closely the aircraft attitude and heading on his instruments. With the autopilot engaged, and especially with the rudder trimmed out, he would not have had such feedback because the autopilot would have been holding the control forces generated, and the PF might not have perceived a need to monitor the aircraft’s attitude closely.

“In addition, both pilots may have been monitoring the fuel gauges to observe the success or otherwise of the fuel transfer. The amount of control-wheel displacement by the autopilot would not have been readily apparent on a dark flight deck at night.”

The report said that the absence of a written standard operating procedure (SOP) for balancing fuel with the Metro’s — and Merlin’s — gravity-crossflow system creates the potential for individual pilots to use different methods, including the “extreme sideslip” that the accident captain instructed the first officer to use.

“Written SOPs are the normal method for an operator to detail to crews how to perform common tasks,” the report said. “This ensures that tasks are carried out in a safe and efficient manner, and that each crewmember knows what is required. While the fuel-balancing procedure might not be required on many flights, it clearly needed a written SOP. Because the gravity-crossflow system was specific to the Metro family of aircraft, the appropriate procedure was unlikely to fall within pilots’ understanding of good aviation practice.”

Based on these findings, the TAIC in February 2006 recommended that the New Zealand Civil Aviation Authority (CAA) work with the U.S. Federal Aviation Administration (FAA) to amend the AFMs of the Metro/Merlin family of aircraft “to include a limitation and caution that the autopilot and yaw damper must be disconnected while in-flight fuel balancing is done.” TAIC also recommended that the CAA and FAA incorporate in the AFMs a procedure for in-flight fuel balancing.

In May 2006, the CAA replied that it accepted the recommendations and had begun correspondence with FAA on amending the AFMs. ●

This article is based on New Zealand Transport Accident Investigation Commission Aviation Occurrence Report 05-006: “Fairchild-Swearingen SA227-AC Metro III ZK-POA, Loss of Control and In-flight Break-up Near Stratford, Taranaki Province, 3 May 2005.” The 44-page report contains illustrations.

Notes

1. Australian Transport Safety Bureau Aviation Safety Investigation Report 200403209.
2. U.S. National Transportation Safety Board preliminary report ATL06FA045.

Looking East

For both Eastern-built and Western-built large transport aircraft, accident rates were higher for turboprops than for jets in 1995 through 2004.

BY RICK DARBY

Eastern-built large transport aircraft — manufactured in the Soviet Union or Russian Federation — were involved in 5 percent of the world's flights, 6 percent of flight hours and 34 percent of fatal accidents during passenger or cargo operations between 1995 and 2004, according to the U.K. Civil Aviation Authority (CAA) Safety Regulation Group.[1]

Those aircraft, shown in Table 1, included turboprops and jets, but not business jets.

"Within the Eastern-built subset, 61 percent of flights flown between 1995 and 2004 were performed by Eastern-built jets and 39 percent by Eastern-built turboprops," the CAA report says. "The breakdown by hours flown between 1995 and 2004 shows that 67 percent were [flown] by Eastern-built jets and 33 percent by Eastern-built turboprops."

The distribution of turboprops versus jets in fatal accidents was approximately the reverse of that for flights and flight hours during the same time period. Jets were involved in 61 percent of flights but 36 percent of fatal accidents, and turboprops flew 39 percent of flights but were involved in 64 percent of fatal accidents, says the report.[2]

Figure 1 shows the three-year moving average rates for fatal accidents involving Eastern-built turboprops, jets and all aircraft.[3] The average peaked at 9.6 fatal accidents per million flight hours for turboprops. The report

Eastern-Built Aircraft Types

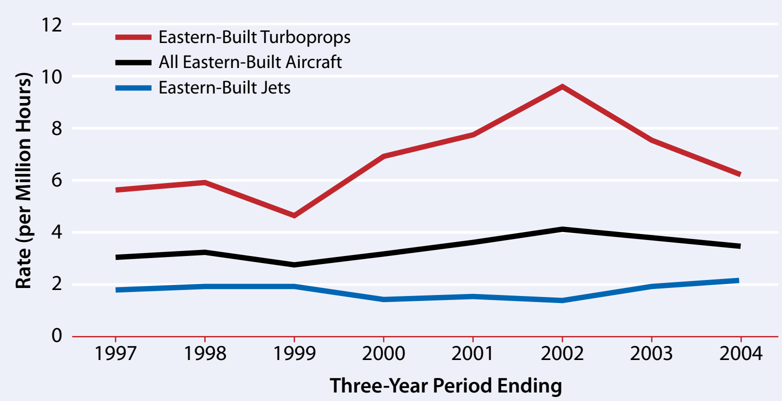
Jets			
Antonov An-124	Ilyushin Il-62	Tupolev Tu-134	Yakovlev Yak-42
Antonov An-225	Ilyushin Il-76	Tupolev Tu-154	
Antonov An-72	Ilyushin Il-86	Tupolev Tu-204	
Antonov An-74	Ilyushin Il-96	Yakovlev Yak-40	
Turboprops			
Antonov An-12	Antonov An-26	Antonov An-38	Let L-410 Turbolet
Antonov An-140	Antonov An-28	Antonov An-8	Let L-610
Antonov An-22	Antonov An-30	Ilyushin Il-114	SAC Y-8
Antonov An-24	Antonov An-32	Ilyushin Il-18	XAC Y-7

Source: U.K. Civil Aviation Authority

Table 1

Fatal Accident Rates for Eastern-Built Aircraft

Three-Year Moving Average, 1995–2004



Note: Excludes business jets.

Source: U.K. Civil Aviation Authority

Figure 1

gives a comparable picture for fatal accident rates involving Western-built aircraft, also excluding business jets, during the same period, shown in Figure 2.

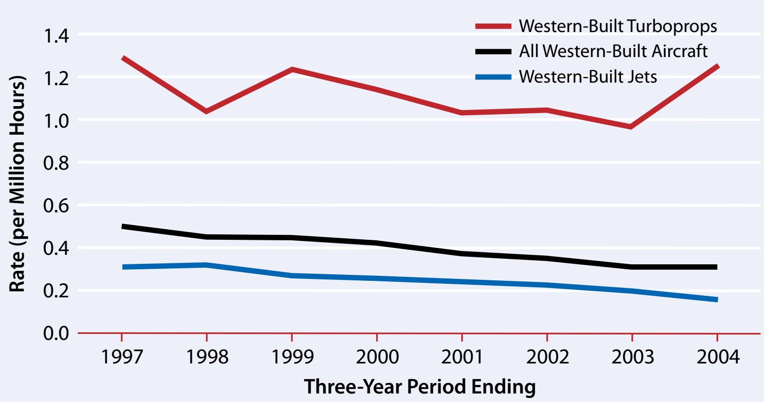
"Western-built aircraft (jets and turboprops combined) have generated 95 percent of flights flown (and 94 percent of hours flown) by all jets and turboprops, and have been involved in 67 percent of the fatal accidents," the report says.[4]

As with Eastern-built aircraft, the fatal accident rate was higher for turboprops than for jets. All the three-year moving average rates for Western-built turboprops were lower than those for Eastern-built turboprops throughout the period, however. For Western-built aircraft, 70 percent of flights and 83 percent of flight hours involved jets. Fatal accidents were divided equally between turboprops and jets, says the report.

Fatal accident rates for all jets and turboprops in the same period are shown in Figure 3. The long-term trend for jets shows a decrease, but no long-term trend for turboprops is evident. ●

Fatal Accident Rates for Western-Built Aircraft

Three-Year Moving Average, 1995–2004



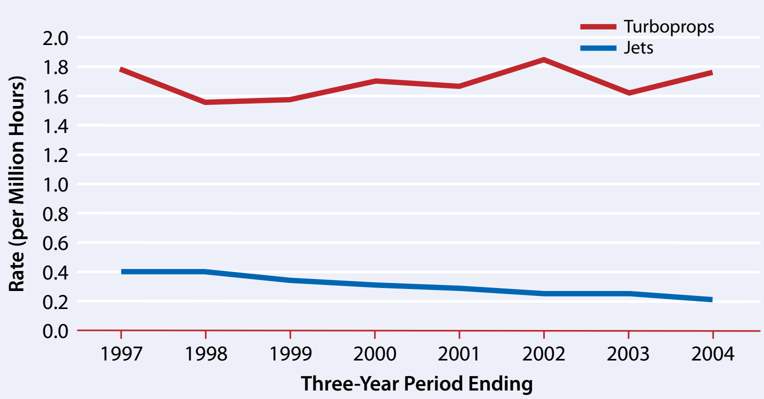
Note: Excludes business jets.

Source: U.K. Civil Aviation Authority

Figure 2

Fatal Accident Rates for Eastern-Built and Western-Built Aircraft

Three-Year Moving Average, 1995–2004



Note: Excludes business jets.

Source: U.K. Civil Aviation Authority

Figure 3

Notes

1. U.K. Civil Aviation Authority (CAA), Safety Regulation Group. *Aviation Safety Review 2005*. CAP 763. Aug. 8, 2006. Available on the Internet at <www.caa.co.uk>.

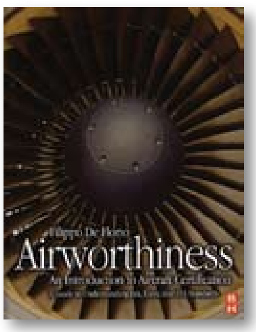
2. Data originated from Airclaims, supplemented by accident briefs and reports from other sources, and were reviewed by the CAA. Utilization data for Eastern-built aircraft (i.e., flight hours) were estimated to a greater extent than for Western-built aircraft.

3. A moving average is an average that is recomputed periodically in a time series by removing the oldest data and including the most recent data. The effect is to smooth out the data points and make trends more visible.

4. One of the fatal accidents was a midair collision involving an Eastern-built aircraft and a Western-built aircraft. "Midair collisions are normally considered as one accident but, when the accidents are broken down by class of aircraft [e.g., Western-built turboprops], there will be double counting if the individual components are summed back together," says the report.

Airworthiness Now

A current guide to certification sees progress in the integration of European standards under one safety organization.



BOOKS

Airworthiness: An Introduction to Aircraft Certification

De Florio, Filippo. Oxford, England, and Burlington, Massachusetts, U.S.: Butterworth-Heinemann, 2006. First edition. 261 pp. Figures, bibliography, index.

"To allow an aircraft to be operational in normal air traffic, it is necessary to demonstrate that its design and construction are in compliance with the applicable requirements; the verification of such compliance is entrusted to the competent authorities," says De Florio. "*Airworthiness* introduces aerospace engineering students and engineers into this world consisting, on the one hand, of designers, manufacturers and operators, and, on the other, of airworthiness authorities, in two disciplines that should work in unison, because they should aim at a common goal: flight safety."

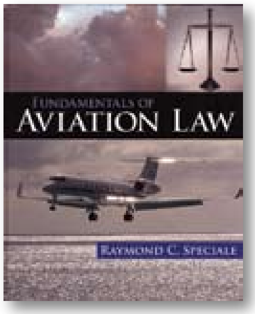
The book discusses certification regulations, the agencies that write them and the agencies that verify that they are followed from aircraft design to construction. Chapters cover the International Civil Aviation Organization and national and regional civil aviation authorities such as the Joint Aviation Authorities (JAA), the European Aviation Safety Agency (EASA) and the U.S. Federal Aviation Administration; airworthiness requirements; type certification; products, parts and appliances; airworthiness certification; and continued airworthiness in flight operations.

De Florio believes that the creation of EASA and its gradual assumption of the regulatory role is a step forward. He says, "In spite of a huge amount of work accomplished for unification of regulations and procedures in Europe, the JAA did not have the authority to impose these rules. The EASA now has this power and can perform as a single authority. For instance, once an aircraft is type certificated by the EASA, this type certificate is valid for all the Member States, without being just a 'recommendation' for the issue of a national type certificate. Today, we have a single European agency instead of 25 national authorities, and a single certificate for aeronautical products."

Fundamentals of Aviation Law

Speciale, Raymond C. New York: McGraw-Hill. 360 pp. Figures, appendixes, bibliography, index.

"It is important for all aviation professionals, including pilots, executives, air traffic controllers and mechanics, to have a fundamental understanding of the legal environment in which they operate," Speciale says. He notes, however, that there is no universal recognition of "aviation law" as a distinct branch of legal systems, and subjects that apply to aviation can fall under traditional headings such as commercial law, tort law, employment law and property law. Non-U.S. readers should note that the book is mainly based on U.S. law, although the final chapter takes up international aviation law with sections on international agreements such as the Chicago Convention, Warsaw Convention and bilateral treaties.



Chapters are devoted to tort (injury) liability and air commerce, administrative agencies such as the U.S. Federal Aviation Administration, commercial law's applicability to aviation transactions, corporate and property law for aviation enterprises and employment law for the aviation industry.

Ways in which criminal law can affect pilots and air carriers are discussed in chapter 3. Offenses can include document falsification, transporting hazardous materials without authorization, operating an unregistered aircraft, and unauthorized fuel tank modifications.

"Whether a regulatory violation crosses the line into the realm of criminal violations is a difficult question to answer at times," Speciale says. He cites the U.S. federal government indictment of SabreTech, the operator of a repair station that packed partially expended oxygen generators as cargo aboard ValuJet Flight 592 in May 1996. The airliner crashed in the Florida Everglades, killing all 110 people aboard, after the eruption of a fire that later was attributed to the oxygen generators on the airplane.

An appeals court overturned a conviction against SabreTech and several of its employees on the grounds that "these aviation repair station personnel committed mistakes, but they did not commit crimes."

REPORTS

Manual for Preventing Runway Incursions

International Civil Aviation Organization (ICAO). Document 9870. First edition. 2006. 86 pp. Figures, references, appendixes. Available via the Internet at <www.icao.int/FSIX/Library1.cfm> or from ICAO.*

In 2001, the ICAO Air Navigation Commission identified areas that needed to be addressed for progress in runway incursion prevention. They included radio communications phraseology, language proficiency, equipment, airport lighting and markings, airport charts, operational aspects, situational awareness and human factors.

ICAO embarked on an education and awareness campaign, beginning with a comprehensive search of the best available educational material for an interactive runway safety tool kit, included in this manual as an appendix. The organization held runway safety seminars in its various regions, culminating in the runway incursion prevention guidelines on which this manual is based.

"An evolution in terms of safety thinking has led to a change of focus, from individuals to organizations," the manual says. "It is now acknowledged that senior management decisions are influential in shaping the operational contexts within which operational personnel perform their duties and discharge their responsibilities. It is also well known that, no matter the extent to which operational personnel may excel in their performance, they can never ultimately outperform, safety-wise, systemic deficiencies and flaws in the system that [includes] them."

Chapters discuss contributory factors in runway incursions; establishing a runway incursion prevention program; recommendations for prevention of runway incursions — for aircraft operators, pilots, air traffic services providers and controllers, and regulators; incident reporting and data collection; and severity classification of runway incursions.

Systems can and should be improved, the manual says, but ultimately "properly selected, trained and motivated personnel" are the last line of defense against breakdowns of the system that are rare but inevitable. "Operational personnel are the true goalkeepers of the aviation safety system," says the manual.

Main Report for the 2005/2012 Integrated Risk Picture for Air Traffic Management in Europe

Spouge, John; Perrin, Eric. European Organisation for the Safety of Air Navigation (Eurocontrol), Eurocontrol Experimental Centre. EEC Note no. 05/06. April 2006. 98 pp. Figures, tables, references. Available on the Internet at <www.eurocontrol.int/eec/public/subsite_homepage/homepage.html> or from Eurocontrol.**

Eurocontrol has developed an integrated risk picture (IRP) for air traffic management (ATM) in Europe to describe the safety priorities in the gate-to-gate ATM cycle and the safety implications of future ATM developments. This report includes a baseline IRP for 2005 and a benchmark for 2012.

Among the questions the report asks, and tries to answer, are:

- What is the safety assessment of the overall system?
- How might new elements (e.g., conflict detection and resolution systems) interact?
- Can negative interactions be avoided, and as-yet unplanned positive interactions be introduced into the system design concept?
- What are the strong and weak safety areas in the overall system?
- Is the resultant system risk-sensitive to the sequence and timing of implication?

The report concludes that the IRP methodology, although needing further development, "provides the best currently available picture of the ATM contribution to aviation accident risks, and appears suitable for the wide range of intended uses and recommendation of safety improvements."

Gate to Gate Safety: Solving Interface Problems in the Aviation System. Results of Working Group B, Flight Operations & Flight Crew Training

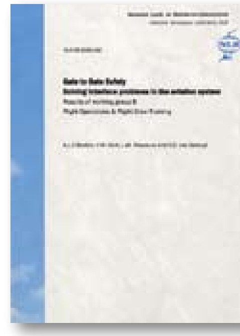
Roelen, A.L.C.; Smit, H.H.; Risseeuw, L.W.; van Bossuyt, B.C. National Aerospace Laboratory (NLR)–Netherlands. NLR-CR-2006-342. August 2006. 26 pp. Figures, tables, references, appendix. Available from NLR.***

"The ability to communicate and cooperate between different disciplines of the aviation system is vital for the system's safety performance," the report says. "In the current aviation system, interfaces [defined as a boundary across which two systems communicate] are not properly managed, and these interface problems downgrade flight safety."

To demonstrate that solutions to interface problems can be developed, two working groups were created, both including operational specialists from various disciplines. This report describes a working group committed to solving interface problems between flight operations and flight crew training. The task of the working group was to provide detailed problem descriptions, develop original solutions and design their practical implementation — a methodology called Gate to Gate Safety.

"The group had a total of four meetings," the report says. "In the first session, a description of the flight crew training process was discussed and agreed upon. A brainstorm was held in the second session to identify flows of information and to describe existing interface problems. In the third session, solutions to the identified interface problems were generated. These solutions were further specified in the final session."

The report concludes that the Gate to Gate Safety methodology works: "Within a limited amount of time and resources, this working group came up with useful results."



WEB SITES

International Civil Aviation Organization (ICAO), <www.icao.int/>

The International Civil Aviation Organization (ICAO), a United Nations Specialized Agency, works with member states to achieve safety, security and sustainable development of civil aviation. Through its Web site, ICAO gives members and nonmembers access to important safety information.

ICAO has posted selected guidance materials online at no cost. These free documents may be viewed, printed or downloaded to the user's computer. Not all are available in all official ICAO member languages. Free material appears in numerous locations throughout the Web site, and the find is worth the hunt. Following are examples of these materials and their locations:

- The publications section lists a number of free items. Examples are *Systems Management Manual* (290 pages); preliminary, unedited chapters from the *Manual of Civil Aviation Medicine*; and *MRTD Report*, the new ICAO journal devoted to machine-readable travel documents.

- The signature publication, *ICAO Journal*, is available in full text and color for years 1991–2005. Viewing these issues requires DjVu Viewer, a Windows program that can be downloaded at no cost using the posted Web link.

- The aviation safety section of ICAO's home page links to the Flight Safety Information Exchange, which has its own online library. Some full-text documents and manuals are *ICAO Manual of Preventing Runway Incursions*, May 2006, and *Principles and Guidelines for Duty and Rest Scheduling in Commercial Aviation* by the U.S. National Aeronautics and Space Administration, May 1996.

Hard-copy and electronic versions of documents and manuals are available for purchase through eCommerce, ICAO's online catalog of publications.

Aircraft Owners and Pilots Association (AOPA), Air Safety Foundation (ASF), <www.aopa.org/asf/>

ASF promotes safety and pilot proficiency through training, seminars and courses, research and analysis, safety education programs, and publications primarily for general aviation pilots. Much of ASF's information is free online.

One free safety online course of interest to airline operators is *Runway Safety*, available in versions for airlines and general aviation. It was "designed to help pilots avoid and prevent runway incursions by studying the various factors involved," says the course introduction. The complex, interactive course uses combinations of graphics, sound and animation to teach and test pilots.

The opening page of the training program describes system and Internet requirements, estimated downloading times and estimated time to complete the program. Participants can comment on the programs through e-mail links to AOPA or Air Line Pilots Association, International (ALPA).

ALPA and FAA Office of Runway Safety and Operational Services provide alternative access to this runway safety program through their respective Web sites.

REGULATORY MATERIALS

Approval of Flight Guidance Systems

U.S. Federal Aviation Administration (FAA) Advisory Circular 25.1329-1B. July 17, 2006. 146 pp. Tables, appendixes. Available from FAA via the Internet at <www.airweb.faa.gov>. ●

Sources

* International Civil Aviation Organization
Document Sales Unit
999 University Street
Montreal, Quebec H3C 5H7 Canada

** Eurocontrol
96, Rue de la Fusée
B-1130 Brussels Belgium

*** National Aerospace Laboratory (NLR)
Anthony Fokkerweg 2
P.O. Box 90502
1006 BM Amsterdam The Netherlands

Books, reports and regulatory materials in InfoScan are available to FSF members on site in the Jerry Lederer Aviation Safety Library <www.flightsafety.org/library.html>.

— Rick Darby and Patricia Setze

Absence of Required Lights Cited in Nighttime Landing Accident

Hawker touched down off the left side of the snow-covered runway.

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

Passengers Did Not Receive Safety Briefing

Hawker-Siddeley HS-125-600A. Substantial damage. Three serious injuries, three minor injuries.

The Hawker, operated by a U.S. aircraft-management company, was on a charter flight from Montreal to Bromont Airport in Quebec, Canada, on Feb. 21, 2005. The flight crew had not flown to Bromont before. The captain, the pilot flying, had 5,000 flight hours, including 750 flight hours in type. The copilot had 1,700 flight hours, including 100 flight hours in type.

The report by the Transportation Safety Board of Canada (TSB) said that while the captain was filing an instrument flight plan before takeoff, he was asked by the flight information center specialist if he needed notices to airmen (NOTAMs). The captain said that he did not need them. At the time, a NOTAM advised that the runway edge lights at Bromont were out of service.

The report said that the airport was not required to be closed because the runway edge lights were out of service. However, the flight crew was prohibited from conducting a nighttime landing at the airport because the absence of runway edge lights or reflective markers meant that the airport's lights did not meet Canadian, or U.S., requirements.

Bromont Airport did not have weather-observation or reporting services. The report said that weather conditions at Bromont were similar to those at an airport 30 nm (56 km) away, which had 1 mi (1,600 m) visibility in light snow flurries and cloud cover at 2,000 ft. "According to paragraph 135.213(b) of the FARs [U.S. Federal Aviation Regulations], when a flight is conducted under instrument flight rules, the weather observations produced and given to the pilots must be taken at the airport where the aircraft is heading, unless otherwise authorized by an operating specification issued by the FAA [U.S. Federal Aviation Administration] or by a designated person," the report said. "However, there is no indication that the company had such a specification."

The flight crew conducted the localizer approach to Runway 05L, which is 5,000 ft (1,525 m) long and 100 ft (31 m) wide. During the approach, the copilot activated the airport's radio-controlled lights and established radio communication with the Unicom operator, who told the crew that there was snow on the runway and that the runway edge lights were not in service. "However, the approach lights and the visual approach slope indicator did turn on," the report said.

The aircraft was about 5 nm (9 km) from the runway threshold and at 1,000 ft when the crew gained visual contact with the approach lights and precision approach path indicator (PAPI). Although the approach chart and airport diagram in the crew's possession indicated that the PAPI was on the left side of the runway, the crew apparently was unsure of its position. "In response to a query from the crew, the Bromont dispatcher [Unicom operator] indicated that the PAPI was on the right side of the runway," the report said. "From his location facing the aircraft, the PAPI was to the dispatcher's right."

The crew continued the approach visually and aligned the aircraft to touch down left of the PAPI. "At approximately two miles [4 km] from the runway threshold, the copilot noticed that the approach lights were at his right," the report said. "He reported his observation to the captain, who paid little attention to it." Both pilots apparently were focusing their attention outside the aircraft; neither pilot noticed instrument indications of deviation from the localizer course.

Two seconds before touchdown, the copilot asked the captain if he had the runway in sight; the captain did not reply.

Two seconds before touchdown, the copilot asked the captain if he had the runway in sight; the captain did not reply. "Since the snow-covered runway provided little contrast with the adjacent terrain, and the flight took place at night without runway edge lights, it was impossible to distinguish the runway from the surrounding terrain," the report said.

The aircraft touched down 300 ft (92 m) left of the runway and 1,800 ft (549 m) beyond the threshold. "When the captain realized that he was not on the runway, he applied full power to execute a missed approach; however, the aircraft hit a ditch approximately four feet [1.2 m] deep that was perpendicular to the flight path," the report said. "The nosewheel and right landing gear collapsed. The aircraft came to a stop facing back the way it had come, after traveling a distance of 1,800 feet during which it made a full turn followed by a 180-degree turn."

Both pilots and one passenger received serious injuries, and three passengers received minor injuries. The pilots were unable to shut down the left engine because of damage that restricted movement of a fuel valve. The report said that the passengers, who had not received a safety briefing before departure, had difficulty hearing the copilot's evacuation instructions because of the noise from the engine. The emergency exit above the right wing could not be opened because of structural damage. The main door at the front, left side of the cabin was opened with difficulty, but the airstairs could not be lowered fully because of the collapsed nose gear. Several occupants tripped or entangled their feet while exiting the aircraft.

Based on the findings of its investigation, TSB said that the following were causes or factors contributing to the accident:

- "The flight crew attempted a night landing in the absence of runway edge lights;
- "The runway was not closed for night use despite the absence of runway edge lights. Nothing required it to be closed; [and,]
- "Poor flight planning, noncompliance with regulations and standard operating procedures (SOPs), and the lack of communications between the two pilots reveal a lack of airmanship on the part of the crew."

Glideslope Excursion Unexplained

Boeing 747-200. No damage. No injuries.

Lacking recorded flight information, investigators were unable to determine whether an instrument landing system (ILS) signal error or a fault in the aircraft's equipment caused the aircraft, which had 15 crewmembers and 450 passengers aboard, to descend to 1,200 ft when it was 8 nm (15 nm) from the runway threshold during a coupled approach to London Heathrow Airport about 1220 local time Jan. 10, 2006.

The report by the U.K. Air Accidents Investigation Branch (AAIB) said that visibility was good below a 1,500-ft ceiling when the flight crew was cleared to conduct the ILS approach to Runway 27R. The airplane was 14 nm (26 km) from the runway and at 4,000 ft when the autopilot captured the glideslope and the aircraft began to descend. "The flight crew reported that after a short time, they identified that the glideslope indications were showing progressively greater 'fly-down' commands and the autopilot was attempting to pitch the aircraft's nose down to follow these indications," the report said.

The crew then received a glideslope failure indication and a "NO AUTOLAND" message on the engine indicating and crew alerting system. The first officer, the pilot monitoring, asked the air traffic controller if there was a fault with the glideslope. The controller, who had observed the aircraft's unusually low altitude, told the crew to climb and said that the glideslope was serviceable. The aircraft was descending at 1,800 fpm when the commander disengaged the autopilot and conducted a climb to 1,800 ft. "With the glideslope indications then looking reasonable again and no failure indications, the commander armed the autopilot to capture the glideslope, and it did so," the report said. "A successful autopilot approach was completed, and the landing was accomplished manually."

None of the pilots who conducted the ILS approach before and after the 747 crew reported problems with the glideslope. No faults or failures were recorded by the ILS self-monitoring system. The 747 crew recorded the glideslope fluctuation in the aircraft's technical log but did not file a report on the incident. Heathrow controllers reported the incident as a level bust.

AAIB said that it became aware of the incident several weeks after it occurred; by then, the aircraft's flight data and cockpit voice recordings had been overwritten. "Based on the available evidence, the problem was either external to the aircraft but experienced only by [the aircraft] or an unidentified internal fault within the aircraft," the report said. "However, the lack of recorded flight data and the inability to evaluate the aircraft soon after the incident rendered further investigation impracticable."

The report said that risk was minimal in the incident. Had the flight crew continued the descent, they likely would have gained visual contact with terrain in time to avoid controlled flight into terrain. "Had the cloud base been lower, the aircraft's GPWS [ground-proximity warning system] should also have provided a timely warning of proximity to the ground," the report said.

Rough Runway Blamed for Jammed Nosewheel

Cessna Citation 560XL. Substantial damage. No injuries.

The Citation was scheduled for a charter flight with four passengers from Stockholm, Sweden, to Plovdiv, Bulgaria, the morning of Dec. 1, 2004, and to return to Stockholm that evening. Neither pilot had flown to Plovdiv previously.

"On short final during approach to Plovdiv, the crew noticed that the runway consisted of concrete blocks and had a rough appearance," said the report by the Swedish Accident Investigation Board (SHK). "The crew considered the landing and the rollout to be very severe for the aircraft."

The pilots inspected the aircraft after landing and found no visible damage. While preparing for departure from Plovdiv that evening, they observed no abnormalities. The commander, the pilot flying, applied the wheel brakes while setting takeoff power to decrease the length of the takeoff roll on the rough runway.

"When the landing gear was retracted after takeoff, a warning was displayed that the nose gear wasn't retracted," the report said. The crew cycled the landing gear and flaps, but the fault indication remained. The commander decided to continue the flight to Stockholm. "Due to the faults, the flight continued with limitations of the performance according to the checklist for abnormal procedures," the report said. "After consultation with a responsible technician in Gothenburg via satellite telephone, the pilots suspected that a failure had occurred in the aircraft hydraulic system."

The crew cycled the landing gear and flaps, but the fault indication remained.

Entering Swedish airspace, the crew told air traffic control (ATC) that they would land the aircraft at Stockholm-Arlanda Airport, rather than Stockholm-Bromma Airport. "The reason that the crew preferred Arlanda was that they [would have] more choices regarding runways if any problem should arise in connection with the landing," the report said. "All runways at Arlanda are longer than the single runway at Bromma and available rescue service has higher capacity."

When the landing gear was extended on approach to Runway 26, the green light indicating that the nose landing gear is down and locked did not illuminate. The crew conducted the alternate gear-extension procedure according to the "Abnormal" checklist. "They followed the list with actions, with exception of 'nose yaw' — an action where side forces help extension and locking, to solve the problem," the report said. The nose gear light did not illuminate.

The commander held the nose gear off the runway as long as possible after touchdown. The aircraft was rolling at about 50 kt when the nose contacted the runway. The aircraft then traveled about 200 m (656 ft) before being brought to a stop. The six occupants were not injured.

Investigators determined that the nose gear strut had not extended and the nose gear had become jammed between the door-hinge arms. The report said that violent vibrations and stress on the aircraft during the landing at Plovdiv had contributed to the leakage of nitrogen through a defective O-ring in the strut and the consequent reduction of pressure within the strut.

Based on these findings, SHK said, "The accident likely occurred because the aircraft was operated on a very rough runway, which caused the damage [to] the nosewheel." The board said that inadequate design of the nose landing gear retraction mechanism was a contributing factor.

A maintenance technician found a small drain hole near the APU inlet blocked by a buildup of dirt and dried oil.

'Oily Smell' Prompts Turn-Around

Airbus A340-600. No damage. No injuries.

The cabin filled with a light white mist as the aircraft was rotated for takeoff from London Heathrow Airport for a flight with 308 passengers to Los Angeles on Dec. 30, 2005. "The mist was accompanied by a smell which was described as 'oily' by the cabin crew," said the AAIB report. "The flight services manager, head of the cabin crew, notified the commander over the intercom that there was 'smoke' in the cabin."

The flight crew also had detected an "oily-type" odor, but there was no smoke or mist on the flight deck. The commander completed the after-takeoff checks, leveled at a safe altitude and asked the relief first officer, who was in the jump seat, to assess the situation in the cabin. The relief first officer reported that there was no smoke in the cabin but the odor of oil persisted.

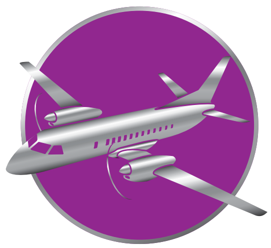
The captain decided to return to Heathrow. The flight crew declared an urgency — pan, pan — conducted the "Smoke/Fumes Removal" checklist and advised the cabin crew and passengers of the situation. The aircraft was above its landing weight limit, and ATC provided vectors to a suitable area to jettison fuel. "It took approximately 60 minutes to jettison the 83 tonnes [182,600 lb] of fuel required," the report said. "The subsequent approach and landing back at Heathrow were uneventful." Fire-service personnel inspected the aircraft after it was taxied off the runway and noticed nothing unusual. The aircraft then was taxied to a remote stand, where the passengers were deboarded.

The operator's SOP for the A340-600 was to operate the auxiliary power unit (APU) during takeoff and until reaching 1,500 ft above ground level (AGL). Maintenance personnel detected a slight oily odor after selecting APU bleed air but found no sign of an oil leak. The aircraft was released to service with the APU inoperative. During subsequent routine maintenance, a maintenance technician found a small drain hole near the APU inlet blocked by a buildup of dirt and dried oil. When he cleaned the drain hole, almost a liter of an oil-water mixture drained out.

AAIB said that the mist and odor encountered during the incident flight likely resulted from the drain hole becoming unblocked by vibration during the takeoff and the subsequent ingestion of the untrapped fluid by the APU.

"Once ingested, this contaminant could pass into the bleed air duct and subsequently into the cabin air-conditioning system," the report said.

TURBOPROPS



Elevator Cable Snaps on Takeoff

Swearingen SA226TC Metro II. Minor damage. No injuries.

The pilot told investigators that he checked the aircraft's flight controls before attempting to depart from Denver International Airport in visual meteorological conditions at 0623 local time April 5, 2006, for an unscheduled cargo flight to Dodge City, Kansas, U.S. He said that the elevator control feel seemed very light during the takeoff roll. When he pulled the yoke back at rotation speed, the yoke moved to its full aft travel, and the aircraft rapidly pitched nose-up.

"The pilot reported that moving the yoke forward had no effect, and it felt disconnected from the elevators," said the U.S. National Transportation Safety Board (NTSB) report. "The pilot quickly began to trim nose-down and reduced power to stop excessive nose-up pitch."

The pilot gained marginal control of the aircraft and told ATC that he had a flight control problem and was returning to land. He said that while flying the downwind leg, he "experimented with various configurations … to determine the method of approach and landing" and then conducted a gradual descent and an uneventful landing on the runway.

Company maintenance personnel found that the elevator "down" cable was improperly routed at the pulley in the vertical stabilizer and had worn to the point of failure from contact with a guide. Maintenance records showed that the cable had been installed by a previous operator of the aircraft in 1998. The aircraft had been inspected at the current operator's maintenance facility 10 days prior to the incident. "According to the inspection checklist, the elevator cables and related components were inspected, with no anomalies noted," the report said.

NTSB said that the probable cause of the incident was "the failure of the elevator down cable due to an improperly routed cable by unknown maintenance personnel" and that a contributing factor was "the improper inspection of the elevator cable by the operator's maintenance personnel."

Propeller Would Not Feather

De Havilland Canada Dash 8-300. Substantial damage. No injuries.

The flight crew was not able to feather the propeller after the right engine failed soon after takeoff from Manchester, England, on Aug. 9, 2005, for a scheduled flight to Aberdeen, Scotland, with 33 passengers. The crew declared an emergency, returned to the airport and landed the airplane.

"It was fortunate that, despite the propeller not being fully feathered, sufficient rudder authority was available to maintain directional control," said the AAIB report.

Investigators found that a propeller blade support bearing had failed catastrophically, resulting in a large imbalance of engine loads. The power turbine shaft fractured, and the consequent overspeed of the power turbine led to the separation and ejection of the turbine blades from the rear of the engine.

"The failure of the propeller to feather was due to a ball from the failed bearing becoming jammed between the propeller blade root and the propeller hub," the report said. "The origin of the bearing failure was not determined, although metallic examination revealed that cracking had been occurring for a period of time." The failed bearing had accumulated 16,714 hours in service. Another bearing in the propeller had accumulated 24,737 hours in service and showed no sign of impending failure.

Strong propeller vibration had been reported six days before the incident, and vibration-monitoring equipment had been installed in the aircraft. The report said, however, that the equipment had been installed incorrectly, and no meaningful readings were recorded before the incident occurred.

Cargo Shift Causes Tail Strike

Convair 440. Minor damage. No injuries.

The flight crew landed the airplane at Kenosha (Wisconsin, U.S.) Airport at 2350 local time Sept. 22, 2005, and removed the straps restraining the cargo. After waiting 1.5 hours for the ground crew to arrive to unload the cargo, the captain called the company and was told to fly the aircraft to Milwaukee and have the cargo unloaded there.

"Since we unstrapped the freight for offload almost two hours ago, we didn't think to check the freight," the captain told investigators. He also noted that the "Before Start" checklist does not remind the flight crew to verify that the cargo is properly restrained.

The captain began the takeoff at about 0120. The aircraft had rolled about 400 ft (122 m) when the cargo shifted. The aircraft's tail struck the runway, and the captain rejected the takeoff.

PISTON AIRPLANES

Chieftain Strikes Trees During Approach

Piper PA-31-350. Destroyed. One fatality.

The pilot was conducting a cargo flight from Knoxville, Tennessee, U.S., to Dayton (Ohio) International Airport in nighttime instrument meteorological conditions on Dec. 7, 2004. He reported that the aircraft was established on the localizer course for the ILS approach to Runway 06L at Dayton. The tower controller told the pilot that touchdown RVR (runway visual range) was 1,800 ft (550 m).

Radar contact was lost when the aircraft was at 1,200 ft. The aircraft struck trees and came to rest inverted about 0.5 nm (0.9 km) from the runway at 0104 local time. A weather observation at the time of the accident included RVR variable between 1,800 ft and 2,000 ft (600 m) in fog and vertical visibility 100 ft. The published minimum visibility for the ILS approach was 1,800 ft RVR, and decision height was 1,198 ft, or 200 ft height above touchdown.

Landing Gear Lever Breaks

Piper PA-23-250. Substantial damage. No injuries.

A flight instructor with 18,800 flight hours, including 500 flight hours in Aztecs, and a student pilot receiving training for a multi-engine airplane type conversion were conducting takeoffs and landings at Napier (New Zealand) Aerodrome on April 13, 2006. The Aztec was on the downwind leg for the second landing when the student attempted to extend the landing gear. "However, the handle of the landing gear selector lever broke off in his hand, and the gear remained selected 'UP,'" said the report by the New Zealand Transport Accident Investigation Commission.

The instructor told the tower controller about the problem and their intention to fly the airplane to a safe position east of the airport where they could attempt to resolve the problem. The Aztec had two emergency landing gear extension systems, but the pilots were not able to use them because they require the landing gear handle to be in the "DOWN" position. With the student flying the airplane, the instructor attempted unsuccessfully to use the crash ax to gain access to the remaining section of the gear lever.

Unable to resolve the problem, the instructor told the controller that he would conduct a gear-up landing on the grass portion of the runway and asked the controller to alert the airport's emergency services. "During the circuit before landing, the instructor shut down the right engine and feathered its propeller, and the student turned off the fuel and magnetos," the report said. "To prevent any propeller damage during the landing, the instructor had the student crank the engine until the stationary propeller was aligned approximately horizontal."

To prevent flap damage, the instructor did not extend the flaps. "To reduce the potential of a fire and to help minimize any engine damage, the instructor shut down the left engine and had the student turn off the fuel, magnetos and master switch just before the aeroplane touched down," the report said. The airplane touched down smoothly on the grass portion of the runway and turned 90 degrees right when it slid onto the paved portion of the runway, where it came to a stop. Damage included a bent left propeller blade, scrapes on the lower fuselage and broken antennas.

False Fuel Indications Lead to Ditching

Beech E55 Baron. Destroyed. Two fatalities, two serious injuries, one minor injury.

The owner of the airplane told investigators that the fuel quantity indicators mounted in the instrument panel did not work properly. Before departing from Redmond, Oregon, U.S., for a flight to Friday Harbor, Washington, on July 1, 2005, the pilot used the fuel tank sight gauges to check fuel quantity. The left gauge showed 45 gal (170 liters), and the right gauge showed 55 gal (208 liters), which the pilot believed was sufficient for the 1 hour, 50 minute flight.

The airplane was descending to land when power was lost from both engines. The pilot ditched the airplane in the ocean about 8 mi (13 km) from the destination. Two passengers were killed, the pilot and one passenger were seriously injured, and one passenger received minor injuries. The surviving passengers said that the airplane hit the water hard in a slightly nose-down attitude and immediately began to sink.

The NTSB report said that maintenance had been performed on the airplane four months before the accident to replace leaking fuel cells and that the fuel sight gauges were installed incorrectly, resulting in float travel being restricted by wing structure. "If the sight gauges had been properly installed, they would have read in the cross-hatched (unusable) area," the report said.

NTSB said that the probable cause of the accident was "the pilot's failure to refuel the airplane, which resulted in a dual loss of engine power during normal descent due to fuel exhaustion" and that a contributing factor was "the incorrect installation of the left and right wing fuel sight gauge/float assemblies by unknown persons."

HELICOPTERS

Broken Hoist Cable Strikes Rotor Blades, Canopy

Sikorsky S-61N. Substantial damage. One minor injury, five uninjured.

The crew was conducting a search-and-rescue training flight over the ocean south of Waterford, Ireland, on Jan. 17, 2006. The helicopter was brought to a hover over a ship at anchor, and the winchman was lowered by cable to the deck on the bow of the ship. As the winchman prepared to release himself from the hoist hook, he was thrown off balance when the ship rose on a 2-m (7-ft) swell; he grasped a ladder to steady himself. "During the process, a coil of cable looped around a small steel protrusion welded to the side of the ladder," said the report by the Irish Air Accident Investigation Unit.

The winch operator aboard the helicopter saw that the winchman had released the hoist hook and began to winch the cable back aboard the helicopter. "At the same time, the bow of the ship pitched down, load was put on the unseen snagged cable, and the cable sheared just above the hook-attachment point," the report said.

The cable, which recoiled after shearing, lacerated the winch operator's hand, broke the canopy above the pilots' heads and struck two of the five main rotor blades. The pilots flew the helicopter back to their base.

Ground Resonance Encounter

Agusta A109E. Destroyed. No injuries.

The 6,500-hour pilot was ground-taxiing the helicopter at Fort Worth (Texas, U.S.) Meacham International Airport in preparation for a repositioning flight on Jan. 19, 2005. He said that when he applied the wheel brakes to give way to an airplane that was being taxied to the ramp, the helicopter began to shake and turn 90 degrees left.

After the helicopter turned left, the main rotor and transmission assembly separated from the aircraft. The pilot was not injured.

NTSB said that the probable cause of the accident was "the pilot's inadvertent encounter with ground resonance." ●

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Aug. 28, 2006	Smith, Nevada, U.S.	Raytheon Hawker/Schleicher ASW-27	substantial/destroyed	3 minor, 3 none
The Hawker 800XP was descending through 16,000 ft when the captain saw the glider close ahead. She attempted evasive action, but the airplane's nose struck the glider's right wing. The Hawker pilots received minor injuries. The airplane's right engine flamed out, and the landing gear would not extend. The pilots conducted a gear-up landing at Carson City, Nevada. The glider entered a flat spin after the collision, and the pilot bailed out. He received minor injuries after landing when the parachute dragged him across the ground.				
Aug. 29, 2006	Ravensthorpe, Australia	British Aerospace 146-100	NA	none
Soon after takeoff, the flight crew reported a fire in the cockpit and returned to the Ravensthorpe airport. The pilots flew the airplane in a holding pattern over the airport while conducting the emergency checklist. They extinguished the fire and landed without further incident.				
Sept. 1, 2006	Mashad, Iran	Tupolev Tu-154M	destroyed	28 fatalities, 120 NA
The nosewheel tires reportedly burst on landing, and the airplane swerved off the runway and caught fire.				
Sept. 1, 2006	Argyle, Florida, U.S.	Mitsubishi MU-2B	destroyed	1 fatal
Intense to extreme weather radar echoes were recorded in the area when the aircraft broke up while descending to land at Panama City, Florida, during a business flight from Tulsa, Oklahoma.				
Sept. 3, 2006	Karachi, Pakistan	Boeing 737-300	NA	NA
Soon after departing from Karachi, the flight crew heard a thud and felt a vibration. The crew saw an unsafe landing gear indication on approach to Doha, Qatar, and conducted a go-around and fly-by of the control tower, which reported that portions of the right elevator and trim tab were missing.				
Sept. 5, 2006	San Juan, Puerto Rico	Boeing 757-200	substantial	116 none
The aircraft began to drift right of the runway centerline, and the first officer, the pilot flying, disconnected the autopilot. "During the landing flare, the nose raised to a high angle, and the tail struck the runway," the preliminary report said.				
Sept. 6, 2006	Porterville, California, U.S.	North American OV-10A	destroyed	2 fatal
The airplane was being maneuvered during a forest-firefighting operation when it struck trees and mountainous terrain.				
Sept. 6, 2006	Somis, California, U.S.	Hughes 369D	destroyed	2 fatal
The helicopter was engaged in a powerline-inspection flight when it struck powerlines about 75 ft AGL and descended to the ground.				
Sept. 14, 2006	Subic Bay, Philippines	McDonnell Douglas MD-11	NA	NA
The aft portion of the aircraft was damaged by a tail strike while landing.				
Sept. 14, 2006	Fort Meade, Florida, U.S.	Piper Aztec	destroyed	2 fatal
The aircraft was engaged in a mosquito-control flight when it struck a tower and descended to the ground.				
Sept. 17, 2006	NA	Boeing 767-300	NA	NA
The aircraft was cruising at Flight Level 320 when the flight crew detected an electrical odor and saw smoke emerging from the autoflight mode control panel. The flight crew declared an emergency after losing the autopilot, autothrottles and flight directors, and diverted the flight to Pointe a Pitre, Guadeloupe.				
Sept. 18, 2006	Brisbane, Australia	Boeing 777-200	none	none
Soon after departing from Brisbane for a scheduled flight to Malaysia, the flight crew reported that the right engine had flamed out. The crew was able to restart the engine and, after dumping fuel, landed at Brisbane.				
Sept. 21, 2006	Kodiak, Alaska, U.S.	de Havilland DHC-2 Beaver	substantial	1 fatal, 2 serious, 4 none
The pilot had transported fishermen to a narrow stream 75 mi (121 km) northwest of Kodiak. Weather conditions deteriorated, and the pilot told the passengers that they would have to return to the operator's lodge. Surviving passengers said there was heavy rain and strong winds when the float-equipped airplane crashed soon after taking off from the stream. One passenger was killed, one passenger was seriously injured, and the pilot and three passengers escaped injury.				
Sept. 22, 2006	NA	Boeing 777-200	NA	NA
The aircraft was en route from Israel to the United States when smoke and fire emerged from the lower corner of the first officer's windshield. The flight crew donned oxygen masks, declared an emergency and diverted to Brindisi, Italy.				
Sept. 29, 2006	Peixoto Azevedo, Brazil	Boeing 737/Embraer Legacy	destroyed/minor	155 fatal/7 none
The 737 was at Flight Level 360 during a scheduled flight from Manaus to Brasilia when it apparently collided with the Legacy and descended into the Amazon jungle. The Legacy, which was on a delivery flight from Sao Jose dos Campos to the United States, was landed safely at Cachimbo Air Base.				

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.