AeroSafety WORLD

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PIECE BY PIECE

ASSEMBLING SAFETY MANAGEMENT SYSTEMS

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

JANUARY 2008

THE NEW Balance

There is some good news. At the recent Federal Aviation Administration International Aviation Safety Forum, the FAA threw its support behind safety management systems (SMS) in a big way. In his remarks, Acting Administrator Robert A. Sturgell reminded us of the challenges we face due to the growth of our system, as well as the high accident rates that persist in some parts of the world. He pointed to SMS as part of the solution, saying, "We all need to take a step up, and I'm including the United States of America in that group as well. The safety management system approach will let us do that."

That statement removed any lingering doubt about where the FAA stands on SMS. No longer are there any question marks about global SMS implementation. It is time to get serious.

But before we go too far, we must address a misconception about SMS that seems to be spreading. Increasingly, SMS is being used as an excuse to reduce the level of aviation expertise in our management and oversight systems. The misconceived logic is that since an SMS is about data and process, the system needs auditors and process managers, not necessarily aviation experts. It is easy to understand why chief financial officers and budget-strapped regulators would like to believe this. We are living in an industry that is rapidly outgrowing its intellectual capital, and aviation experience is at a premium.

This problem is real. I have talked to people from a number of major regulators who are implementing SMS. These people are beginning to believe that their aviation experience is limiting their career. They believe that their time in operations makes them look too "old school" to the people in power; the "process" folks get the promotions.

It is time to get back to reality. To produce at the extraordinary level expected of an SMS, it needs people who have real operational experience *and* the ability to manage data and processes. They must be able to observe a fleet's operations and identify negative trends before the trends become problems. It takes experience and insight to realize that a new rash of flap overspeed events probably has something to do with the new descent procedure that was introduced in the previous month. These professionals have to turn data into insight, and insight into practical action. That takes a combination of new skills and old wisdom. We all celebrate the ability of an SMS to look into the future and predict the next accident before it occurs, but this crystal ball ability comes with a price: It demands well-trained people with solid operational insight.

I don't want to be too negative. Regulating and managing safety with an SMS is far more efficient than the old methods of rules and compliance. Airlines and regulators who have implemented SMS have been able to do more with less. CFOs and government budget czars should be excited. But this doesn't mean that we can simply replace experienced professionals with auditors. As this industry continues to grow at a spectacular rate, we have to remember that.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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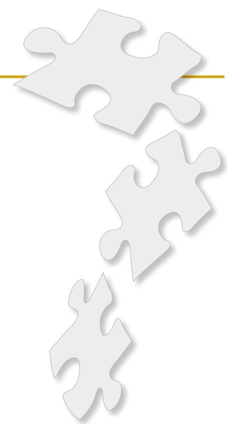

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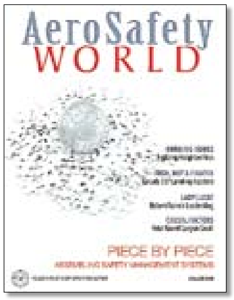

About the Cover
Putting together a safety management system is an assembly job.
Photo: © Emrah Turudu/iStockphoto

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BUILD THE Structure

Five years ago, we happily celebrated the centennial of heavier-than-air powered flight. This year, 2008, marks a more somber centennial, that of the first fatality in an airplane.

Having had the accidental good fortune of designing an airplane that allowed them to crash gently while they learned how to fly, Wilbur and Orville Wright successfully flew for nearly five years without serious mishap, a remarkable record. That string came to an end on Sept. 17, 1908, when a new propeller fractured during a demonstration flight at Fort Myer, Virginia, U.S., causing Orville Wright to lose control and crash, the impact killing Lt. Thomas Selfridge. A pioneer of great potential, Selfridge already was a dirigible pilot and he designed an airplane that flew.

Every aviation death diminishes the industry and robs it piece by piece of its moral authority, regardless of any subjective judgment of a person's value. While this regard for the sanctity of life is a major force driving aviation's safety mania, the traveling public's aversion to risk in an aircraft has pushed the industry even further to achieve an unequaled level of safety.

As we have discussed in previous stories and columns, the past decade has witnessed the development of safety strategies and tools that have allowed the industry to break through to new levels of risk reduction. In this issue, we discuss the next manifestation of that safety offensive, the adoption of safety management systems (SMS).

As the three stories on that topic clearly describe, many in aviation are confused or stalled in their progress by the seeming enormity of the effort of implementing SMS.

However, since most of what constitutes SMS involves institutionalizing the strategies and tools developed over this past decade, many operators already have or are installing some SMS components. Actually, the fact that an SMS mostly is composed of smaller programs is an important take-away for those who, from a distance, see SMS as an enormous, imposing safety edifice.

Beyond the attributes of its component pieces, the unique aspect of SMS is that its reach must extend beyond the safety and operational parts of any aviation organization to include every department and every person, especially in the upper management level. Active support from management compounds the impact of these powerful safety programs by enhancing their visibility within the corporation.

All that I have just said is better stated by the authors of our three SMS stories. My message is to emphasize the importance of every aviation organization beginning to move forward in building its own SMS edifice, one piece at a time if necessary, but moving forward with a goal of eventually having a fully realized SMS in place at some specific point in the not too distant future.

Years of exposure to a succession of management programs, each promising astounding improvements in corporate efficiency and profitability, may put many managers in a cynical frame of mind, distrusting the latest "flavor of the month" being served up by management gurus. As we have said, there is nothing untested or novel about the SMS components: These things work. SMS is the structure that empowers them to work to best effect. Start your installation today.

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

Heads Up, Feet Down

While I appreciate Mr. Victorazzo's comments (*ASW*, 11/07, p. 6) about there being no documented reports of interference from the footrest device [in the Embraer EMB-145], it is beyond me why any aircraft manufacturer would put a footrest in the cockpit in the first place, or an operator would allow such a device in the cockpit, especially if it is collocated with any instrumentation or controls. If something happens that needs a pilot's immediate attention, I would hope that the pilot would not be "kicked back" with his feet up.

We read in your publication, and others, time and time again about inattention or inaction of a flight crew causing incidents or accidents that could have been prevented. Furthermore, today's modern jet aircraft cost tens of millions of dollars. As the steward of our company's aviation assets, I would be remiss for not disciplining a pilot who "put his feet up" on our multimillion-dollar aircraft.

Mark S. Chaney, CAM
Coca-Cola Bottling Co. Consolidated

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

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

Serving Aviation Safety Interests for 60 Years

Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 1,140 individuals and member organizations in 142 countries.

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Safety News

Runway Safety Recommendations

Runway safety is among the issues most critically in need of action by the U.S. Federal Aviation Administration (FAA), the U.S. National Transportation Safety Board (NTSB) said in its annual list of "most wanted" safety improvements.

In previous years, the NTSB list had called for more attention to issues involving runway incursions; the 2007 list expands the category to runway safety, which also includes runway excursions.

"While the FAA is in the process of developing and testing new technologies to make ground operation of aircraft safer, runway safety incidents continue to occur with alarming frequency and consistency," the NTSB said.

FAA data show that 371 runway incursions occurred during fiscal 2007, which ended Sept. 30; the previous year, 330 incursions were reported.

Two individual runway safety recommendations — new on the list this year — call on the FAA to require pilots to obtain specific authorization from air traffic control (ATC) before taxiing across any runway.

Runway safety recommendations include: "Implement a safety system for ground movement that will ensure the safe movement of airplanes on the ground and provide direct warning capability to the flight crews; implement ATC procedures requiring an explicit clearance for each runway crossing; [and] require operators to conduct arrival landing distance calculations before every landing based on existing performance data, actual conditions and incorporating a minimum safety margin of 15 percent."

The FAA has issued Advisory Circular (AC) 91-79, which discusses methods by which pilots and operators of turbine airplanes can "identify, understand and mitigate risks associated with runway overruns during the landing phase of flight." It also provides information that can be used by operators to develop standard operating procedures to mitigate the risks.

In related action, the FAA said that it will establish the Takeoff/Landing Performance Assessment Aviation Rulemaking Committee to review regulatory requirements for takeoff operations on snow- and ice-contaminated runways.

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RVSM in Metric Airspace

Reduced vertical separation minimum (RVSM) has been introduced in China's airspace — the first time the system has been used in airspace in which height is measured in meters.

The new flight level allocation scheme (FLAS), which took effect Nov. 21, requires a minimum vertical separation of 300 m (984 ft) for aircraft between 8,900 m and 12,500 m — approximately Flight Level (FL) 290 and FL 410. Previously, aircraft being operated in that airspace were separated by a minimum of 600 m (1,969 ft).

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The General Administration of Civil Aviation of China (CAAC) says that benefits of RVSM will be the same in China as they have been in much of the rest of the world's airspace, where RVSM has been phased in over the past decade: improved use of airspace for air traffic control (ATC) conflict resolution, fuel savings of about 1 percent because flights will be conducted closer to optimum cruise altitudes and a reduction in ground delays.

Pilots must receive training on the China RVSM FLAS before operating in Chinese RVSM airspace, and all aircraft flown in that airspace must be RVSM-compliant.

In a briefing leaflet on Chinese RVSM, the International Federation of Air Line Pilots' Associations (IFALPA) told its members that, "since most civil aircraft use feet as the primary altitude reference with a minimum selectable interval of 100 ft, ATC will issue the flight level clearance in meters. Pilots shall use the China RVSM FLAS table to determine the corresponding flight level in feet. The aircraft shall be flown using the flight level in feet."

Emergency Response

Canadian airports are now required to comply with a "more formal approach" to development and testing of emergency response plans, according to regulatory amendments being implemented by Transport Canada (TC).

Under the amendments, emergency response plans must include "outlines of potential emergency scenarios and how each type of emergency will be handled, and identify airport and community organizations that are able to provide assistance," TC said. The plans also must include emergency response diagrams for each type of aircraft that uses the airport.

Previous requirements called for airport operations manuals to include information on emergency response planning, but the changes require the inclusion of additional, specific details.

Lawrence Cannon, minister of transport, infrastructure and communities, said that the regulatory changes "highlight the importance of planning to respond effectively to potential emergencies."

© Air Canada

Cargo Fire Suppression

Fire suppression systems should be required on all cargo planes operating under U.S. Federal Aviation Regulations Part 121, the U.S. National Transportation Safety Board (NTSB) says (see p. 36).

The NTSB, citing a Feb. 7, 2006, fire in a UPS Air Cargo McDonnell Douglas DC-8 at Philadelphia International Airport, recommended that the U.S. Federal Aviation Administration (FAA) require installation of the systems. The NTSB also said that the FAA should provide clear guidance to operators of large passenger and cargo airplanes on how to respond to indications of a fire "in the absence of a cockpit alert," using the philosophy adopted by a group of industry specialists in the Smoke/Fire/Fumes Checklist Template, published by Flight Safety Foundation in June 2005.

The NTSB addressed several recommendations to the U.S. Department of Transportation office that oversees transportation of hazardous materials, including a recommendation that the agency require aircraft operators to take steps to reduce the risk that shipments of non-rechargeable lithium batteries — prohibited on passenger aircraft — might become involved in cargo-only aircraft fires. Those steps might include transporting the batteries in fire-resistant containers or in limited quantities at any one location in the airplane.

The investigation of the February 2006 accident revealed that electronic devices containing rechargeable lithium batteries were in the airplane, but investigators could not determine whether the batteries were of any of the defective types that had been recalled by manufacturers or whether they might have contributed to the fire.

Other recommendations included calls for the FAA to require airport inspectors to ensure that airports that meet passenger aircraft requirements and also have cargo operations include cargo aircraft in aircraft rescue and fire fighting (ARFF) training programs and for the Cargo Airline Association to work with member airlines and other groups to "develop and disseminate accurate and complete airplane emergency response diagrams for ARFF personnel at airports with cargo operations."

The airplane in the February 2006 incident was destroyed by fire after landing. All three crewmembers evacuated, and all sustained minor injuries. The NTSB said that the probable cause of the accident was an in-flight cargo fire, initiated by an unknown source.

© UPS

Open-Door Policy

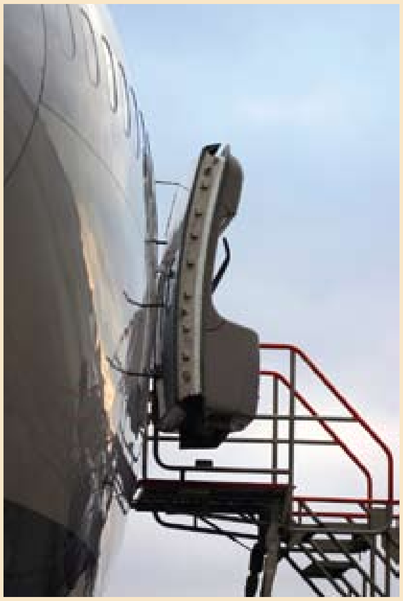
Air carriers should be required to revise cabin crew training procedures to ensure that training programs and manuals specify that a door must be open if an air conditioning (A/C) cart is connected, the U.S. National Transportation Safety Board (NTSB) has said.

In its safety recommendation to the U.S. Federal Aviation Administration (FAA), the NTSB said that the FAA also should "advise that the A/C cart can pressurize the airplane on the ground if all doors are closed, and warn about the dangers of opening any door while the air conditioning cart is supplying conditioned (cooled or heated) air to the cabin."

The NTSB cited a May 31, 2005, accident at Chicago O'Hare International Airport in which an Air Wisconsin flight attendant was ejected from the airplane service door of a Bombardier CL600 after she had closed both that door and the main cabin door and then re-opened the service door. As she lifted the door handle on the service door, the door burst open and she was thrown to the ground. She suffered a fractured shoulder; no one else in the airplane was injured.

The NTSB said that the probable cause of accident was "the opening of the service door when the airplane was pressurized." Contributing factors were "the captain's failure to ensure that one of the airplane doors was open while a ground-cooling cart was connected," the NTSB said.

The NTSB said that, at the time of the accident, the Air Wisconsin flight attendant manual and flight attendant training program "did not include information about keeping a door open to prevent pressurization of the cabin when an A/C cart is supplying heated or cooled air to the cabin on the ground." About one year after the accident, the airline modified its training materials to include warnings that explained why at least one door must be open when an A/C cart is in use, the NTSB said.



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Child Safety Seats

Australia should eliminate the requirement for mandatory use of a "top tether strap" when an automotive child restraint seat (CRS) is used in an aircraft seat, according to a study conducted for the Civil Aviation Safety Authority of Australia (CASA).

The top straps — not part of the CRS design in most other countries — typically extend from the top of a CRS, over the top of the aircraft seat and down the back, preventing the inhabitant of the seat behind the CRS from using the tray table.

The study said that the use of automotive CRSs in Australian regular public transport aircraft may have decreased in recent years and that most children younger than age 3 travel in the laps of an adult, restrained by a supplementary loop belt. Nevertheless, the study recommended that these children should travel in their own seats, "in an appropriately sized and fitted child restraint system."

The study said that acceptable restraint systems include those that use a top tether strap with an "effective tether anchor," those that use belt paths through the rear portion of a CRS and those that use certain types of devices to attach a CRS to an aircraft seat.

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In Other News …

The **Eurocontrol Council** has accepted a plan to create a performance-based air traffic management system for Europe; the plan sets goals for safety, capacity, delays and cost efficiency. … The **Civil Aviation Safety Authority of Australia** (CASA) has conducted a series of unannounced, all-day surveillance exercises at major airports to evaluate specific safety issues that had been identified through data analysis and risk research. The exercises are intended to gather more information on safety risks and to "take a snapshot of operations at a point in time," CASA said.

Correction … An item in the November 2007 issue incorrectly stated Capt. Henry P. "Hank" Krakowski's new job title; he is the chief operating officer of the U.S. Federal Aviation Administration Air Traffic Organization.

Compiled and edited by Linda Werfelman.


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On Whose Side Is Lady Luck?

BY ROBERT T. FRANCIS

Aviation safety officials have recently attributed positive outcomes in accidents or close calls to Lady Luck's intervention. I wonder whether we could cite an equal number of instances where she has been missing.

One example where "good luck" prevailed was the Air France A340 accident in Toronto. Considerable "expert" commentary said how lucky we were that no one was killed. But was Lady Luck on duty that day?

I would argue that the fact that no one was killed was much more attributable to decades of work by numerous aviation professionals and those who empower them. Were not hull structural integrity, flammability of fabrics, 16 g seats, flight attendant training, emergency slides, and aircraft rescue and fire fighting training among the reasons for the extraordinary safety record that we have? Is there not truth in the old adage that "you make your own luck"?

Another recent "near miss" involved an Asiana 747 on approach to Los Angeles International Airport. With Asiana on final, a controller cleared a Southwest 737 on the same runway for takeoff. The controller did not notice the error, but the 747 crew saw the 737 and initiated a go-around. Luck? The Asiana crew was doing what it had been trained to do. One pilot was flying the aircraft and the other was looking out the window. If our Lady friend was involved, she was certainly aided by thousands of hours of research in the fields of human factors, crew resource management and training.

Was Lady Luck absent on the day in 2001 when American Airlines Flight 585 crashed in New York? She may have been, but that certainly took a back seat to poor design certification and poor pilot training.

If we accept, as most safety professionals do, that the runway and airport environment should be the focus of significant expenditures of resources, how do we prioritize? Again, we get back to systems involved in the pre-emptive approach to aviation safety. Flight operational quality assurance (FOQA), aviation safety action programs (ASAP) and line operations safety audits (LOSA) are enormously useful in developing the data from which to prioritize.

However, one sometimes-overlooked factor is the importance of having qualified analysts to ensure that the products of FOQA, ASAP and LOSA are being used properly to reduce risk. "Data-driven" action needs people who are competent to draw the correct conclusions and recommend the most effective responses.

In the higher-risk runway and airport environment, important work continues to be done involving radar, transponders, better signage and lighting, runway friction measurement and overrun protection using engineered materials arresting systems and better overrun areas.

Let's keep making our own luck. ●

The Honorable Robert T. Francis is a former vice-chairman of the U.S. National Transportation Safety Board and is a member of the Flight Safety Foundation executive committee.

JAN. 6–9 ➤ SMS in Aviation Conference. Embry-Riddle Aeronautical University and Saint Louis University. Daytona Beach, Florida, U.S. Mark Friend, <mark.friend@erau.edu>, <www.eruniversity.com/sms.htm>, +1 386.226.6842.

JAN. 21–22 ➤ Middle East Aviation Safety Summit. United Arab Emirates (UAE) General Civil Aviation Authority and Flight Safety Foundation. Abu Dhabi, UAE. Hanan El Moussa, <hmoussa@gcaa.ae>, <www.albawaba.com/en/countries/UAE/218472>, +971 4 2111596.

JAN. 23 ➤ JAR-OPS 1 vs. EU OPS Difference Course. European Joint Aviation Authorities. Hoofdorp, Netherlands. <training@jaat.eu>, +31 (0)23 567 9790.

JAN. 29–FEB. 1 ➤ NBAA 19th Annual Schedulers & Dispatchers Conference. National Business Aviation Association. Savannah, Georgia, U.S. Dina Green, <dgreen@nbaa.org>, <web.nbaa.org/public/cs/sdc/2008/index.php>, +1 202.783.9357.

FEB. 5–7 ➤ 16th Annual Safety-critical Systems Symposium. Centre for Software Reliability. Bristol, England. Joan Atkinson, <joan.atkinson@ncl.ac.uk>, <www.csr.ncl.ac.uk/calendar/csrEventView.php?targetId=377>, +44 191 222 7996.

FEB. 11–14 ➤ Annual International Cabin Safety Symposium. Southern California Safety Institute. Montreal. <www.scsi-inc.com/css%2025/CSS%2025%20Program.html>.

FEB. 13–17 ➤ Lawyer Pilots Bar Association. Miami. <www.lpba.org>, +1 410.571.1750.

FEB. 14 ➤ Asian Business Aviation Conference and Exhibit (ABACE). National Business Aviation Association. Hong Kong. Donna Raphael, <draphael@nbaa.org>, <www.nbaa.org>, +1 202.783.9000.

FEB. 19–24 ➤ Singapore Airshow. Singapore Airshow & Events. <www.singaporeairshow.com.sg>, +65 6542 8660.

FEB. 24–26 ➤ Heli-Expo 2008. Helicopter Association International. Houston. Marilyn McKinnis, <marilyn.mckinnis@rotor.com>, <www.heliexpo.com>, +1 703.683.4646.

FEB. 25–27 ➤ OPS Forum 2008: Fly Safe, Fly Smart, Fly Green. International Air Transport Association. Madrid, Spain. <www.iata.org/events/ops08/index.htm>.

MARCH 5–7 ➤ Airport Wildlife Management Seminar. Embry-Riddle Aeronautical University. Dallas/Fort Worth. <www.embryriddle.edu/wildlife-management>, +1 866.574.9125.

MARCH 10–12 ➤ 20th annual European Aviation Safety Seminar (EASS). Flight Safety Foundation and European Regions Airline Association. Bucharest, Romania. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org/seminars.html#eass>, +1 703.739.6700, ext. 101.

MARCH 11–13 ➤ ATC Global Exhibition and Conference (formerly ATC Maastricht). Civil Air Navigation Services Organisation and Eurocontrol. Amsterdam. <www.atcevents.com/atc08/show_link1.asp>, +44 (0)871 2000 315.

MARCH 13–15 ➤ ARSA 2008 Annual Repair Symposium. Aeronautical Repair Station Association. Washington, D.C. <arsa@arsa.org>, <www.arsa.org/node/400>, +1 703.739.9543.

MARCH 18–20 ➤ 2nd Civil Aviation Week India–Airport and Airline 2008 Expo. Airports Authority of India, Council of EU Chambers of Commerce in India, Business Aviation Association for India, et al. New Delhi. <www.civilaviationweek. com>.

MARCH 18–20 ➤ Aviation Industry Expo. National Air Transportation Association. Dallas. Jill Ryan, <jill.ryan@cygnusexpos.com>, <aviationindustryexpo.com/as3gse/index.po>, 800.827.8009, ext. 3349.

MARCH 18–20 ➤ Search and Rescue 2008 Conference and Exhibition. The Shephard Group. Bournemouth, England. <SC@shephard.co.uk>, <www.shephard.co.uk/SAR>, +44 1628 606 979.

MARCH 28 ➤ IS-BAO Implementation Workshop. International Business Aviation Council. San Antonio, Texas, U.S. Katherine Perfetti, <kathyhp@comcast.net>, <www.ibac.org>, +1 540.785.6415.

MARCH 31–APRIL 2 ➤ 15th Annual SAFE (Europe) Symposium. SAFE (Europe). Geneva, Switzerland. <safe.distribution@virgin.net>, <www.safeeurope.co.uk>, +44 (0)7824 303 199.

APRIL 14–17 ➤ 59th Annual Avionics Maintenance Conference. ARINC. Tulsa, Oklahoma, U.S. Samuel Buckwalter, <Samuel.Buckwalter@arinc.com>, <www.aviation-ia.com/amc/upcoming/index.html>, +1 410.266.2008.

APRIL 15–17 ➤ Maintenance Management Conference. National Business Aviation Association. Daytona Beach, Florida, U.S. Dina Green, <dgreen@nbaa.org>, <web.nbaa.org/public/cs/mmc/200804/index.php>, +1 202.783.9357.

APRIL 18–22 ➤ IFALPA 2008: 63rd Conference. International Federation of Air Line Pilots' Associations. Mexico City. <ifalpa@ifalpa.org>, <www.ifalpa.org/conference/index.htm>, +44 1932 571711.

APRIL 22–24 ➤ World Aviation Training Conference and Tradeshow. Halldale. Orlando, Florida, U.S. Chris Lehman, <chris@halldale.com>, <www.halldale.com>.

APRIL 23–26 ➤ AEA Convention and Trade Show. Aircraft Electronics Association. Washington, D.C. <info@aea.net>, <www.aea.net/Convention/FutureConventions.asp?Category=6>, +1 816.373.6565.

APRIL 29–MAY 1 ➤ 53rd annual Corporate Aviation Safety Seminar (CASS). Flight Safety Foundation and National Business Aviation Association. Palm Harbor, Florida, U.S. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org/seminars.html#cass>, +1 703.739.6700, ext. 101.

MAY 5–8 ➤ RAA Annual Convention. Regional Airline Association. Indianapolis, Indiana, U.S. Scott Gordon, <gordon@raa.org>, <www.raa.org>, +1 202.367.1170.

MAY 11–15 ➤ 79th Annual Scientific Meeting. Aerospace Medical Association. Boston. Russell Rayman, <rrayman@asma.org>, <www.asma.org/meeting/index.php>, +1 703.739.2240, ext. 103.

MAY 20–22 ➤ European Business Aviation Convention and Exhibition (EBACE). National Business Aviation Association and European Business Aviation Association. Geneva. <info-eu@ebace.aero>, <www.ebaa.org/content/dsp_page/pagec/ev_ebace>, +32-2-766-0073 (Europe), +1 202.783.9000 (United States and Canada).

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PIECE *by* PIECE

BY LINDA WERFELMAN

Aviation safety specialists say relatively few of the world's airlines have assembled one of the most significant developments in safety — the safety management system.

Safety management systems (SMS) have tremendous potential not only as tools for risk reduction within individual operations but also for establishing uniform aviation safety standards around the world. Nevertheless, SMS development has been slow, and some international aviation safety specialists say that many operators are unsure exactly how to proceed.

An SMS typically is characterized as a structure of systems to identify, describe, communicate, control, eliminate and track risks. More formally, the International Civil Aviation Organization (ICAO) defines an SMS as "an organized approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures."[1]

In its *Safety Management Manual (SMM)*, published in 2006, ICAO says that the SMS concept represents a shift away from a *reactive* safety mode — in which advances stem from accident investigations and resulting recommendations — in favor of a *proactive* mode — in which the ongoing collection of data enables continual analysis of operations to identify risks and determine the best methods of addressing them before the risks result in an accident or serious incident (Figure 1, p. 16).

The manual is designed to provide information to help ICAO member states meet ICAO standards with respect to the implementation of SMS by aircraft operators, airport operators, air traffic services providers and maintenance organizations within their jurisdictions. Its compliance information was gathered from people who have developed and managed aviation safety activities in operations throughout the industry, and its target audience includes those who are responsible for planning and managing effective safety activities.

Management personnel at operators and service providers have a "special responsibility for safety management," the *SMM* says. "In a major study of airlines around the world, it was found that the safest airlines had a clear safety mission, starting at the top of the organization and guiding actions right down to the operational level. … Above all, management sets the organizational climate for safety. Without its wholehearted commitment to safety, safety management will be largely ineffective."

At press time, ICAO was preparing a letter to be sent to member states proposing establishment of a more specific SMS framework built on four basic components: safety policy and objectives, safety risk management, safety assurance and safety promotion.

ICAO said that airlines and aircraft maintenance organizations around the world should have an SMS in place by Jan. 1, 2009 — a deadline that aviation safety specialists say will be impossible for many to meet.[2] Civil aviation authorities in some countries, including Australia, Canada and the United Kingdom, already require airlines and other aviation organizations to have SMS; in many other countries, civil aviation authorities are actively encouraging the use of SMS. For example, in the United States, SMS is not required but encouraged, and a Federal Aviation Administration (FAA) advisory circular provides guidance for SMS development by aviation service providers.[3]

Full-scale implementation of SMS around the world is "going to take more time," said Capt. Daniel E. Maurino, coordinator of the ICAO Flight Safety and Human Factors Programme.

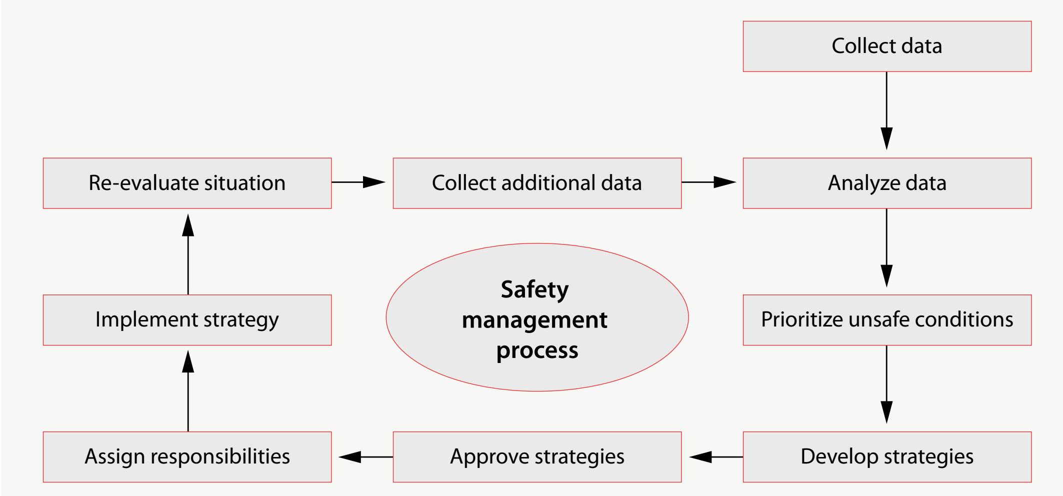
Maurino estimated in November 2007 that only about 10 percent of all airlines worldwide have "a reasonably implemented SMS."

Among the 90 percent that do not, most major airlines in industrialized countries have "the building blocks for an SMS" in the form of incident-reporting systems, safety investigations, safety audits and safety promotion, Maurino said. For many, coordinating the building blocks to craft an SMS will be a time-consuming process, he said.

Maurino described early development of SMS as "piecemeal." By now, he said, "we're still in kind of an awareness phase, but there is a definite move toward making things happen."

Bill Edmunds, senior human performance specialist for the Air Line Pilots Association, International (ALPA), agreed.

Safety Management Process



Source: International Civil Aviation Organization

Figure 1

"It's an evolving process," Edmunds said. "It's pretty intensive in time, effort and money … and it's going to be years before it's in place everywhere."

'10 Different Answers'

Despite the information currently available, there still is no widespread agreement on exactly what constitutes an SMS, said Nicholas A. Sabatini, FAA associate administrator for aviation safety.

"If I talk to 10 people, I get 10 different answers about what an SMS is," Sabatini said in November at the 4th Annual FAA International Aviation Safety Forum.

Acting FAA Administrator Robert A. Sturgell told the same gathering that he perceives SMS as the vehicle that will help the aviation industry take a step forward to improve safety worldwide.

"Ultimately, we don't want to just meet ICAO minimums," Sturgell said. "Our goal is to raise the bar worldwide, no matter where you go. … From takeoff to touchdown and all points in between, we want to ensure a consistent level of safety."

SMS has the potential to help improve safety internationally, in areas where accident rates are high as well as in those where they are low, he said.

"We all still need to take a step up," he said. "The safety management system approach will enable us to do that. …

"At its most fundamental level, a safety management system helps organizations identify and manage risk. It does not wait for something to happen. It doesn't rely on anecdotal information. It is based on hard data. Safety management systems help us manage risk far better than we have because it's a disciplined and standardized approach to managing risk."

As an example, Sturgell cited the recent FAA "call to action" in which the agency used SMS principles in response to a series of runway-related problems: "We [had] looked at 5.4 million records covering a 20-year period. We found 117 isolated instances of flight crew confusion here in the [United] States involving a variety of issues."

With the resulting call to action, FAA officials and industry representatives addressed those issues — including miscommunication, missed turns on taxiways and runways, and unhelpful airport signage — through increased training of both flight crews and airport employees on ground operations, accelerated programs to upgrade signage and airport makings, and development of a voluntary safety reporting system for air traffic controllers.

Capt. Ana Vegega of United Airlines, SMS director for ALPA, said that, despite the emphasis on data collection, SMS also relies on forward-looking data analysis and subsequent actions.

"We can't do much with data by itself," Vegega said during ALPA's 2007 Air Safety and

Security Week, held in August. "We need to be able to analyze the data and turn it into information and then knowledge."[4]

Lack of proper reporting and release of data may be the single greatest obstacle to implementation of SMS, she said.

Some of those attending the FAA safety forum agreed, noting that both mandatory incident reporting and voluntary reporting of observed safety lapses within a corporate just culture are crucial to a healthy SMS.[5]

Data sharing is essential, and in a number of countries, including the United States, laws specify that the information can be "freely given without fear of retribution or punishment," Sabatini said.

Randy Gaston, vice president of flight operations at Gulfstream Aerospace, added, "Without protection of data, you're going to have a hard time progressing with SMS."

Mandatory SMS

Giovanni Bisignani, director general and CEO of the International Air Transport Association (IATA), told the safety forum that his organization has incorporated "SMS thinking" into the IATA Operational Safety Audit (IOSA), "effectively making [SMS] a requirement for all IATA airlines."

He added, "Now, it's time to dig deeper. Although we all agree on the concept and are implementing it as best practice, there is no global standard to guide us, or targets to monitor progress."

If a measurable global standard is adopted, Bisignani said, "SMS has the potential to be a powerful tool to align our safety efforts."

Relationship of Trust

In Canada — where officials of Transport Canada (TC) decided in 2005 to require airlines to implement SMS, although some Canadian airlines voluntarily began using it several years earlier — TC officials today say that the success of SMS internationally depends on the quality of the safety culture within a country's aviation industry and the country's own regulatory authority.

"The development of an effective safety culture is predicated on a relationship of trust between the organization and the employee; the employee and the regulator; and the regulator and the industry," TC said. "In some cases, this may already exist; in most cases it will take some time to establish a foundation that fosters the development of this relationship. Some of the tools that will promote this growth are reporting policies that are, to the extent possible, non-punitive; effective communications at all levels; and feedback on the system's inputs, outputs and continuous improvements."[6]

Canadian airlines were among the first to implement SMS, with goals that included increasing industry accountability, instilling a positive safety culture and improving performance.

In 2008, TC and Canadian operators will complete the three-year SMS implementation process at airlines and will continue the process within airports, flight training operations, maintenance organizations and manufacturers, Capt. Merlin Preuss, director general of civil aviation at Transport Canada, told the FAA safety forum.

"This is a long push for regulatory authorities," Preuss said. He added that TC has developed an internal equivalent of an SMS, because "regulatory authorities must 'walk the walk'" by complying with the same standards that they impose on the aviation industry.

The effort to implement SMS will be especially difficult for operators and regulators without a history of a positive safety culture, TC said.

Capt. Peter Griffiths, director general of civil aviation at the U.K. Department for Transport, said that one good way to propagate SMS throughout the worldwide aviation industry would be to develop a tool kit or some similar method of prescribing the steps needed to implement an SMS.

"People constantly ask for something more concrete," Griffiths told the FAA safety forum. Nevertheless, those who develop a tool kit will face a challenge in drafting plans that will apply to all types of operations, large and small, he said, noting that in some smaller operations, SMS may be implemented by people who have little training in the area.

The U.K. Civil Aviation Authority (CAA) says, in published guidance for aviation organizations developing SMS, that each organization should introduce SMS with whatever component is simplest to implement.

"It is unlikely and probably undesirable that an organization should attempt to introduce a complete SMS in a short time scale," the CAA said. "It is for the organization to decide which components should have priority for introduction if training or new processes need to be developed."[7]

'Part of Their Business'

In Australia, Civil Aviation Safety Authority (CASA) CEO Bruce Byron has told the CEOs of the country's aviation organizations that they must consider safety management "as part of their business — not just a technical add-on."

In a booklet distributed to the CEOs, Byron discussed development of SMS and other key aspects of safety management, including a positive safety culture and human factors issues.[8]

Byron said, "Internationally, it is now recognized that a structured SMS is an essential feature of an aviation business."

Although many CEOs in industry have operated SMS for years, he said, "It is clear that others need some help."

Citing guidance material produced by ICAO and CASA, among others, he said that one of the most pointed actions a CEO can take to advance safety is to preside over the operation's "top" meetings on safety. This ensures that everyone in the company knows that SMS is considered a vital part of the business, he said.

That approach is in place at Continental Airlines, where CEO Larry Kellner chairs quarterly meetings of the corporate safety review board, whose members are the airline's senior executives, said Capt. Don Gunther, senior director for safety and regulatory compliance.

"That's … the top-down approach," Gunther said, "and it sends a message companywide that the SMS is important to senior leadership."

Gunther began work in 2005 on Continental's SMS implementation plans. Today, Continental's program is "pretty far along" but still not 100 percent implemented, he said. In addition to the corporate safety review board, two elements already are in place:

- Numerous safety action teams, which represent Continental employees within a particular geographic location or with a specific type of job or concern; members also include safety personnel from ALPA and, when appropriate, the FAA. The safety action teams are the "heart and soul of the safety management program," Gunther said.

- A business partner program, also known as an airside partnership for safety, which includes Continental's vendors, who participate in quarterly safety programs and training in such areas as threat and error management. Gunther said Continental credits the program with much of this year's 50 percent reduction in ground damage — and 80 percent reduction in associated costs — incurred by vendors. Overall, ground damage has decreased 30 percent this year, he said.

In addition, a safety awards program recognizes employees' advances in safety training and awareness, reductions in injuries and damages, and improvements in compliance with U.S. Occupational Safety and Health Administration (OSHA) requirements. The program reinforces the airline's strong safety culture, Gunther said.

Even with these elements of an SMS in place, Gunther said, "I feel like we've just taken the first step."

He said that a fourth element of the program, expected to be in place in early 2009, will be a safety database that will incorporate existing safety data sets.

Capt. William E. Yantiss, vice president of corporate safety, security, quality and environment at United Airlines, told the FAA forum that most SMS efforts in the United States began when the FAA asked U.S. airlines to develop standards for their foreign code-share partners.

"That presented a unique challenge," Yantiss said, referring to the need to develop standards that would be acceptable to the code-share airlines as well as to regulators. The process has not always unfolded smoothly, as demonstrated when the CEO of one code-share airline threatened to expel him from the airline's property because he was insisting that the code-share operation comply with ICAO standards.

Partly because of that incident and all it represented, Yantiss said that he favors global standardization rather than airline-specific rules or even regional standardization.

Nevertheless, Sabatini cautioned that, although basic operating principles should be established on an industrywide basis, "we cannot walk in lock step" on SMS implementation.

Peter Stasny, head of the Eurocontrol Safety Regulation Unit, agreed.

Although SMS development depends on consistent regulations, the programs cannot operate "in exactly the same way in all the different sectors," Stasny told the FAA safety forum.

U.S. National Transportation Safety Board Chairman Mark V. Rosenker said that there is no such thing as a "one-size-fits-all" SMS and that any new standards must acknowledge that.

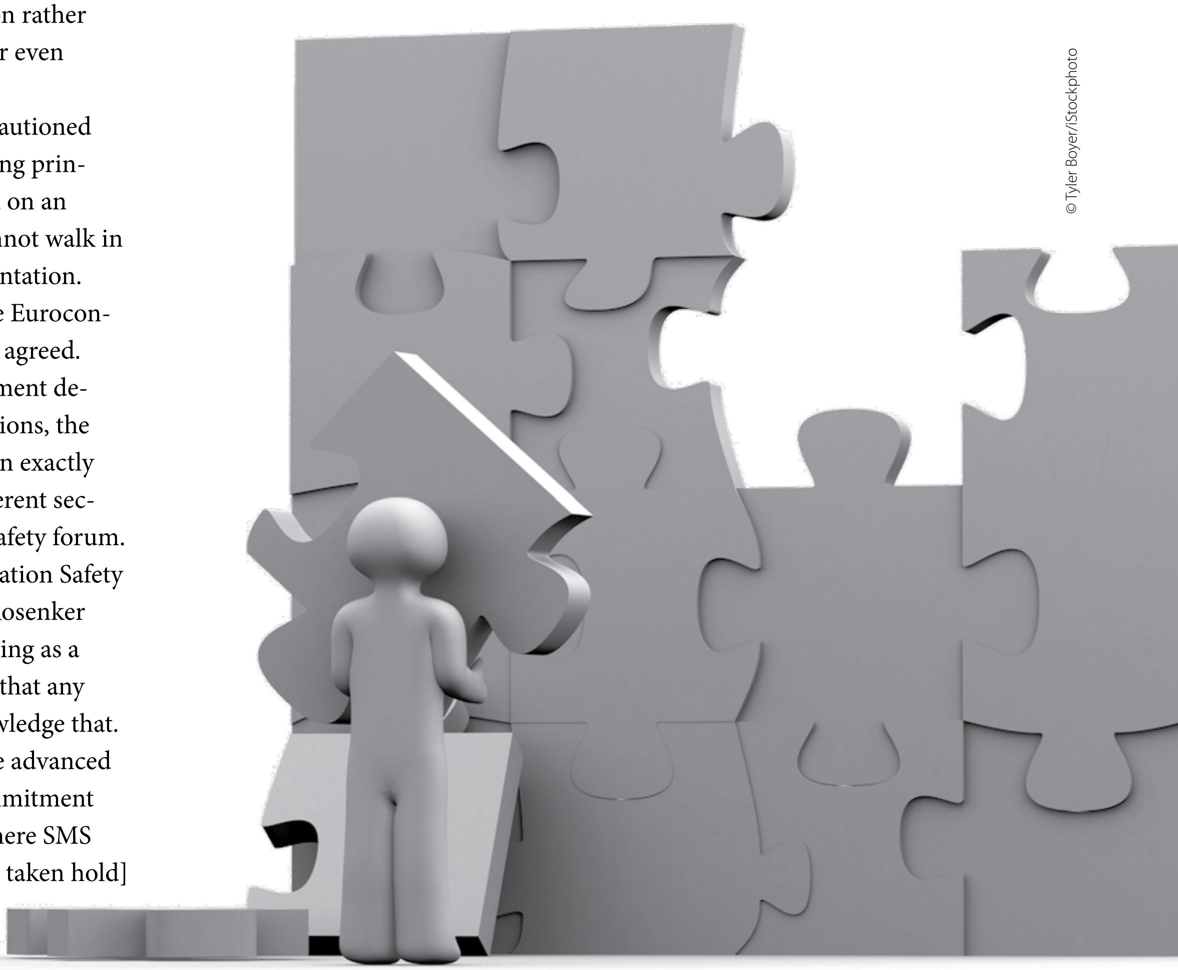
"There are already more advanced regions, and we need a commitment to help [in other regions where SMS implementation has not yet taken hold] and to share information," Rosenker said. ●

Notes

1. ICAO. *Safety Management Manual (SMM)*. Document 9859. 2006.
2. ICAO deadlines for SMS implementation already have passed for airports and air traffic services providers.
3. FAA Advisory Circular 120–92, *Introduction to Safety Management Systems for Air Operators*. June 22, 2006.
4. ALPA. "ALPA Safety Reps Hold Town Meeting." *Air Line Pilot* Volume 76 (September 2007): 21–23.
5. The ICAO *SMM* defines a just culture as one that recognizes that, although personnel should freely share critical safety information without fear of punitive action, "in certain circumstances, there may be a need for punitive action and attempts to define the line between acceptable and unacceptable actions or activities." In general, however, the *SMM* says that evidence indicates that punishment has "little, if any, systemic value on safety" and that punishment "serves little purpose from a safety perspective."
6. TC. *Safety Management Systems (SMS): Frequently Asked Questions (FAQ)*, VIII. International Leadership. <https://www.tc.gc.ca/civilaviation/SMS/FAQ/International/Q2.htm>.
7. CAA, Safety Regulation Group. Civil Aviation Publication (CAP) 726, *Guidance for Developing and Auditing a Formal Safety Management System*. March 28, 2003.
8. CASA. *Safety Management and the CEO*. <www.casa.gov.au/sms/download/sms_ceo.pdf>.

Further Reading From FSF Publications

FSF Editorial Staff. "Unlocking the Potential of a Safety Management System." *Flight Safety Digest* Volume 24 (November–December 2005).



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Stepping Up to SMS

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Most corporate aircraft operators are willing, but few know how.

BY MARK LACAGNINA

Field experience suggests that the greatest challenge to corporate flight departments in establishing a safety management system (SMS) is developing a safety risk profile, which is the keystone of an SMS. The type of risk assessment required for an SMS is different than most corporate aircraft operators are used to conducting.

"We have, for many years, been preaching the concept of having a 'safety program' — that's the term that was used by the industry," said Darol Holsman, manager of aviation safety audits for Flight Safety Foundation. "The basis of the safety program was to monitor your events and activities; if you have accidents or incidents, investigate them, find the causes and then establish mediation steps to keep them from happening again. Risk assessment for an SMS is the opposite approach: You conduct an assessment of what you are doing and develop mitigation to prevent any potential accidents or incidents from occurring. It is a challenge because it's a cultural change to the process of safety management."

Despite the challenge in its application, the risk assessment process holds such promise for further improvement of corporate aviation's excellent safety record that SMS is attractive to many flight departments. "There is no lack of enthusiasm," Holsman said. "The operators we talk to are fully convinced that this is the way to go, and, in many cases, they are very happy to see it happen, because the underlying theme is that it is a reversal of what we have been doing for so many years. Instead of just studying our events and accidents, and finding ways to solve them, we're now trying to prevent them in the first place. For many operators, that is a positive change and certainly is worth pursuing."

John Smith, who spearheaded the development and implementation of an SMS as safety manager for a major corporation, said that risk assessment was one element that was not in place when he began work in 2004.[1] "When he retired, the former safety manager left behind strong safety policies and procedures, a terrific safety culture and a lot of files," he said. "We had religion, so to speak, but it wasn't coordinated, identifiable or measurable."

"We had incident-reporting programs that were very informal and had no

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mechanisms to investigate, document or follow up with takeaways," Smith said. Developing a risk assessment program seemed daunting at first. "Coming up with a documented process took some mental wrangling, but it turned out to be much easier than I originally had thought," he said.

Not Rocket Science

At first glance, SMS guidance materials reveal an intimidating array of systems, procedures, processes and methods — almost all having their own subsystems. Grasping the concept is made more difficult by the different and somewhat complex definitions of SMS given by various organizations. For example, the International Business Aviation Council (IBAC) defines it as "a systematic and comprehensive process for the proactive management of safety risks that integrates the management of operations and technical systems with financial and human resource management."

Developing and implementing an SMS takes time and effort — and money — but is not as difficult as it might first appear.

Aviation safety specialists with whom *ASW* spoke agree that developing and implementing an SMS takes time and effort — and money — but is not as difficult as it might first appear. Likely the most encouraging definition is provided by the International Civil Aviation Organization (ICAO) in its *Safety Management Manual*, which says that an SMS is "an organized approach to managing safety" (see p. 14). The manual goes on to say, "There is no single model that 'fits all.' … The degree of formality and rigidity in the SMS should be a reflection of the organization's needs, rather than blind adherence to doctrine."

"Operators tend to 'complexify' this too much, and I tell them to take what they normally are involved in and implement their SMS risk assessment around that," Holsman said. "On the other hand, some operators are just trying to take their old way of doing business and Scotch-taping the SMS on top of it. They would be better off to start with a restructuring of their existing programs and procedures to match what SMS is all about."

The Gold Standard

The incentives for implementing an SMS include certification as meeting the International Standard for Business Aircraft Operations (IS-BAO), which was developed by IBAC to "promote global standardization and to assist operators in establishing quality flight departments using best practices of business aircraft operations worldwide."

An SMS is an IS-BAO requirement and includes several elements, including a written policy that clearly delineates the safety responsibilities of company executives, the flight department manager, pilots and others; identification and demonstration of compliance with regulations and standards; training programs; operations and other manuals; data collection and analysis; risk identification, analysis and mitigation; accident/incident reporting and investigation; and independent operational safety reviews and audits of the SMS.

IBAC's IS-BAO manual includes detailed descriptions of all the SMS elements and acceptable means of implementing them, a sample safety policy, a generic operations manual, an internal audit manual and other guidance material.

The risk assessment process required by IS-BAO leads to creation of a detailed safety risk profile. The profile is based on analysis of the company's exposure to loss from several factors, including available air traffic services, airports and approach aids used, aircraft and maintenance details, and flight crew qualifications and experience. Mitigation strategies must be developed for high-risk factors. For example, the mitigation strategy for risk from pilot fatigue could be the establishment of flight and duty time limits.

The IS-BAO manual provides examples of safety risk profiles for hypothetical flight departments of different sizes and additional information on risk assessment in a document titled *Guidelines for the Conduct of Risk Analysis for Business Aircraft Operators*.

Building the Foundation

The safety risk profile is the foundation on which an SMS is built. The IS-BAO manual says, "The nature and degree of safety management necessary … should be determined by assessing the nature of the safety risks to which the flight operation is exposed. In other words, the safety risks of an operation should be profiled to determine the appropriate level and focus of safety management. The SMS is then tailored to proactively address the risks specific to a company's flight operation."

Ray Rohr, standards manager for IBAC, told attendees at the Foundation's 2004 Corporate Aviation Safety Seminar (CASS) that the process of creating a safety risk profile need not be complex. "It can be adjusted to suit the time and resources available and the complexity of the operation that is being examined," he said.

The first step in risk assessment is to identify accident scenarios and their associated hazards, defined as "conditions or circumstances that can lead to physical injury or damage." Rohr said, "One effective way of identifying the possible causes of accidents and the related hazards is through a brainstorming session involving a team of as many people in the flight department as possible. This process can be an effective way to create 'buy-in' and to tap into the knowledge base of the organization."

The next step is to determine the potential consequences of the hazards by gauging both the severity of the associated safety risks and the likelihood that they could affect flight operations. There are several methods of classifying risk severity and likelihood; criteria recommended by IBAC are shown in Table 1. "The hazards and associated safety risks with the highest severity and likelihood should receive the most attention," Rohr said.

The risk assessment process is completed by "deciding how to manage the hazards and associated risks, and documenting the information so that action will be taken and tracked, and the results assessed later," he said. Again, a brainstorming session involving everyone in the flight department is a good way to develop mitigation strategies, or "the measures that must be taken to eliminate a hazard or to reduce the severity and likelihood of one or more risks."

"Let the information flow freely during this phase of developing mitigation," Rohr said. "The ideas will subsequently be refined so that they are realistic and appropriate."

The resulting safety risk profile should be presented to everyone in the company who makes decisions affecting the flight department's operations. Rohr said that it is important that company executives, pilots, maintenance technicians, service personnel and others be aware of the risks and understand and support the mitigation strategies.

"The safety risk profile also establishes a framework that ensures that everyone becomes involved in the operator's safety management activities and understands that their participation and input are not only valued but are essential,"

Safety Risk Classification

Severity	
Category A	Potential for loss of life or destruction of the aircraft
Category B	Potential for serious injury or major damage to the aircraft
Category C	Potential for minor injury or damage to the aircraft
Category D	Trivial (e.g., inconvenience)
Likelihood	
High	Often
Medium	Occasionally
Low	Seldom
Rare	Unlikely
Very rare	Highly unlikely

Source: Ray Rohr

Table 1

he said. "A safety risk profile is a living document that must be periodically updated." IS-BAO requires updating at least every two years.

Tracking Hazards

Taking action to address the safety risk profile involves what the IS-BAO manual calls technical management. "The technical management system is the mechanism for translating the mitigation identified in the risk analysis process … into the programs, procedures and manuals used by the operator," Rohr said. For example, if duty and flight time limits were chosen as the best way to mitigate the risk of fatigue, they would be incorporated in the operations manual and training manual.

Beyond the risk profile, technical management also includes documentation of applicable regulations and standards, and how the flight department meets them; and documentation of the safety responsibilities of department personnel. Technical management also ensures that personnel are properly qualified and trained, and have the equipment and tools necessary to meet their safety responsibilities.

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Hazard identification and tracking continues the risk assessment process and provides for evaluating the appropriateness and effectiveness of the department's safety management activities. "The hazard identification program can include voluntary or confidential reporting programs, safety committee meetings, operator data collection systems, brainstorming sessions, SMS audits and safety reviews," Rohr said. "The hazard tracking system is the mechanism to document, track and evaluate the effectiveness of remedial measures that are being undertaken." For example, the effectiveness of the duty and flight time limitations might be evaluated from reports that pilots are required to file after working more than a specified number of hours. "These reports will also build a database that may be used in the future to make modifications to the fatigue countermeasures," Rohr said.

In a paper prepared with Terry Kelly, managing director of SMS Aviation Safety, for presentation at the 2007 CASS, Rohr said, "Another valuable tracking tool that can be used is the corporate flight operational quality assurance (C-FOQA) program that has been piloted by Flight Safety Foundation. A number of operators have used the program to collect data and identify trends, and have achieved very positive results."

Coping With Change

Revision of the flight department's SMS also might be required when changes occur in the aircraft fleet, operating environment, hiring/scheduling practices, organizational structure or maintenance, the IS-BAO manual says.

"Bringing a new airplane into the fleet is a good example," Holsman said. "There are revised SOPs [standard operating procedures] that you have to deal with, there's probably new technology, there are training issues and a variety of other projects that should be plugged into the risk assessment process." Holsman noted a flight department that recently began using a different type of tow vehicle: "Another candidate for risk assessment. It made towing easier, but it required new rules, training and so forth."

Rohr said that a formal change management process is not required for all flight departments. "Single-aircraft operators that operate in stable, low-risk environments may choose not to maintain a change management process," he said. "It is more appropriate for larger or more complex operations, or those that frequently experience significant change."

Certification Stages

As mentioned earlier, SMS development and implementation take time. In recognition of this, IS-BAO certification is conducted in three stages. Initial, Stage 1, certification might be granted if the flight department has developed most of the elements of an SMS and has an action plan to complete development. The next IS-BAO audit is conducted 24 months later. If the flight department is making good progress but does not yet have all the elements in place, it might qualify for Stage 2 certification and will be audited again either in 24 months or 36 months, depending on how much progress has been made. If the department's SMS is found to be fully implemented during the second audit, the department could be granted Stage 3 certification, the highest level.

What usually is still in the development phase during the initial audit is a risk assessment process. "We have done about 30 IS-BAO audits in the last four years and found that about half a dozen of the operators had a fully developed risk assessment process that's being applied to their day-to-day activities," Holsman said. "They're very much in the minority. Only a select few have moved to Stage 3 certification."

Smith's company, which operates a mixed fleet, achieved Stage 1 certification in 2005 and Stage 3 certification last year. "In 2005, we had the 'chapter in the manual' [i.e., documented SMS elements] and the mechanisms were in place to collect the data we needed, but the data weren't there," Smith said.

Achieving IS-BAO certification is not the only reason to implement an SMS. Koch Industries' flight department, which operates 10 jets and a turboprop, set up an SMS in 2002 not only to achieve IS-BAO certification but to prepare its application to become a participant in the U.S. Occupational Safety and Health Administration (OSHA) Voluntary Protection Program (VPP). Flight department manager K.C. Carlson said, "We were the first Part 91 [corporate] flight operation to qualify for VPP 'Star' status." This is the highest status, recognizing companies with exemplary safety and health management systems and performance.

Development and implementation of the Koch flight department's SMS was led by Jonathan Baxt, the department's director of safety and a former

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Air National Guard safety officer. "Jon brought a wealth of experience and information from safety management programs that he implemented in the Guard and used effectively over the years," Carlson said. "We have a safe operation — our department is celebrating its 60th year with no accidents or serious incidents — but up until 2002, we did not have a formal safety management system." He said that implementation of the SMS "stepped up our safety culture to the next level" and also resulted in a reduction of insurance premiums.

Smith said that his involvement in developing and implementing an SMS was typical of corporate aviation. "We are not hiring people with heavy-duty safety backgrounds for a number of reasons, one of which is there are not a lot of them out there in corporate aviation that can come into a department," he said. "So, you're going to appoint someone who knows the department, usually a line pilot. A safety management system is not just a new chapter in a manual. It's not an easy process. You have to identify what you do now and what you can do better, and come up with methods and mechanisms to get there. But the difficulties in getting the pieces of the puzzle together certainly are not insurmountable. It's nothing that anyone in the flight department could not do. You just need to want to do it."●

"You have to identify what you do now and what you can do better, and come up with methods and mechanisms to get there."

Note

1. At press time, the corporation asked *ASW* not to publish its name. "John Smith" is a pseudonym.

SMS GOES VERTICAL

Smaller helicopter operators are the target of a new tool kit that will ease the pain of developing a safety management system.

BY JAMES T. MCKENNA

A campaign to convince commercial helicopter operators to embrace a host of new recommendations for improving rotorcraft safety, including a tool kit for developing a safety management system (SMS), has been launched by an international coalition of helicopter manufacturers, regulators, operators and customers.

The coalition, the International Helicopter Safety Team (IHST), modeled on the airline-oriented Commercial Aviation Safety Team (CAST), since late 2005 has been pursuing the goal of reducing rotorcraft accident rates 80 percent by 2016 (see “International Helicopter Safety Team,” p. 28). The team has two main subteams. One spent 18 months analyzing the root causes of 197 helicopter accidents that occurred in 2000 and recommending means to prevent similar accidents. The other subteam is just beginning the task of turning those recommendations into pragmatic actions.

This group aims to gain industry support for its efforts by offering individual helicopter operators a simplified tool to assist in developing and implementing an SMS tailored to each firm’s mission and business circumstances. Group leaders expect the SMS tool kit will help persuade operators that its recommendations could improve both safety records and bottom lines. The tool kit is available online at <www.ihst.org>.

In developing the tool kit, the group aimed to win acceptance of the SMS approach — and by extension the group’s subsequent recommendations — from operators of five or fewer helicopters. Such operators make up the largest single segment of the civil helicopter industry, approximately 80 percent, and are involved in the vast majority of helicopter accidents.

“The real target audience is the operator of two to five helicopters,” said B. Hooper Harris, manager of the U.S. Federal Aviation Administration (FAA) Accident Investigation Division.

All photos: ©Chris Sorensen Photography


N9

Harris is co-chairman of the subteam that watched over the development of the SMS tool kit and participated in drafting it. He shares the chair of the Joint Helicopter Safety Implementation Team with Greg Wyght, vice president of safety and quality for CHC Helicopter Corp., among the world's largest providers of helicopter services to the global offshore oil and gas industry.

The IHST calls an SMS "a proven process for managing risk that ties all elements of the organization together laterally and vertically and ensures appropriate allocation of resources to safety issues." It urges that the term "safety management" be taken to mean safety, security, health and environmental management. The key focus of such a system, though, "is the safe operations of airworthy aircraft."

The helicopter industry faces challenges in making such an approach common. To date, the SMS approach has been applied in industries large

International Helicopter Safety Team

The Safety Management System Tool Kit for helicopter operators is the first product of a 10-year effort to cut worldwide rotorcraft accidents by 80 percent.

Making this effort is the International Helicopter Safety Team (IHST), the outgrowth of a September 2005 gathering of manufacturers, regulators and operators from around the world. That gathering was supported by the International Civil Aviation Organization and regulators in Canada, France, the United Kingdom and the United States. Also backing it were Canadian, French and U.S. accident investigators, rotorcraft manufacturers, and major civil and military operators.

Convened in Montreal at the behest of the American Helicopter Society International and the Helicopter Association International, the gathering marked the participants' recognition of a daunting challenge: their inability year after year to reduce the number of accidents. That inability seemed to reinforce a public impression of helicopters as unreliable and unsafe, an impression that stood as a critical obstacle to the growth and prosperity of the industry.

To dismantle that obstacle, the 260 attendees of the first International Helicopter Safety Symposium agreed to draw on the successful experience of the Commercial Aviation Safety Team (CAST) in the United States. That is, they would search all credible data on helicopter accidents for root causes and use that data to prioritize mitigation measures to address the most common problems.

The IHST is co-chaired by Matt Zuccaro, president of the Helicopter Association International, and Dave Downey, manager of the Rotorcraft Directorate of the U.S. Federal Aviation Administration (FAA) Aircraft Certification Service. It includes the Joint Helicopter Safety Analysis Team, which is doing root-cause analysis of rotorcraft accidents on an annual basis, and the Joint Helicopter Safety Implementation Team, which will develop mitigation measures based on the analysis team's recommendations.

While the IHST is drawing on the model of CAST, its goals are more ambitious in several respects.

First, while CAST focused on an 80-percent reduction in fatal accidents, the helicopter team aims for a similar reduction in both fatal and non-fatal accidents. Second, CAST's target group is a fairly homogeneous one: commercial airlines generally flying large fleets drawn from a small set of fixed-wing transports. Roughly 80 percent of civil helicopter operators have fleets of fewer than five aircraft, and they fly aircraft built by more than 15 different manufacturers, including those from former Soviet republics.

Third, CAST concentrates on scheduled airline service. The helicopter team must cover aircraft used in a variety of missions, with each mission type having unique operational, training, and equipment aspects. The IHST settled on grouping its analysis and mitigation work into 15 different mission sets.

Most challenging of all, perhaps, was the lack of reliable utilization numbers for helicopters. Hours flown by commercial airlines are tracked in detail by regulators and financial markets. But helicopter flight hours in the United States, the world's largest rotorcraft market, are based on sampling by the FAA, an approach that has proven inaccurate for the small fleets involved. So before it could tackle its goal of reducing helicopter accident rates, the international team had to build the database for establishing those rates.

"You can't even meet the goal until you know how many hours are flown," said Roy G. Fox, chief of flight safety at Bell Helicopter, who is leading the effort to compile that database. That work should be completed in 2008.

Most of the team's work has focused on the United States, but team leaders aim to establish regional teams throughout the world, already under way to varying degrees in Australia, India and Latin America. The European helicopter community is pursuing a parallel effort. This year, team leaders plan to meet with industry officials in United Arab Emirates, Japan and South Africa to launch regional teams in the Middle East, Asia and Africa.

— JTM

in scale and homogeneous in mission: railroads, energy, chemicals, airlines, aircraft maintenance and air traffic services. While there are large helicopter operators, such as CHC, and many of them have adopted SMS or major components of SMS, most helicopters are spread among many small operators, and are used in a wide variety of missions.

When the Joint Helicopter Safety Analysis Team presented its recommendations for mishap-mitigation measures, for instance, it did so in a number of mission-specific categories. They include instructional/training, personal/private, aerial application, emergency medical services, law enforcement, and offshore oil and gas platform support. Other categories are business/company-owned aircraft, aerial observation/patrol, air tour and sightseeing, electronic newsgathering, external load, logging, fire fighting, numerous other commercial activities, and utilities patrol and construction. The Joint Helicopter Safety Implementation Team proposes to adhere to the same divisions in developing its mitigation recommendations.

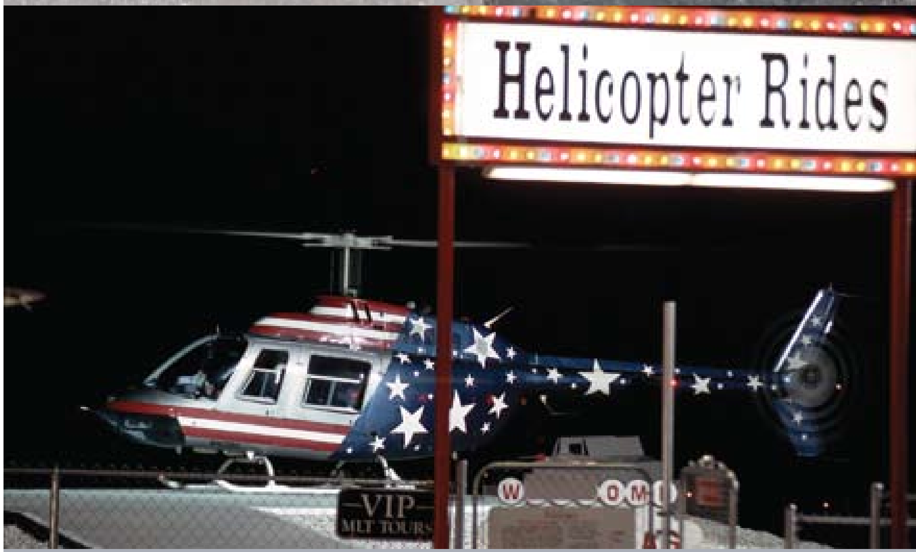
"That means we're not after the bigs, we're after the little guys," said Roy G. Fox, chief of flight safety at Bell Helicopter, who worked on drafting the SMS tool kit.

There is ample cause to target the small operator. The number of helicopter accidents has remained fairly constant for the last 20 years, including U.S. civil and military operations, and operations outside the United States.

"The rotorcraft industry understands its risks more clearly than other elements of the [aviation] industry," said the FAA's Harris, "simply because they have an accident rate that is significant."

In its bid to change that trend, the IHST adopted the general approach used with great success in the U.S. by the CAST. That team began its work in 1997 with the objective of cutting the U.S. airline fatal accident rate 80 percent in 10 years; it has nearly achieved that goal. The foundation of its work was basing safety initiatives on reliable, verified data about accident causes.

The helicopter team works on the same basis. Yet its Joint Helicopter Safety Team had not yet completed its work when it called for widespread use of SMS. Team members said that their interim



All photos: © Chris Sorensen Photography analysis argued strongly for adoption of such systems. The analysis team looking at the 197 accidents found that a major contributing factor in most accidents was the failure to adequately manage known risks, said Keith Johnson, safety program manager for the Airborne Law Enforcement Association. Johnson is a member of the Joint Helicopter Safety Implementation Team (JHSIT) and participated in drafting the SMS tool kit.

In addition to the benefits an SMS brings in itself, they said, it also would serve as the framework for subsequent safety recommendations.

"We needed something to start this structure," Fox said.

"A good, strong SMS is a springboard" for other improvements, said Fred Brisbois, director of aviation and product safety for Sikorsky Aircraft. He is a member of the JHSIT and helped develop the SMS tool kit. "You can have the most modern, best equipped aircraft. If you don't have an SMS, you compromise all the other safety advances."

The tool kit's drafters said they reviewed several SMS models, as well as regulations and guidance material from around the world, to tailor a kit for the helicopter industry. They also said they included contributions from small, medium and large helicopter operators, airlines, industry groups and governments.

"We're taking what's out there and putting it into laymen's terms that the smaller operator can use," said Brisbois.

The result "is somewhat unique," said Harris. "Almost everybody else talks around SMS in a 'big system' way."

In a bid to win acceptance from the broadest range of smaller operators, he said, the team opted for a tool kit that fosters a performance-based SMS, as opposed to one that lays out a rigid structure and procedures. Harris explained the difference:

"Every person has a financial management system. You balance your checkbook, you pay your taxes and you pay your bills. You may do that by yourself, with a checkbook and a calculator or computer. [Microsoft founder] Bill Gates may rely on accountants and lawyers. Whoever you are, the functions are the same and the performance objectives are the same: to manage your funds, pay your taxes and honor your debts."

Toward that end, the IHST tool kit lays out 11 attributes of an effective SMS and offers checklists of steps operators should take to achieve each attribute. But it leaves the details up to each operator.

Perhaps most important to its efforts to win widespread acceptance of its SMS tool kit, the team gives operators the option of integrating such systems into their activities in incremental steps. "This allows the organization to become acquainted with the requirements and results before proceeding to the next step," the tool kit says.

The core attributes of the IHST's SMS are:

- An SMS management plan;
- Safety promotion;
- Document and data information management;
- Hazard identification and risk management;
- Occurrence and hazard reporting;
- Occurrence investigation and analysis;
- Safety assurance oversight programs;
- Safety management training requirements;
- Management of changes;
- Emergency preparedness and response, and;
- Performance measurement and continuous improvement.

Essential to the effectiveness of an SMS, Johnson said, is its acceptance by senior management as a core business responsibility.

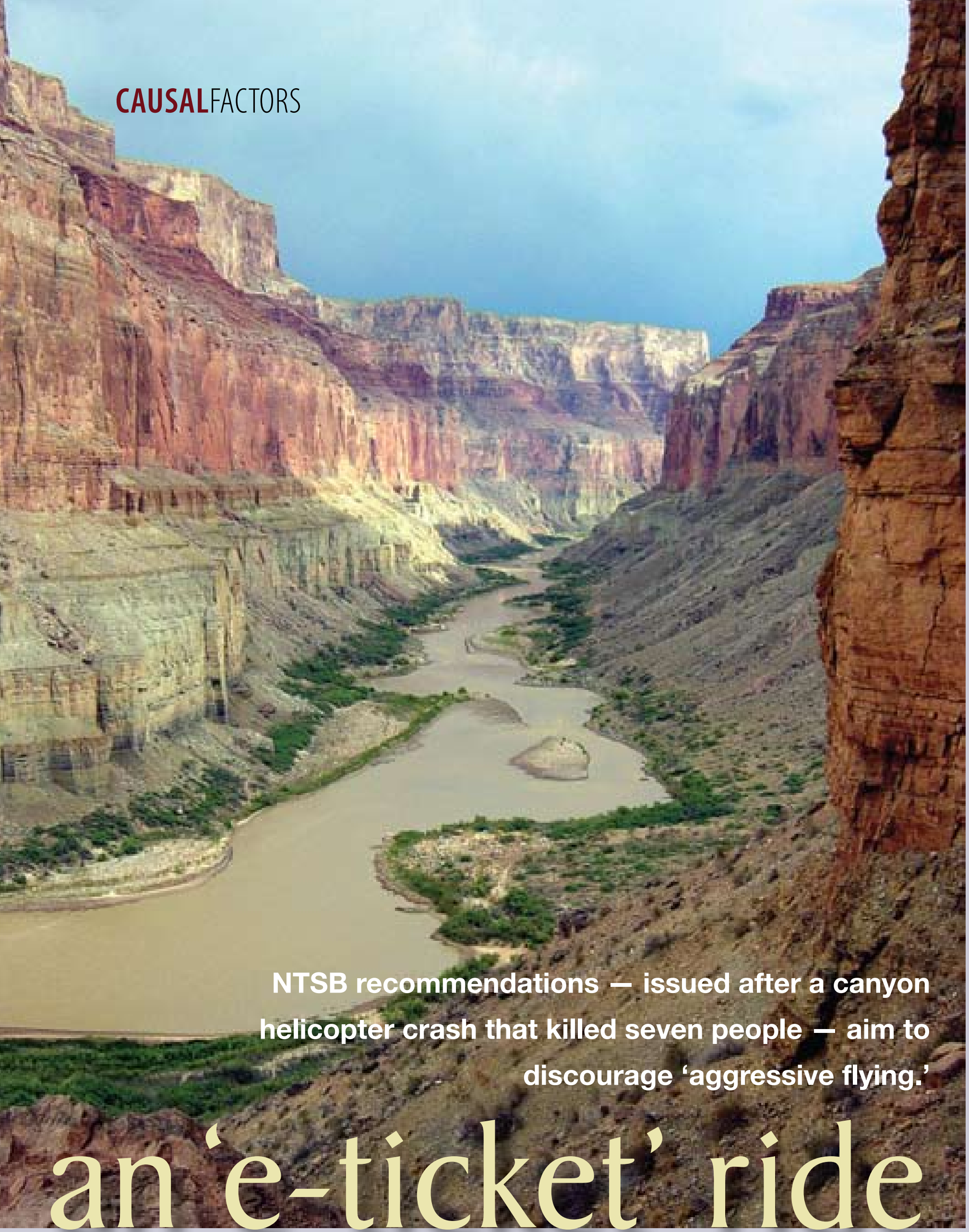
The team plans additional steps to promote acceptance of SMS. It is developing computer software to help operators assess the savings that could be achieved through use of an SMS. It plans to offer training in the use of that software and SMS at the Helicopter Association International's Heli-Expo annual convention in February in Houston. It also plans to develop a second edition of the tool kit targeted at medium-sized operators.

Team members believe their efforts got an important boost in October, when ExxonMobil Aviation issued a memorandum to vendors. The unit that contracts for and oversees aviation support for that company's oil and gas exploration activities worldwide, ExxonMobil Aviation, noted that its "mature and established aircraft operators" have SMS in place.

"However, smaller operators often face challenges in the implementation of a fit-for-purpose SMS that meets operational requirements whilst being economically viable," the memo states. Nonetheless, ExxonMobil Aviation considers 11 elements, or attributes, of an SMS "as a minimum standard template for long-term contracted aviation activities." Those are the same 11 listed in the tool kit.

"Having people outside the aviation community saying it can be done lends credibility" to adoption of an SMS, said Sikorsky's Brisbois. ●

James T. McKenna is editor of Rotor & Wing *magazine.*



National Park Service, U.S. Department of the Interior

NTSB recommendations — issued after a canyon helicopter crash that killed seven people — aim to discourage 'aggressive flying.'

an 'e-ticket' ride

BY LINDA WERFELMAN

Disregard of safe flying procedures by a helicopter pilot sometimes called "Kamikaze" and inadequate surveillance of canyon air tour operations by his employer and the U.S. Federal Aviation Administration (FAA) were probable causes of the fatal crash of an Aerospatiale AS 350BA in Arizona's Descent Canyon, the U.S. National Transportation Safety Board (NTSB) says.

In its final report on the Sept. 20, 2003, accident, which killed the pilot and all six passengers, the NTSB said that the 44-year-old pilot had a "documented history of aggressive flying," that Sundance Helicopters did not have a proficiency check policy to evaluate pilot performance on the route on which the accident occurred, and that the FAA principal operations inspector assigned to Sundance had never conducted surveillance of flights on that route.

The accident occurred about 1238 local time, as the pilot transported passengers from a helipad at Grand Canyon West Airport (1G4) near the canyon's upper rim at an elevation of 4,775 ft to another helipad — designated as "the Beach" — on the floor of the Grand Canyon next to the Colorado River at 1,300 ft. Skies were clear at the time, with winds of less than 10 kt and no significant turbulence or wind shear.

The 3.5-minute flight, which involved maneuvering through Descent Canyon, located directly west of the Grand Canyon, was the pilot's 11th such flight of the day; the flights had been preceded by a short operational check flight at the Sundance base at McCarran International Airport in Las Vegas and a 45-minute flight from the base to 1G4.

The 3.5-minute Descent Canyon flights were included in a tour package that featured a boat ride on the Colorado River, followed by a helicopter flight through another canyon for the return to 1G4.

There were no known witnesses to the crash and no air traffic control radar information on the accident flight's progress inside Descent Canyon, but a pilot from Papillon Grand Canyon Helicopters saw a fireball on the canyon wall behind his helicopter as he approached the Colorado River helipad. The wreckage was found on a ledge about 400 ft (122 m) beyond a section of canyon wall that bore evidence of a main rotor blade strike. The distribution of the wreckage and the location of the rotor blade strike indicated that the helicopter was being flown at a high speed along a near-level flight path.

Flight-School Owner

The accident pilot held an airline transport pilot certificate for helicopters and multi-engine airplanes; a commercial pilot certificate for single-engine airplanes; and a flight instructor certificate for helicopters and single- and multi-engine airplanes. He also was rated to teach instrument flight in airplanes and helicopters. His first-class medical certificate had been issued Sept. 16, 2003.

He had owned and operated a flight school in California for 10 years before he was hired by Sundance in May 2000. At the time of the accident, he had 7,860 flight hours, including 6,775 flight hours in helicopters.

An autopsy found no preexisting medical conditions; tests were negative for use of prescription and over-the-counter medications and illegal drugs.

'Free-Fall'

A passenger who had flown on the 1000 flight said that the accident pilot had hovered the helicopter near the canyon rim before he "banked right and nose-dived into the canyon"; he proceeded through a narrow section of the canyon, "very fast and swerving back and forth." Other passengers on the same flight described the trip through Descent Canyon as "a scary free-fall" and said that the pilot had "pointed the nose of the helicopter straight down into the canyon." No one took pictures during the descent, one man said, because "they were all hanging on with both hands"; he said that one passenger screamed throughout the descent.

Two years earlier, in July 2001, a passenger had faxed a complaint to Sundance about the accident pilot's flying during a Descent Canyon flight.

"Being a heart patient with … a very dangerous pilot in charge of the helicopter, I thought I was about to die," the passenger wrote. "He flew so fast and dangerous[ly], I could not believe his behavior."

In August 2001, Sundance's chief pilot told the accident pilot that he faced disciplinary action because of a complaint from another customer — the owner of Air Vegas, whose aircraft flew passengers to 1G4 for Sundance tours. The Air Vegas CEO had told the chief pilot that, during a flight from 1G4 to the Beach helipad, the accident pilot asked if he wanted "a helicopter ride or an 'E-ticket' ride" — a reference to Disneyland's designation of its most thrilling amusement park rides.

Later, the CEO told investigators that he was concerned that there would be complaints from passengers about the "hot rod" flying and that, even with his experience in the U.S. Air Force, he had been uncomfortable during the flight, which he believed had not met standards established by the Tour Operators Program of Safety (TOPS), an industry safety group.

In his subsequent memo to the accident pilot, the Sundance chief pilot said, "This type of flying is not tolerated at Sundance Helicopters and is grounds for disciplinary action." The disciplinary action was to have been a one-week suspension without pay. Sundance records showed that the suspension was not ordered immediately because the operator had a shortage of pilots; later, by the time business slowed, the planned suspension had been forgotten, Sundance's director of operations told the NTSB.

The report said that, although Sundance prohibited reckless behavior by its pilots, "there was no emphasis on these procedures to ensure that the pilot adhered to them. … The company's failure to enforce the [suspension] might have conveyed to the pilot and other Sundance pilots that the completion of tours was more important than safety policies and procedures, or that the company did not consider such flying practices to be serious safety concerns."

A former Sundance tour coordinator said that when she talked to the accident pilot over the radio during his Descent Canyon flights, she could "hear tourists screaming."

She gave investigators a videotape that she made when she rode with the pilot in November 2001, when he "flew very close to the canyon wall. [He] banked off one wall and then turned the other way, almost upside down."

Safety Concerns

Papillon ground employees began calling the accident pilot Kamikaze after

A photograph taken by a passenger on an earlier flight shows the accident helicopter near a canyon wall.

U.S. National Transportation Safety Board watching him fly over Papillon helicopters during refueling or passenger-loading operations, "stopping his helicopter in a hover, dipping its nose towards them and then going on," the report said.

"The Papillon operations manager stated that many pilots talked about the accident pilot's flying and that Papillon's chief of safety had discussed these concerns with the accident pilot," the report said. "He noted that the accident pilot 'was always very nice but didn't change.'"

A former Sundance pilot described the accident pilot as "extremely good" and "more qualified in the helicopter than the job demanded." The accident pilot "pushed the aircraft and pushed the rules of flight in Descent Canyon," he said; those rules included limits of 30 degrees of bank and 10 degrees to 15 degrees of nose-down pitch.

He conceded that the accident pilot was given his nickname for "flying the [expletive] off the helicopter" but added that he had "never seen him take the helicopter to any point he could not easily bring it back from."

The Sundance director of operations said that most pilots flew between 100 and 110 kt, with descent rates into the canyon averaging 1,000 fpm but possibly as high as 2,500 fpm. Another Sundance pilot on the Descent Canyon route the day of the crash estimated that the accident pilot was flying 120 to 140 kt, the report said.

The helicopter, manufactured in 1985 as an Aerospatiale AS 350B, was converted in 1996 to an AS 350BA, in accordance with a Eurocopter service bulletin; changes included modifications to the structure, new main rotor blades, a new tail rotor and drive system modifications. Sundance acquired the helicopter in 1999 and in 2002, replaced the original engine with a Honeywell LTS 101-600A-3A engine. When the accident occurred, the helicopter had 10,890 hours total time and 54,976 cycles, and the engine had 9,516 hours total time and 12,465 cycles. Maintenance was current, and all airworthiness directives, service bulletins and required inspections had been accomplished.

Weight and balance for the accident flight were within acceptable limits.

U.S. National Transportation Safety Board

Passenger photos show the accident helicopter on an earlier flight; graphics depict pitch and bank angles.

The helicopter had been involved in two incidents: In May 2000, the vertical fin assembly received minor damage when it struck a rock during an attempted landing at a remote helipad, and in July 2000, a main rotor blade struck a tree during a turn. Each time, the helicopter was inspected and repaired in accordance with Eurocopter's approved procedures.

Ban on Diving

Sundance Helicopters, established in Las Vegas in 1985 as a pilot training operation, began offering air tours in 1987 and, at the time of the accident, operated 14 helicopters. In the year preceding the accident, the helicopters were flown for a total of about 50,000 cycles; from Jan. 1, 2003, until the accident date, they had made about 11,000 flights on the Descent Canyon route.

Company safety standards prohibited diving into Descent Canyon, established a 120-kt maximum speed for Eurocopter operations in the canyon and specified that "safety and good judgment must be the top priority in conducting all operations."

As a member of TOPS, Sundance was committed to safety standards that included "avoiding any perception of a thrill ride, aerobatics … or unnecessary abrupt maneuvers." TOPS standards also specified maximums of 30 degrees bank and 10 degrees pitch, the report said.

TOPS members underwent annual safety audits, but the last audit before the accident did not include flights along the Descent Canyon route, the report said. In addition, Sundance did not require its check airmen to observe flights on that route, although the Sundance CEO said that pilots were trained and route-checked on operations from a landing location near the Beach helipad.

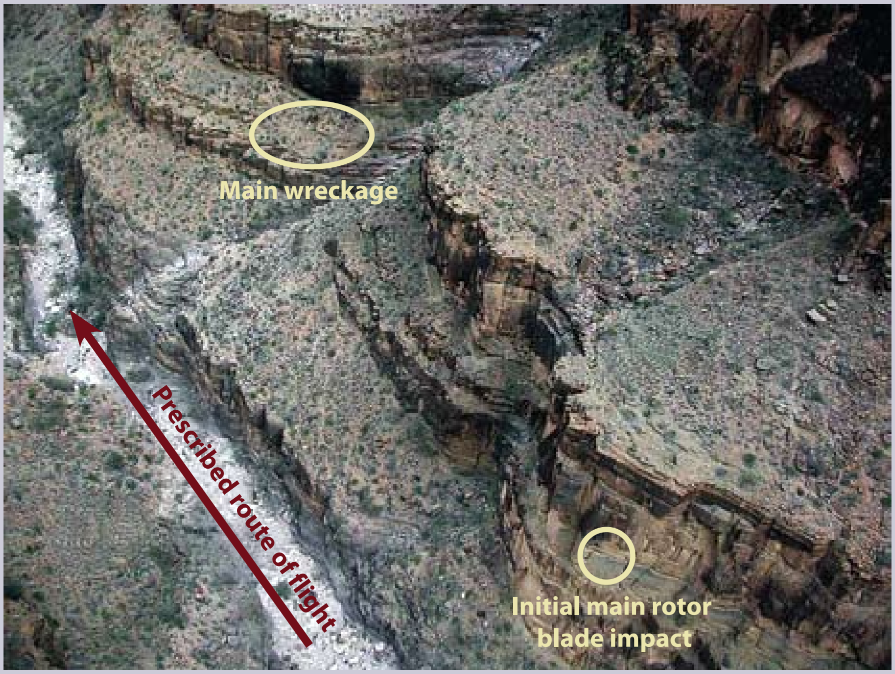
After the accident pilot's 2001 reprimand, he was not given a route check, and the Sundance director of operations said that he had never flown with the accident pilot on the Descent Canyon route and had never asked other managers to conduct a route check with the pilot.

A principal operations inspector (POI) at the FAA Flight Standards District Office in Las Vegas said that, because of his workload and time constraints, he conducted proficiency and line checks only on Sundance routes over Grand Canyon National Park and routes between the Grand Canyon and Las Vegas — not on the Descent Canyon route. Both the POI and the assistant POI assigned to Sundance said that they had never flown into Descent Canyon with the operator and were unfamiliar with the route.

Safety Initiatives

After the accident, Sundance implemented several initiatives to improve safety:

- Video recording equipment was installed on all but one of the company's helicopters (the exception was a helicopter acquired on a short-term lease) to enable management to monitor pilot performance. The videos also were sold to passengers as souvenirs;
- Survey cards were offered to each passenger to encourage reports of flight safety concerns. The Sundance director of operations said that all survey cards concerning safety are immediately evaluated and the reporting passengers are contacted; and,
- A Ride-A-Long program was implemented. The program allows passengers with piloting experience to ride free; their experience is not disclosed, and when the flights are over, these passengers complete in-depth surveys about their flight safety observations.



U.S. National Transportation Safety Board

Recommendations

As a result of its accident investigation, the NTSB said that en route surveillance should become routine for commercial sightseeing flights over the Grand Canyon. NTSB safety recommendations said that the FAA should require "periodic en route surveillance of all repetitively flown commercial air tour routes in the Grand Canyon area" and that the TOPS safety audit program should include similar surveillance; guidance material for the TOPS safety audits program should clearly define "air tour flight" to ensure effective en route surveillance, the NTSB said. The FAA also should encourage commercial air tour operators to establish a monitoring program, the NTSB said.

Other recommendations called for the FAA to require all commercial air tour operators to maintain records of safety-related complaints and for the TOPS safety audits to include reviews of such records. In addition, the NTSB recommended that the FAA require operators to maintain names and contact information for all passengers for at least 30 days after their flights. ●

This article is based on NTSB aircraft accident brief LAX03MA292 and related documents, including NTSB safety recommendations A-07-89 through A-07-95.

Frustrating fires in which cargo airline pilots narrowly escape from a freighter burning on an airport runway — and intense flames ultimately can rob accident investigators of causal evidence — have rekindled calls for wide-ranging reforms in the United States. With freighter traffic growth projections by Boeing Commercial Airplanes averaging 6.2 percent annually from 2006 to 2026 (Figure 1), the Federal Aviation Administration (FAA) and National Transportation Safety Board (NTSB) have joined freighter manufacturers, U.S. cargo airlines, aircraft rescue and fire fighting (ARFF) officials and pilot organizations in revisiting core assumptions about how to protect people, airplanes and cargo when freighter fires occur.

Debates about the reforms have not included much data on the incidence of these fires or formal risk analyses. But the sense of stakeholders expressing opinions at recent meetings is that the effectiveness of ARFF firefighters in these scenarios does make a difference in whether occupants are rescued, the aircraft and cargo are saved or adverse economic consequences from temporary closure of an airport are minimized.

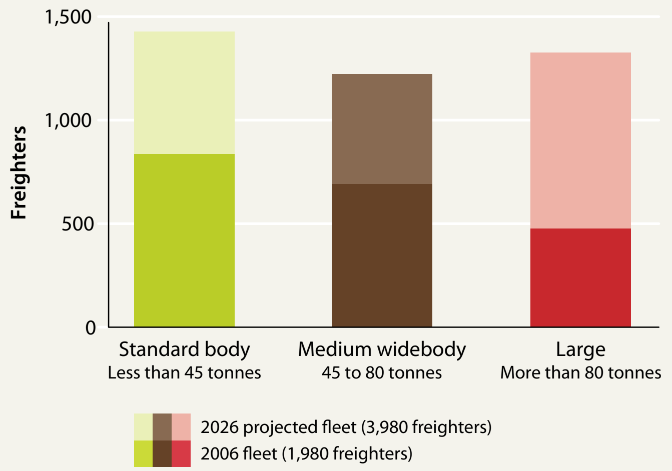
Several vocal advocates of change — the Air Line Pilots Association, International (ALPA), the ARFF Working Group, the Independent Pilots Association[1] and the NTSB — acknowledge that ongoing research and development by freighter manufacturers, individual airlines, fire departments and the FAA are advancing cargo fire safety on several fronts (*ASW,* 11/06, p. 28). They argue, however, that ARFF capability to handle freighter fires no longer should depend

Burning Issues

U.S. pilot unions, ARFF specialists and the NTSB assess shortcomings of freighter fire fighting.

BY WAYNE ROSENKRANS

Freighter Fleet Projection



1 tonne = 1,000 kg/2,205 lb

Source: Boeing Commercial Airplanes

Figure 1

© Chris Sorensen Photography

on airports voluntarily exceeding regulatory requirements but should involve amendment of federal transportation law and related regulations.

The investigation of the UPS Air Cargo Flight 1307 accident at Philadelphia International Airport in February 2006 has advanced this discussion because the accident involved circumstances that recall earlier ARFF responses to freighter fires (Table 1, p. 38).[2] The NTSB's final report included among ARFF-related findings that "growth of the fire after landing was fed by air entering through open doors and burnthrough holes"; the response was adversely affected by firefighters' unfamiliarity with the main cargo door; some personnel were not trained adequately on using a Snozzle[3] turret; and freighter diagrams should be available to firefighters. NTSB recommended in part that the FAA "require airport inspectors to ensure that [U.S. Federal Aviation Regulations (FARs) Part 139, *Certification of Airports*] airports with cargo operations include cargo aircraft in their [ARFF] aircraft familiarization training programs."

Describing the urgency of in-flight and ARFF solutions for freighter fires, Ron Wickens of FedEx Express told a July 2006 NTSB public hearing on the Flight 1307 accident, "Our tests show that if the fire is not contained in the [cargo] container and it migrates, the airplane has about 40 minutes and it is lost. There is nothing you can do [with currently required systems]; it is out of control. It is going to go down. We are going to continue to follow existing procedures for depressurization, but we want to supplement what we have today with a fire-suppression system."

Constructive Criticism

The ARFF community and other professions have criticized the ARFF response to the fire aboard Flight 1307, finding reason to believe that best practices in freighter fire tactics still may not be adopted widely. If correct, this is important primarily for its life safety implications.

Capt. Gary Loesch, who was the initial ARFF incident commander for the Philadelphia Fire Department, explained during the July 2006 NTSB hearing the tactics used and the problems encountered. Contrary to tactics that some freighter fire specialists recommend, several doors were opened to apply water, significant time and effort were expended trying to gain interior access via the main cargo door, and operations to pierce the fuselage skin and inject foam extinguishing agent did not begin until fire breached the top of the fuselage.

"The tactics that we used [initially were] stretching 1 3/4-in [4.4 cm] hand lines in an attempt to make [entry] into the interior of the aircraft," Loesch said. "Those particular tactics are basic tactics that we use even on, say, a dwelling or a building fire. … Once we were finally able to make entry into the aircraft, we had hand lines up on the left hand side and the right hand side and also up at the L1 door. … [ARFF vehicle] roof turrets and bumper turrets were used at the rear after [firefighters] entered the rear door on the right hand side. We used it for streams to try to knock down the fire."

Efforts to open the main cargo door also began as soon as ARFF firefighters arrived. "I [ordered] firefighters to go to the main cargo door to attempt to open it as I [ordered] them to open all the lower compartment doors to make access as much as possible to the aircraft,"

Freighter Accidents Reveal ARFF Issues

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Sept. 5, 1996	Newburgh, New York, U.S.	Douglas DC-10-10CF	Destroyed by fire after landing	2 minor, 3 none
The diversion and emergency landing of Federal Express Flight 1406 at Stewart International Airport was prompted by smoke in the cabin cargo compartment. Aircraft rescue and fire fighting responders first attempted to fight the fire from the courier area with handheld hose lines. The incident commander hesitated to use a skin penetrator agent application tool, and unsuccessfully tried to contact the aircraft manufacturer about non-damaging fuselage-access methods. Other firefighters broke the main cargo door control, opened the door by operating this control with pliers and attempted to fight the fire through this opening with handheld hose lines. About 10 minutes later, flames breached the crown of the fuselage. Firefighters then withdrew from their interior attack and aimed water from truck-mounted turrets through multiple flame-breached areas of the fuselage until the fire was extinguished.				
Dec. 18, 2003	Memphis, Tennessee, U.S.	McDonnell Douglas MD-10-10F	Postcrash fuel-fed fire destroyed right wing and side of fuselage	2 minor, 5 none
Three ARFF vehicles operated by the city and two ARFF vehicles contracted by the aircraft operator — operating without a formal agreement specifying their emergency responsibilities — responded to the hard landing and right main gear collapse of Federal Express Flight 647. The captain, first officer and five non-revenue pilots evacuated in about 152 seconds through the cockpit windows, descending via two evacuation tapes. The first city ARFF responders arrived two minutes after the crash alarm. Air traffic control — which failed to immediately clear all ARFF vehicles to the crash site and did not consider the contract ARFF responders to be official mutual aid firefighters — instructed the contract firefighters to hold short of another runway for about two minutes for landing traffic while the airplane burned. On arrival, the city ARFF responders were unaware of how many people were aboard the airplane — which could have jeopardized any rescue if required — although ATC had received this count from the captain. The firefighters were surprised to see seven people exit from the freighter.				

Source: U.S. National Transportation Safety Board

Table 1

Loesch said. "I also used that procedure because I needed to see where the fire actually was and if it was extending in any direction." Difficulty opening the cargo door precluded moving any cargo containers, as had been intended, to gain closer proximity to the seat of the fire.

Capt. John Prater, president of ALPA, during a November 2007 symposium sponsored by ALPA said, "The Philadelphia Fire Department operated a truck equipped … to locate the precise position of a fire within an aircraft fuselage. They found the fire. They used the Snozzle, but the Snozzle did not make it to the fire. The tip had been designed for a passenger aircraft — it was not long enough. If the Philadelphia ARFF personnel had been provided the proper training for cargo aircraft configurations and [had known] the loading practices, they could have fought that fire more successfully."

Sgt. Eric Johansen, a firefighter and instructor in the Fire Rescue Division of Dallas/Fort Worth International Airport Fire Services, concurred. "They were pumping thousands and thousands of gallons of water into a DC-8 … if they had … started removing [cargo containers], what would have happened to that aircraft?" Johansen said.

Capt. Michael Moody, a UPS Air Cargo pilot and chairman of the Safety Committee of the Independent Pilots Association, said that he could think of no reason to open the main cargo door and remove cargo containers during the knockdown phase. "If they start taking things out of the aircraft, they will put the airplane on its tail and kill a firefighter; it is easy to tip the aircraft," he said.

Another ARFF specialist summarized the current best practice as quickly cutting a vertical ventilation hole into the burning freighter

U.S. National Transportation Safety Board

Flames breached the top of the fuselage after UPS Air Cargo Flight 1307 landed.

Bradley International Airport Fire Department

Firefighters in Windsor Locks, Connecticut, U.S., in May 1991 extinguish a fuel-fed fire burning a Boeing 727-100QC freighter after shrapnel from an uncontained engine failure severed a fuel line during takeoff.

without hesitation. Les Omans, a retired captain and ARFF specialist for the San Jose (California, U.S.) Fire Department, consultant and author of the State of California ARFF training curriculum and the FAA's compact disc for ARFF computer-based training, said, "Every structural firefighter knows that if you stop the fire's vertical ventilation by discharging agent into that hole, you are going to drive the fire horizontally throughout the aircraft, and you are going to help to burn it up. You are just wasting time by [waiting to open a main cargo door, giving] a fire time to build its intensity and spread. … It is no problem, if you have the right-size [handheld rescue] saw and the right-size saw blade, to cut a hole and quickly make your own door opening wherever you want it."

One Level of Safety

The FAA in recent years updated regulations and guidance that directly or indirectly affect freighter operators — such as safer loading practices in 2005 in Advisory Circular 120-85, *Air Cargo Operations,* and revised ARFF requirements for passenger aircraft in the 2006 update of Part 139. These regulations apply only to airports used for specified passenger air carrier operations, but in their FAA-approved airport emergency plans, many Part 139 airports state explicitly or implicitly that ARFF firefighters will respond to incidents involving freighters.

In responding to the NTSB and to public comments about Part 139's omission of any reference to freighter operations, the FAA said that current federal transportation law does not give the FAA authority to regulate ARFF response to freighter fires.[4] Some cargo airlines therefore operate only into Part 139 airports while others do not restrict operations to these airports, said Capt. Shannon Jipsen, a UPS Air Cargo pilot and chairwoman of the Accident Investigation Committee of the Independent Pilots Association. "My hope is that [freighters] will be included in the next cycle of any kind of a rewrite of Part 139," Jipsen said.

Under current airport certification rules, there is no federal funding for ARFF training specifically on freighters, said Chief Brian McKinney of the Dallas/Fort Worth International Airport Fire Services. "That is something [of] concern for us," McKinney said. "Unlike the passenger airline industry with simulators for doors, slides, etc., there is none of that in the cargo industry. … My vision is to construct a new large aircraft simulator with cargo compartments included, possibly a combi configuration with a passenger compartment and a freight deck."

Advocates of improved freighter fire fighting capability see the legal hurdles as only one facet of moving toward what they call "one level of safety" for passenger operations and cargo operations. One related issue, for example, is the adequacy of Class E requirements — which essentially include fire-detection equipment but not fire-suppression equipment — as the minimum for freighters.[5]

Freighter fires have not been identified as a national priority by the Commercial Aviation Safety Team (CAST), although the team includes air cargo operators. Without data to show the relative probability and severity of freighter fires in relation to other commercial aviation safety risks, dispassionate discussions about allocation of resources are difficult compared with many other aviation safety issues. Ongoing introduction of safety management systems within the FAA, airports and cargo airlines provides processes to recognize possible ways to mitigate the threats currently perceived, some advocates said. Capt. Dave Wells, FedEx Central air safety chairman, ALPA, said that his statistics on air cargo accidents from 1990 to 2006 show that 20 percent involved fires. "FedEx has had six hull

Wayne Rosenkrans

Speakers from top, Omans and Jipsen

losses, and five were fires," Wells said.

ARFF stations at U.S. airports generally function within a system of municipal fire stations and a hierarchy of fire command that is separate from airport operations. Typical ARFF firefighters in cities first gain qualifications and experience as structural firefighters, supplemented by aviation/airport training on specialized theory and apparatus. Yet ongoing simulator training at best covers passenger jet fires, symposium presenters said.

The purpose of the relatively small contingent of ARFF firefighters at any airport is to save lives, they said, and their incident-response tactics presume that off-airport structural firefighters — most likely with minimal or no specialized training on aircraft — will handle most of the extinguishment.

Fire Fighting Traps

Various myths about fighting freighter fires and avoiding injury in the process prevail among some structural firefighters — even some ARFF firefighters. To rescue the flight crew and courier-space occupants, assuming they are the only occupants, the ideal situation is for firefighters to enter through the main cabin door. If they enter to fight the fire, however, firefighters may not be able to maneuver themselves along the length of compartments packed tightly with containers that weigh tons. They easily might trip or become entangled in cargo netting across the floor. Moreover, firefighters wearing self-contained breathing apparatus may not fit through openings other than the main cabin door or cargo doors except in the largest freighters.

From the outside, the fuselage skin may be 4.5 ft (1.4 m) from the cargo containers, which means that to apply an extinguishing agent into a burning container — not just the surrounding space — firefighters must work from above the window line and use a sufficiently long Snozzle extension to pierce specific containers by reference to a thermal imaging camera that reveals the fire's invisible heat signature.

In recent years, the Independent Pilots Association helped an ARFF station obtain unserviceable freighter windshields and test techniques for flight deck access and occupant extraction if flight crewmembers are incapacitated or trapped. "How does ARFF get into a [freighter] fuselage that has been structurally compromised, or you have a twisting of the fuselage so that you cannot get the doors or windows open?" Jipsen said. "[As pilots] we're stuck. ARFF rescuers can try to cut in, but where are they going to cut?" This research produced a video showing use of a fire rescue saw — a handheld tool with 12–16 in (30–41 cm) diameter carbide-tip or diamond-tip chopper blade powered by a small gasoline engine and cooled by water from a fire hose — to cut through a typical freighter windshield. The video has been distributed within the ARFF community. Rescue problems require further research, she said.

Near-Term Enhancements

Symposium participants agreed that the introduction of discrete emergency frequency procedures has been disappointing since FAA Advisory Circular (AC) 150/5210-7C, *Aircraft Rescue and Firefighting Communications,* was issued in 1999 (*Airport Operations,* 11–12/00). Fire Chief Robert Donohue of Boston Logan International Airport urged ARFF organizations, pilots and air traffic controllers to take the initiative on optimizing communications using the existing FAA guidance. "If there is no discrete emergency frequency at your airport, go after it — you make the call to them," Donohue said. "Air traffic controllers will tell the flight crew that Logan emergency services are on the frequency, and [we have] another fire captain on a separate maintenance frequency. With a discrete emergency frequency [program], ARFF provides visual observation and feeds the pilot real-time information."

Dallas/Fort Worth firefighters know that most freighters do not have evacuation slides, Johansen added, so the ARFF incident commander is likely to stand by the runway with an airstair for the L1 door, possibly eliminating the need for as many as 27 occupants to descend via rope, cockpit tape or inertia reel with the risk of serious injury from a fall and/or hand injuries. The ARFF incident commander, using a thermal imaging camera, also can see the heat signature of a fire, advise the flight crew about aircraft brake temperatures and/or cool the brakes with fans on request.

To enable freighters to land with improved in-flight control of fires, air cargo operators already may choose a higher class of cargo compartment — such as the optional Class C configuration of the Boeing 747-400 freighter — or obtain supplemental type certificates to retrofit equipment in Class E cargo compartments. The FAA also has been working with the industry on a new Class F compartment for both passenger and cargo aircraft, specifying detection and fire-suppression standards that could be met, as technology advances, by various chemical agents, special container designs or depressurization procedures.

At the July 2006 NTSB hearing, Wickens described two proprietary FedEx systems that NTSB said are scheduled to be operational under supplemental type certificates in August 2008, reflecting about five years of research and development. The active fire suppression system comprises a system control unit; one overhead reservoir containing compressed inert gas and a proprietary noncorrosive high-density foam extinguishing agent; an overhead array of passive infrared sensors that continuously measure and analyze temperature and rate of temperature change for each of 28 to 30 same-size cargo containers inside the main deck cargo compartment of a widebody freighter; and tubing from the reservoir to an array of overhead penetrator devices.

When the rate of temperature rise for any single cargo container exceeds a preset value, the flight crew receives a fire warning and the respective penetrator automatically punctures that container, and mixes and injects enough foam to fill it. For a widebody freighter, this active system has a weight penalty of about 1,000 to 1,500 lb (454 to 680 kg). Because this system was not designed for typical international pallets, however, FedEx also has developed a passive fire-resistant device called a Peltz bag wrapped around pallets to keep fire in a smoldering condition for at least three or four hours — enough time on the longest company routes across the Pacific Ocean for diversion to an alternate airport and safe landing.

"If [we] can hold the fire and deny it oxygen and combustible gas, we think we can get the airplane to an alternate … and let the fire department do their job," Wickens said. ●

For an enhanced version of this story, go to <www.flightsafety.org/asw/jan08/cargofire.html>.

Notes

1. The Independent Pilots Association is a union representing about 3,000 pilots employed by UPS Air Cargo.
2. On Feb. 7, 2006, about 2359 local time, the McDonnell Douglas DC-8-71F freighter landed in visual meteorological conditions at Philadelphia International Airport, the destination airport, after a cargo smoke indication on the flight deck. The captain, first officer and flight engineer evacuated and received minor injuries; the airplane and most of the cargo then were destroyed by fire. The NTSB said that the probable cause was "an in-flight cargo fire that initiated from an unknown source, which was most likely located within cargo container 12, 13 or 14" and contributing factors were "inadequate certification test requirements for smoke and fire detection systems and the lack of an on-board fire suppression system."
3. A Snozzle is a high-reach extendable turret with a fuselage skin-penetrating nozzle.
4. U.S. Code. Title 49, *Transportation.* Subtitle VII, *Aviation Programs.* Part A, *Air Commerce and Safety.* Subpart iii, *Safety.* Chapter 447, *Safety Regulation.* Section 44706, "Airport Operating Certificates." What prohibits freighters from inclusion in FARs Part 139 are provisions of this law making it applicable only to airports serving "an air carrier operating aircraft designed for at least 31 passenger seats." The FAA also may use ARFF-related exemptions in the law based on passenger boardings or on its determination that the requirements for fire fighting and rescue equipment are unreasonably costly, burdensome or impractical. An October 2005 bill — HR 4123 — unsuccessfully proposed to amend this law to include ARFF requirements if an air carrier operates aircraft that provide all-cargo air transportation and have a maximum certificated gross takeoff weight of 100,000 lb (45,360 kg) or greater.
5. During the Dec. 4, 2007, public hearing on UPS Air Cargo Flight 1307, NTSB Vice Chairman Robert Sumwalt cited the FAA's 1998 explanation of Class E compartments in a letter, which said in part, "In lieu of providing extinguishment in Class E compartments, the FAA requires that a means be provided to shut off the flow of ventilating air to or within the compartment. Additionally, procedures like depressurizing the airplane are stipulated to minimize the amount of oxygen available in the event a fire occurs in a Class E compartment. … This does not preclude the installation of Classes A, B or C compartments in all-cargo airplanes. … The principal reason for using the Class E concept is that the added weight for extinguishing systems and fluid is eliminated, allowing more cargo to be accommodated. Requirement of built-in suppression systems would add considerable weight to the airplane."

BY MARK LACAGNINA

HIGH, HOT and FIXATED

Despite several warnings, the Garuda 737 pilot stayed focused on landing.

The copilot called twice for a go-around, and the ground-proximity warning system (GPWS) aboard the Garuda Indonesia Boeing 737-400 provided 15 alerts and warnings during the approach. But the pilot-in-command (PIC) was intent on landing the aircraft on the runway at Yogyakarta, Indonesia, and either did not hear or did not heed the warnings. He continued the steep and excessively fast approach, which resulted in an overrun, several fatalities and serious injuries, and the destruction of the aircraft.

The Indonesian National Transportation Safety Committee (NTSC) said, in its final report, that the causes of the March 7, 2007, accident were ineffective flight crew communication and coordination; the crew's failure to reject the approach when stabilized approach criteria were not met; the PIC's failure to act on the warnings from the copilot and the GPWS; the copilot's failure to take control of the aircraft; and the absence of pilot training by the airline on required responses to GPWS alerts and warnings.

The accident occurred during a scheduled flight from Jakarta, which is about 450 km (243 nm) west-northwest of Yogyakarta, both on the island of Java.

The PIC, 45, had 13,421 flight hours, including 3,703 flight hours in type. He was hired by Garuda in 1985. The copilot, 31, had 1,528 flight hours, including 1,353 flight hours in type. He was hired by Garuda in 2004.


© Corbis

The GPWS provided 15 alerts and warnings during the approach.

The training records for the PIC and the copilot showed that they had attended enhanced GPWS (EGPWS) introductory seminars in August and October 2005, respectively. "However, the records showed no evidence that [they] had been checked or received simulator training in appropriate vital actions and responses (escape maneuvers) with respect to GPWS or EGPWS alerts and warnings," the report said.

The PIC had been off duty for more than 35 hours and the copilot had been off duty for more than 69 hours before reporting for the accident flight at 0430 local time. No significant weather was forecast for the route. The forecast for Yogyakarta's Adi Sucipto Airport called for surface winds from 240 degrees at 10 kt, scattered clouds at 2,000 ft and 8 km (5 mi) visibility, with visibility occasionally 5 km (3 mi) and a few cumulonimbus clouds with bases at 1,500 ft.

The aircraft was manufactured in 1992 and exported from the United States to Indonesia in 2002. It had accumulated 35,207 airframe hours and 37,360 cycles. "There was no evidence of any defect or malfunction with the aircraft or its systems that could have contributed to the accident," the report said.

The report noted, however, that recorded flight data indicated that only the right engine thrust reverser had been used during the previous two landings. "Further examination found that only the right thrust reverser had been used for the previous 27 sectors," the report said. "This indicated that the left thrust reverser may have been unserviceable for a considerable number of flights immediately prior to the accident flight."

While the aircraft was being pushed back from the gate, the PIC told ground engineers that the left thrust reverser fault light had illuminated. "The engineers reset the thrust reverser in the engine accessories unit, and the fault light extinguished," the report said. The 737 departed from Jakarta at 0617, 17 minutes behind schedule.

Cleared for a Visual

The aircraft was in cruise flight at 0647 when the PIC, the pilot flying, briefed the copilot on the instrument landing system (ILS) and localizer approaches to Runway 09, landing with 40 degrees of flap and the published missed approach procedure. Soon after the briefing, the crew began the descent to Yogyakarta.

The report said that the crew had communicated, mostly in their native Indonesian language, "in normal tones and in an orderly manner, [but] during the approach below 10,000 feet and prior to reaching 4,000 feet, the PIC was singing and there was some minor nonessential conversation, which was not in accordance with the Garuda Basic Operations Manual policy for a sterile cockpit below 10,000 ft."

The 737 was descending through 6,560 ft when the approach controller asked the crew if they were in visual meteorological conditions. The copilot replied "affirm," and the controller cleared the crew to conduct a visual approach and told them to establish the aircraft on a "long final" and to report the airport in sight. "Although the crew acknowledged the visual approach clearance, they continued with the ILS approach but did not inform the controller," the report said.

At 0655, the aircraft crossed the initial approach fix at 283 kt and at 3,927 ft — 1,427 ft higher than the published minimum crossing altitude of 2,500 ft (Figure 1, p. 44). The 737 tracked the localizer course from the initial approach fix inbound and crossed the final approach fix in clean configuration at 254 kt and at 3,470 ft — 970 ft above the published crossing altitude. Groundspeed was 286 kt; the tailwind component decreased as the aircraft descended.

'Focused on Landing'

The PIC twice expressed concern about the 737's vertical flight path. He later told investigators that he did not conduct a go-around because he was "focused on landing the aircraft." He also said that his actions were not influenced by Garuda's fuel-conservation policy, as had been reported by the media.

The 737 was about 4 nm (7 km) from the runway and about 2,800 ft above ground level (AGL) — 1,262 ft above the glideslope — when the PIC began a steep descent. "The PIC descended the aircraft steeply in an attempt to reach the runway, but in doing so, the airspeed increased excessively," the report said. He did not deploy the speed brakes, and over the next two minutes airspeed increased to 293 kt before decreasing to 243 kt.

The copilot established radio communication with the airport air traffic control tower at 0656 and was told that the surface winds were calm. He then extended the landing gear at the PIC's command; maximum extension speed is 270 kt. Airspeed was 252 kt, and the aircraft was 2,596 ft AGL when the PIC told the copilot, "Check speed, flaps fifteen."

"Because the aircraft was being flown at speeds that were in excess of the wing flaps operation speed [205 kt for 15 degrees], the copilot elected not to extend the flaps as instructed by the PIC," the report said. The PIC repeated the instruction three more times. The copilot did not comply and did not caution the PIC about the excessive airspeed. The report said that the tone of communication between the pilots changed during this time.

Rate of descent was 3,520 fpm at 0657, when the GPWS generated the first of several "SINK RATE" alerts; several "TOO LOW TERRAIN" alerts also were generated. The aircraft was descending at 245 kt about 953 ft AGL when the copilot selected 5 degrees of flap; the maximum flaps 5 extension speed is 250 kt. He called out the action but "did not inform the PIC that the reason he only selected flap 5 was that the airspeed … exceeded the flap 15 degrees maximum operating speed by 35.5 knots," the report said. The PIC again called for flaps 15.

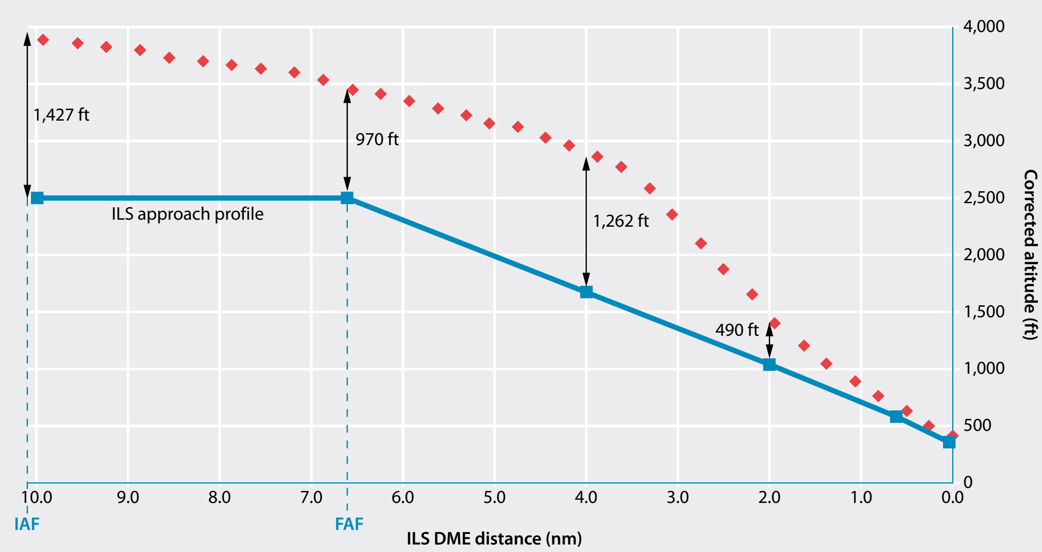
Boeing 737-400


© Tsung Tsen Tsan/Airliners.net

Produced from 1988 to 2000, the 737-400 is 10 ft (3 m) longer than the 737-300, has strengthened landing gear and can accommodate 146 to 168 passengers. Powered by CFM56-3B2 or -3C turbofan engines, maximum operating speed is 0.82 Mach, and maximum range is 2,808 nm (5,200 km). Maximum standard weights are 138,500 lb (62,824 kg) for takeoff and 121,000 lb (54,886 kg) for landing.

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

Aircraft Flight Path



DME = distance measuring equipment ; FAF = final approach fix; IAF = initial approach fix; ILS = instrument landing system

Source: Indonesian National Transportation Safety Committee

Figure 1

'Go Around, Captain'

The 737 was about 153 ft AGL when the GPWS generated the first of two "WHOOP, WHOOP, PULL UP" warnings. The copilot said, "Oh, captain. Go around, captain." The PIC did not acknowledge the warning; instead, he said, "Landing checklist completed, right?"

The airline's operations manual states that the pilot monitoring must take control of the aircraft from the pilot flying and conduct a go-around if the PIC fails to respond appropriately to an unstabilized approach. The report said, however, that there was no record that the copilot had received training on the "vital actions" that would be required in this situation.

The aircraft was near the runway threshold and descending at about 1,400 fpm when it reached glideslope altitude. With the flaps still extended only 5 degrees, it crossed the threshold at 232 kt — 98 kt faster than the landing reference speed of 134 kt. This landing reference speed was appropriate for the aircraft's landing weight — 53,366 kg (117,651 lb) — with flaps extended 40 degrees. Airspeed was 221 kt when the aircraft touched down about 860 m (2,822 ft) from the runway threshold. The runway is 2,200 m (7,218 ft) long and 45 m (148 ft) wide.

"Immediately after touchdown, the copilot called with high intonation, 'Go around,' but the PIC did not respond orally or with actions to comply," the report said.

The aircraft bounced twice. Vertical accelerations during the three touchdowns were +1.86 g — that is, 1.86 times standard gravitational acceleration — +2.26 g and +2.96 g, respectively. After the second bounce, the nosewheel assembly touched down hard on the runway before the main landing gear, and the left nosewheel tire burst. Both thrust reversers were deployed for seven seconds. The PIC said that he shut down both engines when he realized that the aircraft was going to run off the end of the runway.

"The delay in extinguishing the fire may have significantly reduced survivability."

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The 737 was 10 m (33 ft) right of the centerline when it overran the runway at 110 kt at 0658. It crossed three ditches and a road, and struck two fences and an embankment before stopping in a rice paddy 252 m (827 ft) from the end of the runway. The nosewheel assembly had separated from the aircraft on the runway. "The engines and landing gear separated from the aircraft and were destroyed," the report said. "The right wing was severed from the fuselage, swung around the fuselage and came to rest on top of the left wing."

There were 140 people aboard the aircraft. One flight attendant and 20 passengers were killed. One flight attendant and 11 passengers sustained serious injuries, and two flight attendants and 98 passengers sustained minor injuries. The two pilots, a flight attendant and four passengers were not injured. The aircraft was destroyed by the impact and a post-impact fire.

'Reduced Survivability'

Two aircraft rescue and fire fighting (ARFF) vehicles had been mobilized after firefighters saw the 737's nosewheel tire burst. "The fire fighting vehicles were dispatched in a timely manner to the crash site, but they stopped … behind the airport perimeter fence," the report said. There was no access road to the accident site.

"The airport rescue services' personnel were not familiar with the area surrounding the airport, and the airport fire service vehicles were not suitable for, or capable of, traversing swampy or soft ground such as the rice field," the report said.

ARFF personnel attempted to spray foam on the burning aircraft but were too far away. They deployed a flexible extension hose, but the hose was rendered ineffective by damage from rescue and onlookers' vehicles driving over it.

"There was no appropriate rescue coordination at the crash site, due to the AEP [airport emergency plan] not being followed, and too many unqualified people [were] giving instructions," the report said. "About 45 minutes after the accident, two city fire fighting vehicles arrived and were ordered by an unqualified person to start hosing the fire. However, the city vehicles did not have foam, only water."

Because of the inability of the ARFF personnel to reach the accident site and the inappropriate suppressant agent used by city firefighters, the fire was not extinguished until two hours and 10 minutes after the accident. "The delay in extinguishing the fire and the lack of appropriate fire suppressant agents may have significantly reduced survivability," the report said.

Rescue operations continued until late afternoon. "The airport operator did not establish a collecting area, care area or holding area at the accident site, as required in the AEP," the report said.

Nonstandard Safety Area

The report said that the runway end safety area (RESA) for Runway 09 did not meet International Civil Aviation Organization (ICAO) standards and was a factor in the accident. A RESA is intended to "reduce the risk of damage" to aircraft that overshoot or undershoot the runway, according to ICAO.

The airport chart identifies a 60-m (197-ft) stopway at the end of Runway 09 as the RESA. "An additional grassed area, not defined on the aerodrome chart as a RESA, is 98 meters [322 ft] long," the report said.

In Annex 14, *Aerodromes*, ICAO says that a RESA must extend 90 m (295 ft) from the end of the "runway strip," which is defined as a designated area that includes the runway and stopway. In addition, "[ICAO] recommends that for a Category 3 airport such as Yogyakarta, a RESA should, as far as practicable, extend from the end of a runway strip to a distance of at least 240 meters [787 ft]," the report said.

Based on these findings, NTSC recommended that the Indonesian Directorate General of Civil Aviation "ensure that airline operators have published procedures that take into consideration the RESA requirement when calculating performance specifications for operations into airports with runways having a RESA that does not meet the ICAO Annex 14 standard."

Among 18 other recommendations generated by the investigation (*ASW*, 12/07, p. 8), NTSC said that Indonesian airline operators should provide initial and recurrent pilot training in approach and landing accident reduction (ALAR) and controlled flight into terrain (CFIT) prevention, using materials developed by Flight Safety Foundation. The accident report contains copies of the *Approach-and-Landing Risk Reduction Guide* and the *CFIT Checklist*, two elements of the Foundation's CD-based *ALAR Tool Kit*.

The report noted that, among several actions taken after the accident, Garuda issued a notice assuring its pilots that the company will not take disciplinary measures for a go-around executed in response to any unsafe or unstabilized approach. The notice also repeated that the pilot monitoring must take control and conduct a go-around when the pilot flying does not respond appropriately to an unstabilized approach. ●

This article is based on NTSC Aircraft Accident Investigation Report KNKT/07.06/07.02.35: "Boeing 737-497, PK-GZC, Adi Sucipto Airport, Yogyakarta, Indonesia, 7 March 2007."

Fade-Free Memory

Enhanced airborne flight recorders will safeguard vastly more data, including images if required.

BY WAYNE ROSENKRANS

On the Boeing 787, the forward and aft enhanced airborne flight recorders (EAFRs), cockpit area microphone and preamplifier (CAM-P) and forward recorder independent power supply (RIPS) are directly linked via the airplane's fiber-optic data network.

So long as accidents are possible, the Airbus A380, Boeing 787 and other airplanes with cutting-edge safety technologies will have to be equipped to faithfully capture what happens during each flight. A good example is the 787, which will incorporate dual enhanced airborne flight recorders (EAFRs) designed to reflect the world's newest specifications for airplanes that have fiber-optic aircraft data networks as part of their digital architecture.

The U.S. Federal Aviation Administration (FAA), in a 2007 technical presentation to the International Civil Aviation Organization, characterized EAFRs as one of the products that have become a reality because of a 10-year effort by the aviation industry and governments to overhaul the global standards for flight recorder systems with crash-protected solid-state memory.[1] Basic international agreements on the subject have been distilled into Document ED-112, "Minimum Performance Specification for Crash Protected Airborne Flight Recorders," published by the European Organisation for Civil Aviation Equipment (EUROCAE). This document set the stage for separate working groups to develop ARINC Characteristic 767, "Enhanced Airborne Flight Recorder (EAFR)" and other applicable standards.[2] In the 787, the flight data recorder (FDR) function in the GE Aviation EAFR, as currently configured, can record approximately 2,000 parameters and 50 hours — versus up to 88 parameters and 25 hours under current requirements — before overwriting the oldest flight data, according to Jim Elliott, a systems/applications engineer for the manufacturer.[3] "Although one EAFR has the capabilities of both an FDR and a [cockpit voice recorder (CVR)], current regulations require that two EAFRs be installed on the aircraft," Elliott said. "An important benefit of the dual combined recorder installation is that there [will be] two complete copies of all of the recorded [data] available to the [accident] investigators."

Unlike typical FDRs, the FDR function within each EAFR on the 787 receives flight-parameter data directly from aircraft sensors and systems as a fiber-optic avionics full-duplex switched Ethernet data stream. The EAFRs' built-in documentation also complies with an ARINC standard for complete configuration description of the FDR data frame, which Elliott called a major time-saver, considering the nearly 23-fold increase in recorded parameters. This enables accident investigators anywhere to have "a consistent, accessible, complete and accurate interpretation of the flight data," he said.

The data link recorder function captures messages to and from the crew when digital air-ground communication is used. In the 787, the EAFRs store within their CVR-function memory partitions two hours of data from four audio channels and all data link messages. "The CVR function receives audio from three digital audio crew channels provided by the flight deck audio system and one analog audio channel from the cockpit area microphone and preamplifier," Elliott said. Data from the crew channels are sent to the forward EAFR and aft EAFR. Sounds from the cockpit area microphone also are sent as a data stream to both EAFRs. The forward EAFR, the cockpit area microphone and the preamplifier for this microphone have 10 minutes of backup power from a forward recorder independent power supply.

The GE Aviation EAFR also has sufficient memory capacity and a dedicated Ethernet network interface to support two hours of image recording if required by a civil aviation authority. So far, however, the FAA has said that while its 2005 proof-of-concept test to determine the effectiveness of using sequences of still images for accident/incident investigation was "promising," the camera technology tested was not "mature enough to be installed."

"The images [from a forward-facing camera in an FAA-operated Beech King Air] were used to derive parametric aircraft performance data as well as ascertain general conditions within the cockpit and the condition of the crew," the FAA said. "The results of the test were favorable. The U.S. National Transportation Safety Board (NTSB) derived 51 parameters [of 88 parameters that FDRs currently capture] from the recorded images and, in most cases, did so within the parameter range and accuracy tolerances of the regulations. In fact, the data from the images identified an FDR altimeter data–correlation issue." Similar to the results of a U.K. Civil Aviation Authority study (*ASW,* 4/07, p. 18), however, the challenges included difficulty finding a suitable position for only one camera, inadequate performance under specified lighting conditions, and laborious analysis. "It took several weeks for the NTSB investigators to derive the 51 parameters they obtained from five minutes of image recording," the FAA said.

Essentially, EAFRs will position the industry to respond to many issues identified by the accident investigation community. Proposals in three current FAA rule-making activities, for example, in part would increase recording durations, add data link message recording, increase the data-recording rate from sensor signals for some FDR parameters without increasing the total number required to be recorded, specify different FDR parameters to record for some aircraft types, physically separate FDRs and CVRs, and make more reliable the power supply to all recorders.●

Notes

1. FAA. "An Outline of the Development of Work on Flight Data Recorder Systems." Paper presented by the United States to the Technical Commission of the 36th Session of the Assembly of the International Civil Aviation Organization. Information Paper A36-WP/300, Sept. 22, 2007.
2. As described in ARINC Characteristic 767, an EAFR can combine any or all of the following functions — instead of separate hardware as in previous designs — in a single line replaceable unit: the digital FDR function, CVR function, data link recording function, image recording function and integrated flight data acquisition function.
3. Elliott, Jim. "Enhanced Airborne Flight Recorder (EAFR) — The New Black Box." Paper presented at ISASI 2007 Singapore, a conference of the International Society of Air Safety Investigators, August 2007. Elliott is a systems/applications engineer, Digital Systems, GE Aviation, and was a member of EUROCAE Working Group 50 during the development of Document ED-112.

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A Passage Through India

Air traffic in India is growing fast, an economic success story but a safety challenge.

BY RICK DARBY

Changes in volume of air traffic, usually in the background of the safety picture, can shift to the foreground for rapidly developing nations, where a sizzling economy often means expansion of the aviation industry and a strain on its systems. India is an example of a country with a fast-growing economy and an emerging middle class that expects air transportation to play a role similar to that in Europe or North America.

A report[1] by the Directorate General of Civil Aviation of India offers striking data on the aviation boom in that country.

Indian domestic air transportation, formerly a state monopoly, was opened to private companies in 1994. As a consequence, private operators that include Jet Airways, JetLite, Simply Deccan, SpiceJet, Paramount Airways, GoAir and Kingfisher Airlines now operate scheduled service. State-owned Indian Airlines, which is being merged with state-owned Air India, flies scheduled domestic routes and serves destinations in Asia and the Middle East. Meanwhile, numerous non-Indian airlines operate international routes to and from the country.

Table 1 (p. 50) shows the trends for Indian carriers' passengers and cargo — freight plus mail — from 1990–1991 to 2005–2006.[2] The number of passengers grew from 10,386,000 to 32,155,000, or 209.6 percent. The corresponding growth in cargo was from 198,154,000 to 368,962,000 tonnes, a jump of 86.2 percent.[3]

Accelerated Growth

The volume of scheduled domestic passenger traffic for all Indian airlines from the 1996–1997 measurement period to the 2005–2006 measurement period is shown in Figure 1 (p. 50). After seven periods of more modest expansion, the growth accelerated beginning in 2002–2003. From that period to the next, passenger traffic increased 12.4 percent; in the following period, it increased 24.0 percent; and in the final period,

After seven periods of more modest expansion, the growth accelerated beginning in 2002–2003.

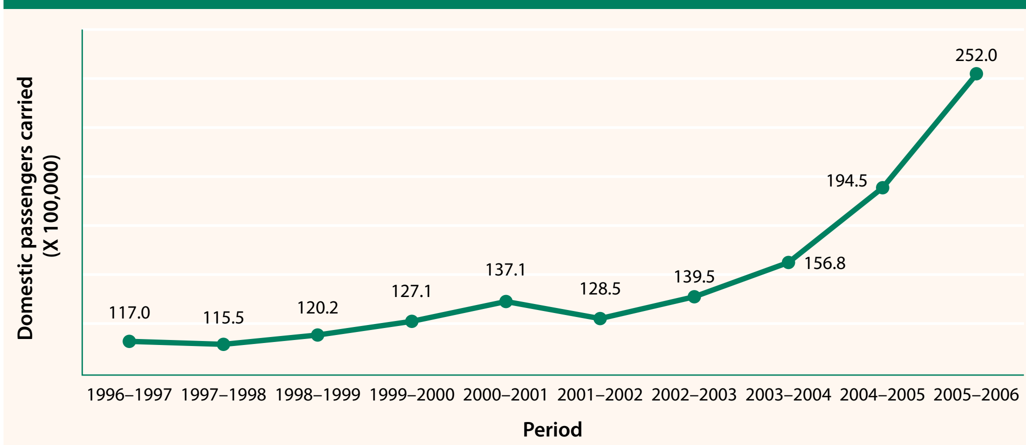
Total (Domestic and International) Traffic, Indian Carriers, 1990–2006

	Passengers (Thousands)			Cargo (Tonnes)		
Period	Scheduled	Non-Scheduled	Total	Scheduled	Non-Scheduled	Total
1990–1991	10,343	43	10,386	197,960	194	198,154
1991–1992	11,153	81	11,234	176,043	327	176,370
1992–1993	10,529	759	11,288	157,345	304	157,649
1993–1994	12,259	94	12,353	163,305	58	163,363
1994–1995	13,648	197	13,845	188,680	79	188,759
1995–1996	15,282	424	15,706	215,951	65	216,016
1996–1997	14,996	173	15,168	211,788	253	212,041
1997–1998	14,981	324	15,305	217,582	465	218,047
1998–1999	15,545	284	15,829	231,092	0	231,092
1999–2000	16,368	390	16,758	250,177	339	298,894
2000–2001	17,540	405	17,945	268,019	120	310,519
2001–2002	16,552	303	16,856	258,085	414	308,063
2002–2003	18,152	344	18,496	283,314	597	338,515
2003–2004	20,170	305	20,474	295,188	186	353,404
2004–2005	24,771	352	25,123	357,308	402	438,015
2005–2006	31,752	403	32,155	368,660	302	368,962

Source: Directorate General of Civil Aviation, India

Table 1

Domestic Passengers Carried by All Scheduled Carriers, India, 1996–2006



Source: Directorate General of Civil Aviation, India

Figure 1

the growth was 29.6 percent. That compared with an annualized growth rate of 8.9 percent over the entire 10 years.

Domestic scheduled service by Indian carriers, measured in passenger kilometers performed (PKP), rose comparably — 23.8 percent in 2004–2005 over the previous period, followed by 31.5 percent in 2005–2006 over 2004–2005. Figure 2 charts available seat kilometers and revenue PKP for scheduled domestic services by Indian carriers beginning in 1996–1997. The annualized growth rate was 10.1 percent for available seat kilometers and 10.3 percent for revenue PKP.

The combined fleet size of scheduled Indian air carriers grew from 158 to 243 aircraft (53.8 percent) from the 2003–2004 measurement period to the 2005–March 31, 2006 period, the report said. The number of scheduled departures per day increased between these periods from 642 to 865 for domestic flights and from 98 to 147 for international flights.

Scheduled domestic and international flights combined on Indian airlines carried 11.1 percent more passengers in 2003–2004 than in the previous period, a further 22.8 percent more in 2004–2005 and another 28.2 percent in 2005–2006, the report said.

Turning up the Volume

Indian carriers' international traffic volume was 4,493,000 passengers carried in 2003–2004. By 2005–2006, the figure had increased to 6,547,000, a 45.7 percent increase. The report said that scheduled domestic plus international traffic volume on Indian carriers rose from 18,151,799 passengers in 2002–2003 to 31,752,173 in 2005–2006, a jump of 74.9 percent.

PKP on Indian carriers' international flights added 23.0 percent in 2004–2005 compared with 2003–2004, and an additional 25.1 percent in the next period.

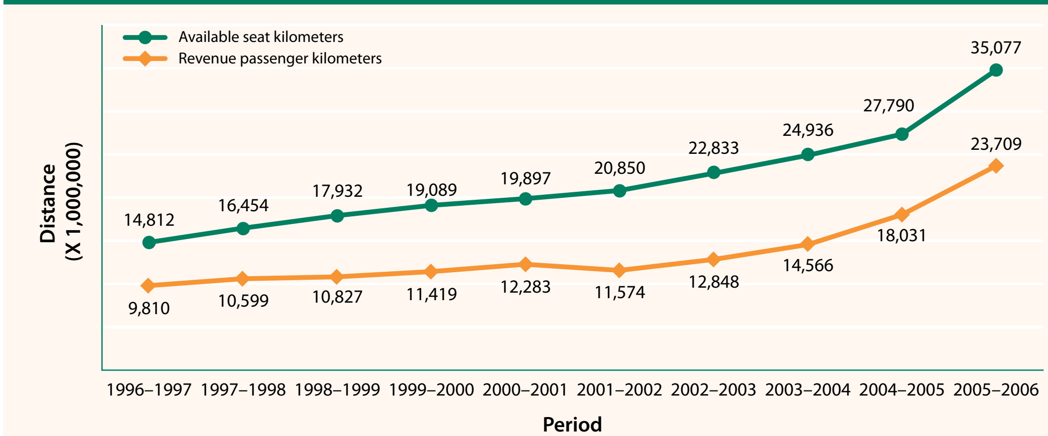
Between 1996–1997 and 2005–2006, the passenger load factor for combined domestic plus international operations of Indian carriers stayed within a narrow range, and at 68.3 percent ended near where it began at 67.4 percent. PKP, in the same period, increased 121.8 percent.

Carry That Weight

Scheduled domestic cargo on Indian carriers rose from 120,901,000 tonnes[3] to 256,481,000 tonnes between 1996–1997 and 2005–2006 (Figure 3). The increase from the 2001–2002 period to the 2005–2006 period alone was 59.7 percent. Freight on international scheduled services of Indian carriers rose modestly, from 95,000 tonnes in 2003–2004 to 110,000 tonnes in both 2004–2005 and 2005–2006.

Growth from 1996–1997 to 2005–2006 in available tonne kilometers and revenue tonne kilometers (including the weight of passengers) in scheduled domestic service on Indian carriers is charted in Figure 4 (p. 52). Available tonne kilometers rose from 1,572 to 3,488, or 121.9 percent, between 1996–1997 and 2005–2006. Revenue tonne kilometers increased by 150.3 percent, from 935 to 2,340, during the same time.

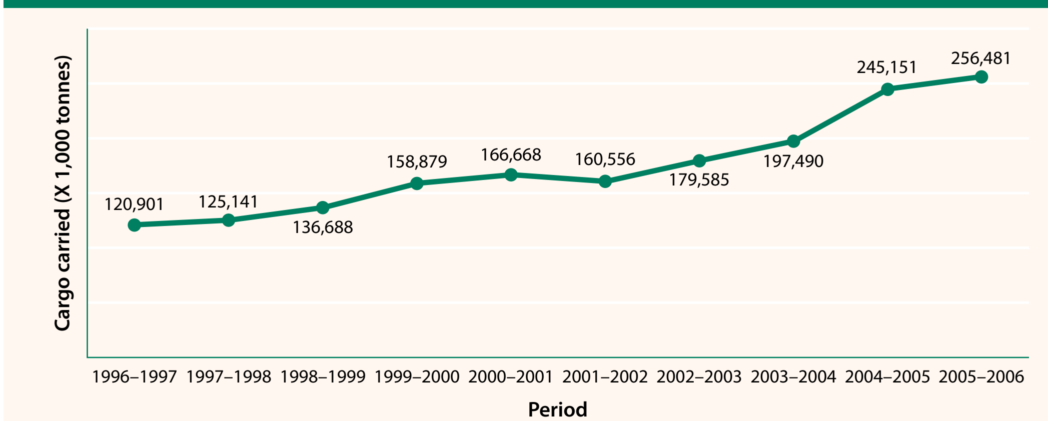
Available Seat Kilometers and Revenue Passenger Kilometers Performed, Scheduled Indian Domestic Carriers, 1996–2006



Source: Directorate General of Civil Aviation, India

Figure 2

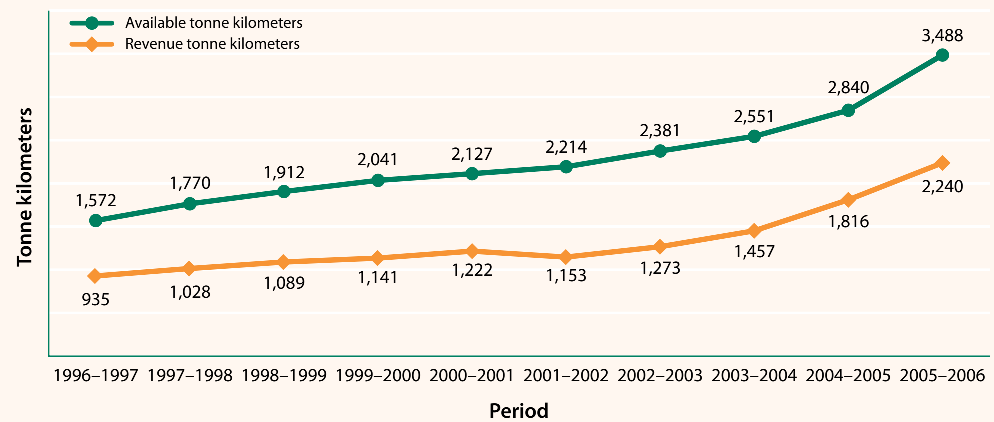
Cargo, Scheduled Indian Domestic Carriers, 1996–2006



Source: Directorate General of Civil Aviation, India

Figure 3

Available Tonne Kilometers and Revenue Tonne Kilometers Performed, Scheduled Indian Domestic Carriers, 1996–2006



Note: Revenue tonne kilometers performed include the weight of passengers, standardized at 75 kilograms (165 pounds).

Source: Directorate General of Civil Aviation, India

Figure 4

The number of passengers flying to and from India on all airlines rose by 18.0 percent between 2003–2004 and 2004–2005, and a further 16.8 percent between 2004–2005 and 2005–2006, the report said. Freight carried to and from India on all airlines increased 19.9 percent and 10.2 percent, respectively.

Aircraft movements, passengers boarding and exiting, and freight grew substantially at India's three major airports, Mumbai — formerly Bombay; Delhi; and Kolkata — formerly Calcutta (Table 2). At Mumbai, aircraft movements increased from 115,280 in 2001–2002 to 171,145 in 2005–2006, or 48.5 percent. Between these periods, passenger traffic at Delhi increased from 8,240,419 to 16,001,466, representing 94.2 percent growth. Freight showed similar growth patterns; at Delhi, for example, a five-year rise from 233,049 to 383,052 tonnes, a 64.4 percent increase. ●

Annual Air Traffic, Passengers and Freight at Three Major Airports, India, 2001–2006

Period	Aircraft Movements	Passengers	Freight (Tonnes)
Mumbai			
2001–2002	115,280	10,954,308	275,941
2002–2003	125,551	11,731,861	307,605
2003–2004	137,212	12,764,959	326,497
2004–2005	153,166	15,078,019	402,715
2005–2006	171,145	17,789,193	431,321
Delhi			
2001–2002	86,413	8,240,419	233,049
2002–2003	93,463	8,843,645	276,042
2003–2004	105,540	10,165,965	295,805
2004–2005	122,123	12,539,258	344,501
2005–2006	151,117	16,001,466	383,052
Kolkata			
2001–2002	28,549	2,506,118	56,149
2002–2003	32,359	2,773,260	58,259
2003–2004	38,820	3,061,336	62,307
2004–2005	42,374	3,464,764	69,628
2005–2006	51,560	4,355,536	74,499

Source: Directorate General of Civil Aviation, India

Table 2

Sources

1. Directorate General of Civil Aviation of India, Statistical Division. *India Air Transport Statistics 2005–06.* Accessible via the Internet at <www.dgca.nic.in/reports/stat-ind.htm>.

2. Statistics are recorded by the Directorate General of Civil Aviation in terms of fiscal years, which include parts of two calendar years, such as 2005–2006.

3. A *tonne* is the mass equal to 1,000 kg (2,205 lb). The number of tonnes of cargo or freight carried is obtained by counting each tonne on a flight with a single flight number once only, not repeatedly on each segment of the flight.

The Five-Second Nap

Microsleep is among the symptoms experienced by fatigued flight attendants.


Flight Attendant Fatigue

REPORTS

Flight Attendant Fatigue

Nesthus, Thomas E.; Schroeder, David J.; Connors, Mary M.; Rentmeister-Bryant, Heike K.; DeRoshia, Charles A. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-07/21. Final report. July 2007. 64 pp. Figures, tables, references, appendixes. Available via the Internet at <www.faa.gov/library/reports/medical/oamtechreports/2000s/media/200725.pdf> or from the National Technical Information Service.*

There may once have been a golden age of gracious flying for passengers, but it appears that flight attendant fatigue is nothing new. The report says, "On international flights before World War II, workload duties lasted from 16 to 24 hours, depending upon weather. The flight attendants were required to check passports, prepare formulas for infants, care for children, pass out reading and writing material, make up berths for 16 passengers, serve up to three complete meals and wash dishes if additional meals were necessitated by weather delays. Therefore, it was not uncommon for a flight attendant to work up to 25 hours without sleep."

Today's flight attendants don't have such a grueling schedule, but "they are required to perform a number of physically demanding tasks," the report says. "Many flight attendants report that they spend most of their time on their feet. But they are also challenged emotionally, e.g., by requirements to perform multiple tasks on a tight schedule, and by being the point of contact that all passengers look to for information, help and support. In short, one of the stressors of flight attendants is that they are always 'on.'"

The U.S. Congress directed the FAA to study and report on flight attendant fatigue, a safety issue because flight attendants must be physically and mentally ready to cope with emergencies.

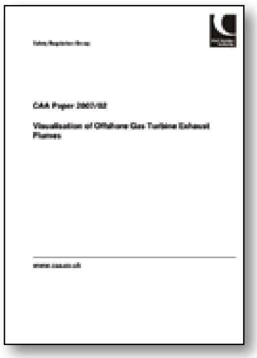
"To meet the goals of this study, this report contains a literature review on fatigue as potentially experienced by flight attendants, an evaluation of currently used (actual versus scheduled) flight attendant duty schedules and a comparison of these schedules to the current CFRs [Code of Federal Regulations, in this case U.S. Federal Aviation Regulations (FARs)]," the report says. Supplementing the scientific literature review, the authors studied fatigue-related incident and accident reports from the U.S. National Aeronautics and Space Administration Aviation Safety Reporting System (ASRS) and the U.S. National Transportation Safety Board (NTSB) accident/incident database.

"One section of the report also describes the application of three different performance and fatigue models currently available as examples to provide the reader with an idea of how flight attendant duty schedules contribute to increased levels of fatigue and predicted changes in performance," says the report.

Reports in the ASRS database — voluntarily self-reported and subjective — "reflect a perception among the flight attendants … that fatigue and performance are safety issues," the report says. "One NTSB accident report indicated that flight attendant fatigue contributed to that accident. The literature reviewed also contains information relating fatigue to safety concerns and suggests the intervening states by which fatigue can lead to safety problems."

The report cites two main causes of flight attendant fatigue: sleep loss and disruption of circadian rhythms — the body's biological "clock" that regulates alertness and other physiological functions according to the person's internal time, which on long-haul flights can differ considerably from local time.

"The sleep losses documented in this report raise operational performance and safety concerns by reference to other studies," the report says. "It has been shown in various ground-based studies that such levels of sleep deprivation affect neurobehavioral functioning [and] result in increased reaction times, memory difficulties, cognitive slowing and increased lapses of attention."


CAA Paper 2007/02
Visualisation of Offshore Gas Turbine Exhaust Plumes
www.caa.co.uk

Memory lapses are "clearly related to disturbances of circadian rhythms and night work," the report says. "Performance problems associated with fatigue include microsleeps (brief intrusions of EEG [electroencephalograph] indicators of sleep greater than 5 seconds), lapses in attention, slowed reaction time, increase in errors, doing things in a slipshod manner, short-term memory impairment, lack of situational awareness, and impaired decision making. The non-routine situation presents the greatest challenge to the effective performance required of flight attendants. It is here that the effects of fatigue and circadian disruption would be expected to have the most serious impact on safety."

FARs concerning scheduled work and rest periods for flight attendants have been in place since 1994, but the off-duty time typically includes tasks such as clearing security, passport control and customs, eating meals and checking into a hotel, the report says. "The time required for most of these tasks and the time devoted to fall[ing] asleep are unavoidable, with the result that reductions in off-duty time must be absorbed by the time that should be devoted to sleep," says the report.

The regulations are meant to provide acceptable limits to duty time. "But [FARs] do not, and perhaps cannot, capture the multiple variables that impact fatigue and the individual's ability to tolerate fatigue," the report says. "Taken from the standpoint of just the pre-determined dimensions of the flight itself, the [FARs] do not distinguish among the number of segments flown, daytime versus nighttime flights, flights that are uni-meridional [in a single time zone] versus those that are trans-meridional [or] regional versus domestic flights.

"To truly address the fatigue issue, regulations must be combined with sound and realistic operational practices, and supplemented, as needed, by personal strategies. Air travel will always require flexibility in operations in order to adjust to unusual and/or non-routine circumstances. From the standpoint of flight attendant fitness and well-being, it is essential that work/rest practices address the exceptions and do not become the standard."

Visualisation of Offshore Gas Turbine Exhaust Plumes

U.K. Civil Aviation Authority (CAA) Safety Regulation Group. Paper 2007/02. October 2007. 114 pp. Figures, tables, references, appendixes. Available via the Internet at <www.caa.co.uk/docs/33/Paper2007_02.pdf> or from CAA.**

"Hot gas fumes from offshore platform power generation turbines present a hazard to helicopter operations," the report says. "The temperature rises above ambient can have a significant effect on helicopter performance and need to be taken into account by the pilot when calculating the maximum operating weight of the aircraft. In addition, the rates of change of temperature in the plume can cause the helicopter engines to surge or flame out, and the turbulent flow in the plume can give rise to handling difficulties."

These exhaust plumes normally cannot be seen by a pilot. CAA Civil Aviation Publication (CAP) 437, *Offshore Helicopter Landing Areas — Guidance on Standards* suggests that introducing a smoke generating agent into emissions to make the plumes visible could offer a safety benefit.

The report describes a preliminary onshore trial to determine the best agent to use, estimate the quantity of agent needed to make consistent smoke, determine how to design a later offshore trial phase and find out whether there was any risk of damaging the gas turbines.

The onshore trial evaluated six smoke generating agents. "The trial demonstrated that injecting agents into a gas turbine exhaust could produce plumes that were visible from several kilometers," the report says. "Injecting diesel [fuel] into the exhaust resulted in the best visualization. Theatrical smoke oil [a highly refined mineral oil] and glycerol/water solution produced plumes that were less dense than those generated by diesel, [and] the plume produced by glycerol/water solution reduced in density after a short period. Water, kerosene and rapeseed oil were ineffective in creating a visible plume."

In view of the good results obtained with diesel fuel, the researchers conducted an environmental impact study on that agent. Diesel fuel was found to be unacceptable because of personnel exposure and marine environment effects.

"Overall, it is concluded that a gas turbine exhaust plume visualization system would be beneficial to helicopter flight safety at platforms where significant exhaust plume encounters are experienced, and that such a system is feasible to design and operate using an environmentally friendly glycerol/water solution as the smoke generating agent," said the report.

Acknowledging that tagging a turbine exhaust location with a smoke plume would improve visibility only during daylight, the report does not consider that a serious shortcoming, because most offshore helicopter operations are in the daytime. "Nobody interviewed could explain why the idea had not been tried before, despite being recommended good practice in CAP 437 since 1981," says the report. It recognizes, however, that installation and running costs of a smoke generating system are "not insignificant," and the CAA plans to recommend that they be considered only for platforms where a problem can be identified.

An International Survey of Maintenance Human Factors Programs

Hackworth, Carla; Holcomb, Kali; Dennis, Melanie; Goldman, Scott; Bates, Cristina; Schroeder, David; Johnson, William. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-07/25. Final report. September 2007. 28 pp. Figures, tables, references, appendixes. Available via the Internet at <www.faa.gov/library/reports/medical/oamtechreports/2000s/media/200725.pdf> or from the National Technical Information Service.*


An International Survey of Maintenance Human Factors Programs

The report, citing various specialists, says that maintenance-related errors were associated with as much as 15 percent of commercial aircraft hull loss accidents from 1982 through 1991; a study of 92 accidents found that a maintenance factor initiated the accident chain in 26 percent of the accidents; and maintenance errors are responsible for an estimated 20 to 30 percent of in-flight engine shutdowns.

This report says that according to one study, human factors are believed to be a factor in 50 percent of maintenance-related accidents. Maintenance errors are in two broad classifications — failure to detect a problem or the introduction of an error during maintenance.

"There are a variety of international approaches to the regulation of human factors programs for maintenance organizations," the report says. "Transport Canada and the European Aviation Safety Agency have established specific, yet differing, regulations regarding maintenance human factors. … The FAA has not yet established regulations but, instead, has created guidance documents and developed voluntary reporting programs for maintenance organizations. For now, the FAA has chosen to adopt a voluntary rather than a regulatory approach to maintenance human factors."

The project that resulted in this report sought to assess the effect of voluntary versus regulatory approaches to maintenance human factors programs. It tried to answer questions such as:

- "How are organizations applying human factors principles in their day-to-day operations?
- "What is the effect of a maintenance human factors program on the organization and on aviation maintenance personnel? [and,]

- “Is there a significant difference in the implementation of maintenance human factors programs across the international spectrum?”

The report describes safety practices and opinions among human factors managers, quality control managers, human factors trainers and labor organization representatives in the international airline maintenance industry. Information was derived from a questionnaire containing 66 items, with 12 possible follow-up items that could be triggered by pre-specified responses to specific items.

Items were organized into eight categories: demographics, error management, human factors training, fatigue management, proactive human factors support, motivation for a human factors program, human factors metrics and organizational policies. The questionnaire is included as an appendix.

“For organizations that [resemble] agencies with regulatory requirements, the human factors programs are more widely adopted, and the human factors instructors are given more training to prepare them for their responsibilities,” said the report in discussing the results. “Human factors programs reduce cost [of events associated with maintenance errors] and foster continuing safety and control of human error in maintenance. This survey found that the best targets of opportunity for improvement are use of event-data reporting, creation of a fatigue management program and increased use of data as a means of tracking errors over time to justify the cost of human factors programs.”

Co-author William Johnson will discuss the survey and its results in an article tentatively scheduled for the March 2008 *ASW*.

WEB SITE

Global Safety Network, <www.aci-safetynetwork.aero>

“Airports Council International (ACI) considers safety to be [the] no. 1 priority for airports and the aviation community,” the organization says on the opening page of the Global Safety Network, an ACI Web site dedicated to safety. It “contains information to be used by airport operators and aviation executives in ensuring their operations are safe for their customers and employees.”

Sections include safety management systems (SMS) information, best practices, policies, documents, training, and a questions-and-answers forum. The forum categories are runway incursions, wildlife management, new large aircraft, winter services, low visibility operations, training, adverse weather operations, and aircraft rescue and fire fighting.

The SMS section presents an overview with a model or chart of the elements of an SMS, followed by key information for developing and implementing an airport SMS. There is a discussion about identifying risks and steps to take in conducting a risk assessment of tasks and activities.

The resources section is primarily a listing of ACI documents, position papers, reports and manuals. Some materials are available online for a fee. Others are free, such as the *Global Aviation Safety Roadmap* that was produced by the Industry Safety Strategy Group, which includes ACI and Flight Safety Foundation. ●

Sources

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** U.K. Civil Aviation Authority
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P.O. Box 29
Norwich NR3 1GN
United Kingdom
Internet: <www.tso.uk/bookshop>

— *Rick Darby and Patricia Setze*

'Dangerously Low'

Pilots misinterpreted departure procedure.

BY MARK LACAGNINA

The following information provides an awareness of problems in the hope that they can be avoided in the future. The information is based on final reports by official investigative authorities on aircraft accidents and incidents.

JETS

Commander Said Chart Was 'Unsuitable'

Boeing 737-800. No damage. No injuries.

The 737 took off from Runway 05 at London Stansted Airport in visual meteorological conditions (VMC) for a return flight with 93 passengers to Istanbul, Turkey, the morning of Oct. 16, 2006. The flight crew had been cleared by air traffic control (ATC) to conduct the Dover Five Sierra standard instrument departure (SID) procedure. The chart has a note that says, "Initial climb straight ahead to 850 [ft]." Although the note means that flight crews should climb straight ahead to 850 ft — about 500 ft above airport elevation — before making any turns, the commander and copilot believed that they were required to maintain 850 ft until receiving a further climb clearance from ATC, said the report by the U.K. Air Accidents Investigation Branch (AAIB).

The departure procedure calls for a right turn to a southwesterly heading soon after takeoff and an initial climb to 5,000 ft.

The copilot, the pilot flying, had set 900 ft in the altitude selector while briefing the commander on the departure. The copilot hand-flew the takeoff and engaged the autopilot and the altitude-hold mode while climbing through about 880 ft. "A pitch-down command was signaled by the autopilot, but, due to the rate of climb and late acquire, [the aircraft] overshot the selected altitude," the report said. The commander took control, disengaged the autopilot and began a descent to 900 ft. Recorded flight data indicated that the 737 had climbed to 1,186 ft during this time and that the subsequent descent rate reached 2,029 fpm.

The crew of another aircraft, an Airbus A319 that had just landed at Stansted, saw the 737 descending in a steep nose-down attitude and believed that an engine had failed. One of the A319 pilots told the ground air traffic controller, "See the aircraft on climb-out? The 737 on climb-out just rapidly lost height."

The 737 leveled at 900 ft about 1 nm (2 km) northeast of Runway 05 and turned right to the southwesterly heading. The crew had been told to establish radio communication with London Air Traffic Control Centre (LATCC), but there was a delay because of congestion on the frequency. Meanwhile, the LATCC controller had been notified about the situation. "The LATCC controller was aware of the incident when [the 737] came onto his frequency," the report said. "If he had not been aware, there would have been a delay in [his realization] that the aircraft was at a dangerously low altitude." The 737 was below ATC radar coverage.

The report said that the aircraft had been flown below the minimum safe altitude (MSA), 1,800 ft, for several miles when the controller asked the crew to confirm their altitude. When the crew replied "900 feet," the controller said, "Climb now immediately to altitude 5,000 feet." The crew complied with the instruction and subsequently completed the flight without further incident.

Investigators interviewed the pilots in Istanbul three weeks later. "The commander realized that he and the copilot had not registered the exact meaning of the 'initial climb' note on the SID [chart] and thought this might have been due to a language issue," the report said. "He added that the format of the [chart] was also 'unsuitable,' compared to those of the other major European airports into which he operates, where the initial level-off altitude is displayed more conspicuously."

AAIB concluded that the incident resulted from "a misunderstanding of the notes on a SID [chart] and a breakdown in CRM [crew resource management]." The report said that "had the MSA been more critical [or had the aircraft] been in IMC [instrument meteorological conditions] and operating from an airport where terrain was more prevalent, this incident could have quickly become more serious."

Control Lost Briefly During Flare

Airbus A319-100. No damage. No injuries.

The A319 pitched about two degrees nose-down while the captain was applying aft sidestick control to flare the aircraft for landing at Denver the afternoon of Oct. 23, 2006. "The rate that the nose descended seemed to be commanded and extremely smooth," said the report by the U.S. National Transportation Safety Board (NTSB). About one second later, the captain's sidestick became responsive again, and he landed the airplane without further incident.

The captain's sidestick became responsive again, and he landed the airplane without further incident.

Analysis of recorded flight data indicated that the takeover and priority button on the first officer's sidestick inadvertently had been pressed, deactivating the captain's sidestick. "With the first officer's priority button pressed, the EFCS (electronic flight control system) disregarded the captain's inputs to the benefits of the first officer's [inputs]," the report said. "During this time, as no order (neutral) was applied on the first officer's sidestick, the aircraft elevators returned to the neutral position, [causing] pitch attitude to be reduced. The EFCS switched back to the captain's sidestick when the priority switch was released."

The airline requires the pilot monitoring to be in a position to take control from the pilot flying, if required, but to keep his or her hand off the sidestick during critical phases of flight, such as the landing flare. The report said that the A319 first officer "wondered if he could have accidentally bumped his sidestick, but he did not think that action occurred."

Pitot Icing Causes Erratic Indications

Boeing 717-200. No damage. No injuries.

The autopilot disengaged and airspeed indications on the flight crew's primary flight displays became erratic when the 717 was climbing through 21,500 ft in IMC about 10 minutes after departing from Perth, Australia, for a scheduled flight to Port Hedland on Sept. 7, 2006. "The pilot-in-command's displayed airspeed dropped as low as 115 kt, while the co-pilot's [displayed] airspeed reached a maximum of 348 kt," said the report by the Australian Transport Safety Bureau (ATSB). "Both the stall warning and overspeed warning sounded."

While conducting the "Airspeed: Lost, Suspect or Erratic" checklist, the crew determined that the airspeed indications displayed by the standby instrument system seemed to be accurate and used the standby instruments to continue the climb to Flight Level (FL) 330 (approximately 33,000 ft). They cycled the air data heat switch, a pushbutton on the overhead ice protection panel, while conducting the checklist and observed the primary airspeed indications return to normal. "The aircraft returned to Perth and conducted a normal approach and landing with all air data systems operating," the report said.

Analysis of recorded flight data indicated that ice had accumulated on two of the three pitot probes, blocking the opening of the probe associated with the air data system for the captain's displays and both the opening and drain hole of the probe for the first officer's displays.

Examination of the air data heat switch showed that its latching mechanism had been broken "when the lamp capsule was forcibly opened while the switch was in the latched ['ON'] position," the report said. Although the switch is designed to remain in the "ON" position following a failure of the latching mechanism, "it is possible that a piece of the broken latching mechanism jammed the switch in the 'OFF' position, which resulted in no heat being supplied to the air data sensors, including the pitot probes," the report said. "The 'OFF' light on the air data heat switch was probably illuminated. However, the crew may not have noticed it due to its location on the overhead panel."

The auxiliary pitot probe for the standby instrument system likely had accumulated ice, also. "As a result, it was likely that the indicated airspeed displayed on the [standby system] was also inaccurate," the report said. "The flight data displayed on the [standby system] was not recorded on the flight data recorder, so the accuracy of the indicated airspeed could not be verified."

Following the incident, Australian and U.S. authorities issued airworthiness directives requiring separation of the air data heating systems to reduce the risk of ice accumulating simultaneously on all three pitot probes.

Engine Fails After Ingesting 'Hard Object'

Airbus A300-B4. Substantial damage. No injuries.

The flight crew heard an explosion and saw instrument indications that the left engine had failed while the airplane was accelerating for takeoff from Amsterdam (Netherlands) Airport Schiphol the night of June 29, 2005. The crew rejected the takeoff at 142 kt — 10 kt below V_1 — and stopped the A300 on the runway, said the report by the Dutch Safety Board.

"After arrival of the fire brigade, tire and brake cooling operations were carried out, and, after completion of all the safety measures, the aircraft was pulled back to the parking area," the report said. "Inspection of the left engine revealed severe damage to the engine fan and fan inlet duct. One fan blade had separated [and] a piece of debris had penetrated and exited the acoustic panels and engine cowling. The airplane fuselage showed a few little dents."

The investigation concluded that the engine failure was caused by foreign object damage. No traces of a bird strike were found. The report said that ingestion of "a hard object — for example, a metal fragment left behind on the runway by another aircraft or a piece of concrete — is likely [to have caused the engine damage]."

Snowplow Involved in Near Collision

Boeing 737-500. No damage. No injuries.

After plowing snow on a service road at Denver International Airport the evening of Feb. 2, 2007, the snowplow operator drove toward another area that required snow removal. The route crossed a taxiway and the parallel, active, runway. "The driver stopped short of the taxiway but, without ATC or airport operations clearance, crossed the runway," the NTSB report said.

The flight crew saw the snowplow holding short of the taxiway when the 737, with 101 people aboard, was on final approach. After touchdown, the crew saw the snowplow crossing the runway in front of them and applied "significant" reverse thrust and wheel braking to stop the 737. The incident was classified as a near collision.

After touchdown, the crew saw the snowplow crossing the runway in front of them.

"The ground controller did not see the snowplow but was alerted to the runway incursion by the flight crew's report," the incident report said. "The airport movement area safety system (AMASS) was operational, but no alarm sounded."

The report noted that the snowplow driver was employed by the airport in 2004 and in 2005 was authorized to drive ground vehicles on airport movement areas with prior approval from airport operations personnel. The authorization was changed in 2006: "He was allowed to drive only on specific routes and cross certain taxiways," the report said. "He could not drive in a movement area unless escorted."

Hydraulic Leak Leads to Runway Excursion

Cessna Citation X. No damage. No injuries.

The Citation was en route from Newcastle, England, to London Luton Airport the evening of Sept. 20, 2006, when the master caution light illuminated and a "LOW FLUID" warning was displayed for Hydraulic System A. "The crew observed the hydraulic fluid level decreasing on the flight deck display, and, shortly afterward, the A system power transfer unit (PTU) failed," the AAIB report said.

The A system is pressurized by a hydraulic pump driven by the left engine. The PTU is a hydraulic pump, a backup to the engine-driven pump, and is driven by pressure from the B system. "The PTU operates automatically when a drop in system pressure is detected," the report said. The emergency checklist for a hydraulic leak requires disabling the PTU by pulling its circuit breaker.

"The loss of Hydraulic System A disabled the left engine thrust reverser and required the landing gear to be deployed using the emergency system," the report said. "It also meant that the emergency braking and nosewheel steering systems would have to be used on landing."

The crew told ATC that they had an urgent condition, recalculated their landing distance requirements and decided to continue the flight to Luton. "The touchdown was uneventful, and, as the aircraft decelerated through 70 kt, nosewheel steering was required to maintain the runway heading," the report said. "After [the Citation] had slowed further, nosewheel steering proved ineffective, and the aircraft began to drift to the left edge of the runway. It came to rest with the nosewheel on the grass … but with both main wheels on the paved surface."

Investigators found that a pressure hose connected to the PTU had failed after having been exposed to abnormally high temperatures, likely during prolonged operation of the PTU during a previous flight, and that an O-ring seal in a connection between a hose and the hydraulic manifold was defective. "Examination of the O-ring revealed signs of mechanical damage to its outer edge, which were indicative of it having been 'pinched' during installation," the report said.

TURBOPROPS

Pilots Deceived by Faulty Fuel Gauge

Fairchild Metro III. No damage. No injuries.

The aircraft was at FL 170, en route from Thangool, Australia, to Brisbane with 16 passengers the evening of Sept. 23, 2005, when a warning light illuminated, indicating that the left fuel transfer pump was not operating and that less than 70 lb (32 kg) of fuel remained in the left wing tanks. The flight crew "initially thought that the warning may have been false, as the fuel quantity indicator showed that there was substantial fuel in the left tanks," the ATSB report said. "In accordance with the checklist, they selected the alternate boost pump, but the caution light remained on."

The crew diverted the flight to Bundaberg, which was 55 nm (102 km) away and 42 nm (78 km) closer than Brisbane. The left engine flamed out about 10 nm (19 km) from the Bundaberg airport, and the crew conducted a single-engine approach and landing without further incident.

When the Metro was examined the next day, the fuel quantity indicator showed 400 lb (181 kg) of fuel in the left tanks and 250 lb (113 kg) in the right tanks. "Four pounds [2 kg] of fuel was subsequently drained from the left tanks, indicating that the left engine stopped because of fuel exhaustion," the report said. "There were 49 pounds [22 kg] of fuel in the right tanks, sufficient for about 10 minutes of flight."

Investigators found that the fuel quantity indicating system had not been recalibrated properly during maintenance performed before the incident flight. "The crew relied on the fuel quantity indicator to determine the quantity of fuel on the aircraft before the flight," the report said. "That practice was common to most of the operator's crews. The fuel quantity management procedures and practices within the company did not ensure validation of the aircraft's fuel quantity indicator readings. There was also no system in place to track the aircraft's fuel status during and after maintenance."

Mis-Set Switches Suspected in Avionics Loss

Beech King Air B200. Substantial damage. No injuries.

Soon after departing from Glasgow, Scotland, with two passengers for a flight to Peterborough, England, the morning of March 28, 2006, the pilot noticed a gradual and progressive loss of information displayed by the primary electronic flight instruments. He attempted to tell ATC that he was returning to Glasgow but found that the radios were not functioning, the AAIB report said.

The pilot referred to standby instrument indications while continuing the climb in IMC to his assigned altitude, FL 150, where the King Air was above the clouds. "Throughout the flight, the [pilot] considered that the workload involved in maintaining controlled flight had made fault-finding almost impossible," the report said.

After losing radio and secondary radar contact with the airplane, ATC arranged to have a Royal Air Force (RAF) Tornado intercept the King Air. The Tornado pilot rocked his wings, to indicate that the King Air pilot should follow him, and turned southwest toward Prestwick, Scotland. Although the King Air pilot had rocked his wings in response, he did not understand the Tornado pilot's signal and turned northeast toward an area where weather conditions were better. "The RAF crew saw [the King Air] enter cloud in an apparently uncontrolled fashion, and they transmitted a 'MAYDAY RELAY' message," the report said.

The King Air pilot said that the standby instruments had begun to flash on and off, and then had failed. "By then, [the King Air] was in a steep descent in cloud, and the [pilot] had great difficulty in recovering the aircraft into a climb," the report said. "He eventually achieved straight and level flight above cloud." The Tornado crew saw the aircraft emerge from the clouds in a steeply banked turn.

A passenger used his mobile telephone to contact ATC and was told that the Tornado would escort the King Air to RAF Leuchers. "In company with the RAF aircraft, the [pilot] eventually found sufficient gaps in the cloud and descended to VMC below cloud," the report said. He used the backup, manual landing gear extension system and landed at the RAF base without further incident. "The aircraft had been airborne for almost two hours and had been without electrical power for at least 90 minutes," the report said.

Examination of the aircraft showed that the skin on the outer wing panels was wrinkled. When the panels were removed, the outer wing spars were found damaged. "The damage to the aircraft was characteristic of it having been subjected to abnormally high flight loads," the report said.

When external electrical power was applied, the King Air's instruments and radios functioned correctly. The avionics equipment and electrical system were tested extensively, but no defects were found.

The report said that the loss of electrical power might have been caused by the pilot's inadvertent selection of the ignition and engine-start switches when he meant to select the engine autoignition switches just before takeoff. The unguarded switches are located on the lower left subpanel. Selection of the ignition and engine-start switches would have caused the generators to trip off-line. Although the starter motors would not have engaged the engines, they would have drawn substantial electrical current, draining the batteries within about six minutes, which is consistent with the avionics failure encountered by the pilot. The standby instruments have a battery backup that provides about 30 minutes of operation. Tripping of the generators would have caused the master warning light and two amber caution lights to illuminate. "It was possible that the [pilot] may have canceled the [master warning] as a reflex action and then did not critically examine the lights on the caution panel," the report said. "Tests indicated that these lights would have dimmed within about five minutes of the generators going off-line."

Selection of the ignition and engine-start switches would have caused the generators to trip off-line.

Blade Separation Causes Engine Failure

ATR 42. Substantial damage. No injuries.

The aircraft was climbing through FL 170 during a flight with 33 passengers from Farranfore Airport, Kerry, Ireland, to Dublin on Nov. 1, 2006, when the flight crew heard a loud bang and felt a jolt, said the report by the Irish Air Accident Investigation Unit (AAIU). The interstage turbine temperature indication for the left engine exceeded 1,200 degrees C

(2,192 degrees F), and a cabin crewmember told the pilots that flames and smoke were coming from the left engine.

The flight crew shut down the no. 1 engine, completed the in-flight engine fire checklist, declared an emergency and diverted to Shannon Airport, which was 5 nm (9 km) away. "A single-engine approach was carried out, and a normal single-engine landing was made on Runway 24," the report said.

Examination of the Pratt & Whitney Canada PW-120 engine indicated that two blades on the low-pressure turbine, as well as a small portion of the turbine disc that held the blades, had broken off and lodged in the stators, causing impact damage to the remaining blades. The first-stage power turbine also was damaged.

The report said that a service bulletin, SB 21555, had been issued in 1997 to reduce corrosion of the low pressure turbine caused by hot gas leaking onto the disc. The bulletin, which called, in part, for replacement of the seal assembly and turbine blades with improved parts, was classified as Compliance Category 7 — "low priority" to be accomplished "when all pre-SB parts are used up," the report said.

During maintenance to repair an oil leak in the left engine in October 2005, the seal assembly and several turbine blades on the low pressure turbine had been replaced; 47 blades had not been replaced. "Had the modification been classified as a Category 6, 'recommended,' service bulletin, greater emphasis would have been placed on renewing [all] the blades to the higher standard," the report said.

As a result of the investigation, AAIU told the manufacturer that it should "give more urgency to the implementation of SB 21555" by changing the compliance category from 7 to 6.

PISTON AIRPLANES

Engine Fire Could Not Be Extinguished

Douglas C-54G. Substantial damage. No injuries.

The four-engine airplane was on an unscheduled cargo flight, carrying 3,000 gal (11,355 L) of heating fuel from Fairbanks, Alaska, U.S., to the Nixon Fork Mine on Jan. 17, 2007, when the no. 2 — left inboard — engine began to run rough. The captain decided to shut down the engine and return to Fairbanks. However, during the shutdown procedure, the engine caught fire, the NTSB report said. The captain then turned toward Nenana Airport.

"The fire-extinguishing system was activated," the report said. "The crew thought the fire was out, but it erupted again, and the captain elected to land the airplane gear-up on the snow-covered tundra." The emergency landing was conducted about 5 nm (9 km) from Nenana Airport. "Once on the ground, the left wing was consumed by fire," the report said.

Examination of the no. 2 engine by company maintenance personnel indicated that the fire had been caused by a cylinder failure. "The airplane was not examined by the NTSB due to its remote location," the report said.

Thunderstorms in Vicinity of Breakup

Piper Chieftain. Destroyed. Four fatalities.

Scattered thunderstorms were forecast along the route from Archerfield, Australia, to Griffith on Dec. 2, 2005, but soon after the Chieftain departed on the corporate flight, a significant weather advisory (SIGMET) was issued for a line of thunderstorms south of Coonamble, a waypoint on the route. "Air traffic services did not pass the SIGMET information to the pilot of the aircraft, nor did their procedures require the information to be passed," the ATSB report said. "There was no request from the pilot for weather information at any stage during the flight."

The aircraft, which did not have weather radar or lightning-detection equipment, was at 10,000 ft near Coonamble when the pilot told ATC that he was diverting 20 nm (37 km) left of course due to weather. Ten minutes later, the pilot said that he was deviating farther left of course. Soon after this report, ATC lost radio and radar contact with the aircraft.

The report said that the Chieftain likely was "surrounded … by a large complex of storms" when it broke up in flight. The wreckage was found about 30 nm (56 km) left of course. "The wreckage trail extended for more than 4 km [3 mi]," the report said. "The wings outboard of the engine nacelles, the right engine and sections of the empennage had separated from the aircraft in flight. The remaining structure impacted the ground inverted and was destroyed by a post-impact fire."

Bolt Separation Results in Elevator Flutter

Cessna 421. Substantial damage. No injuries.

While climbing through 9,400 ft during a positioning flight from Idaho Falls, Idaho, U.S., to American Falls on Jan. 30, 2007, the pilot heard a thud and felt the control wheel move back and forth. The 421 then began to shudder and entered a diving left turn, the NTSB report said. The pilot reduced power and saw that the right horizontal stabilizer and elevator were "fluttering violently."

"He then further reduced the power on the right engine and added power to the left engine, which effectively crabbed the aircraft to the right and reduced the airflow over the right stabilizer/elevator," the report said. The 421 stopped shaking, and the pilot conducted an emergency landing at Pocatello, Idaho.

"After exiting the aircraft, the pilot discovered that the inboard one-half of the right elevator had departed the airframe while in flight," the report said. Investigators found that the bolt that connects the elevator trim tab actuator rod to the trim tab horn had separated in flight.

HELICOPTERS

Control Loss Likely During Survey Flight

Robinson R44. Destroyed. Four fatalities.

The pilot was conducting aerial survey flights near Gunpowder, Australia, on Feb. 21, 2006. "When the helicopter did not arrive at a prearranged rendezvous point [during the fourth flight], a search was initiated," the ATSB report said. "Searchers found the burned wreckage of the helicopter the next day." Examination of the wreckage indicated that the piston engine was producing power and the main rotor had low rotational energy when the R44 struck the ground at a high vertical velocity and in a level attitude.

Investigators found that the helicopter had been operated over its maximum takeoff weight, at low speed and in a hover during previous survey flights. "At the estimated helicopter weight and the prevailing air density, the helicopter did not have the performance to hover at the survey altitude, which was estimated to be about 1,000 ft above ground level," the report said. "The helicopter probably descended contrary to the pilot's intentions, possibly influenced by a partial engine power loss or downdraft, and induced the pilot to apply collective, which developed into overpitching and ultimately main rotor stall."

Moose Charges, Strikes Tail Rotor

Hughes 369D. Substantial damage. No injuries.

The passenger was a scientist who was shooting tranquilizing darts at moose so that they could be captured and collared by ground personnel in Gustavus, Alaska, on March 3, 2007. A witness said that after being shot by a dart, one moose charged the helicopter, reared or jumped and struck the tail rotor. The pilot lost directional control during the attempted autorotational landing, and the tail boom separated.

The helicopter operator had required pilots to remain at least 10 ft above the ground and 10 ft (3 m) from the animal during such operations. "This was the first incident of extreme, erratic behavior on the part of a darted animal," the report said. "The company … now requires the pilot to maintain 30 feet of altitude above the ground and 30 feet [9 m] horizontally from a darted animal." ●

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Nov. 2, 2007	Wichita, Kansas, U.S.	Douglas DC-8-73F	minor	4 none
About an hour after departing from Kentucky for a cargo flight to California, the flight crew saw smoke. The captain removed a panel in a lavatory and emptied a halon fire extinguisher into the opening. The smoke dissipated. The crew conducted an emergency landing in Wichita without further incident.				
Nov. 4, 2007	São Paulo, Brazil	Learjet 35A	destroyed	8 fatal, 1 serious, 1 minor
Visual meteorological conditions prevailed when the air ambulance banked right and crashed in a residential area on departure from Campo de Marte Airport. The two pilots and six people on the ground were killed.				
Nov. 4, 2007	Santa Elena, Guatemala	Beech King Air A100	destroyed	2 fatal
During a flight from Colombia to Mexico, the crew reported a technical problem and diverted to Santa Elena. The airplane crashed in a field about 30 km (16 nm) from the airport.				
Nov. 5, 2007	Jamestown, Tennessee, U.S.	Robinson R44	destroyed	3 fatal
Strong winds were reported when the helicopter struck a power line while departing from an oil-drilling site.				
Nov. 5, 2007	Culiacán, Mexico	Cessna 208B	destroyed	3 serious, 12 minor
The airplane struck terrain after losing engine power during departure for a scheduled air taxi flight to Cabo San Lucas.				
Nov. 6, 2007	Chino, California, U.S.	Beech King Air A100	destroyed	2 fatal
Instrument meteorological conditions prevailed when the airplane struck trees and crashed in an open field soon after departing on a business flight.				
Nov. 7, 2007	Cape Town, South Africa	Boeing 737-200	substantial	106 none
The right engine separated during departure. The crew returned to Cape Town and landed without further incident.				
Nov. 8, 2007	Khartoum, Sudan	Antonov An-12	destroyed	2 fatal, 4 serious
An engine failed when the airplane struck birds on departure. The airplane crashed during the emergency landing, killing two people on the ground.				
Nov. 9, 2007	Quito, Ecuador	Airbus A340	substantial	349 none
Inbound from Madrid, Spain, the airplane overran the runway after one or more tires burst on landing at Quito.				
Nov. 9, 2007	McFarland, California, U.S.	Piper Aerostar 602P	destroyed	3 fatal
The airplane crashed in a citrus grove soon after the pilot declared an emergency because of engine problems. The preliminary report said that the airplane had been parked on a slope and might not have been refueled fully before departure.				
Nov. 11, 2007	Kansas City, Missouri, U.S.	Learjet 60	minor	2 none
The crew rejected the takeoff after a tire burst, and the airplane veered off the runway.				
Nov. 11, 2007	Fox Harbour, Nova Scotia, Canada	Bombardier Global 5000	substantial	10 none
The left wing contacted the runway during landing. The airplane spun, and the landing gear collapsed.				
Nov. 15, 2007	Toulouse, France	Airbus A340	substantial	3 serious, 7 NA
The airplane reportedly jumped its chocks during an engine test and struck a blast fence.				
Nov. 15, 2007	Nakatsukawa, Japan	Cessna 404	destroyed	2 fatal, 1 serious
The airplane was on a photographic flight when it crashed near the summit of a mountain.				
Nov. 15, 2007	Las Vegas	Eurocopter EC30	substantial	1 none
The helicopter was being shut down when downwash from another helicopter passing overhead caused the main rotor to strike the tail boom.				
Nov. 30, 2007	Isparta, Turkey	McDonnell Douglas MD-83	destroyed	57 fatal
Inbound from Istanbul, the airplane was on approach to Isparta when it crashed in mountainous terrain about 20 km (11 nm) from the airport.				

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.


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