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Unlocking the Potential of a Safety Management System

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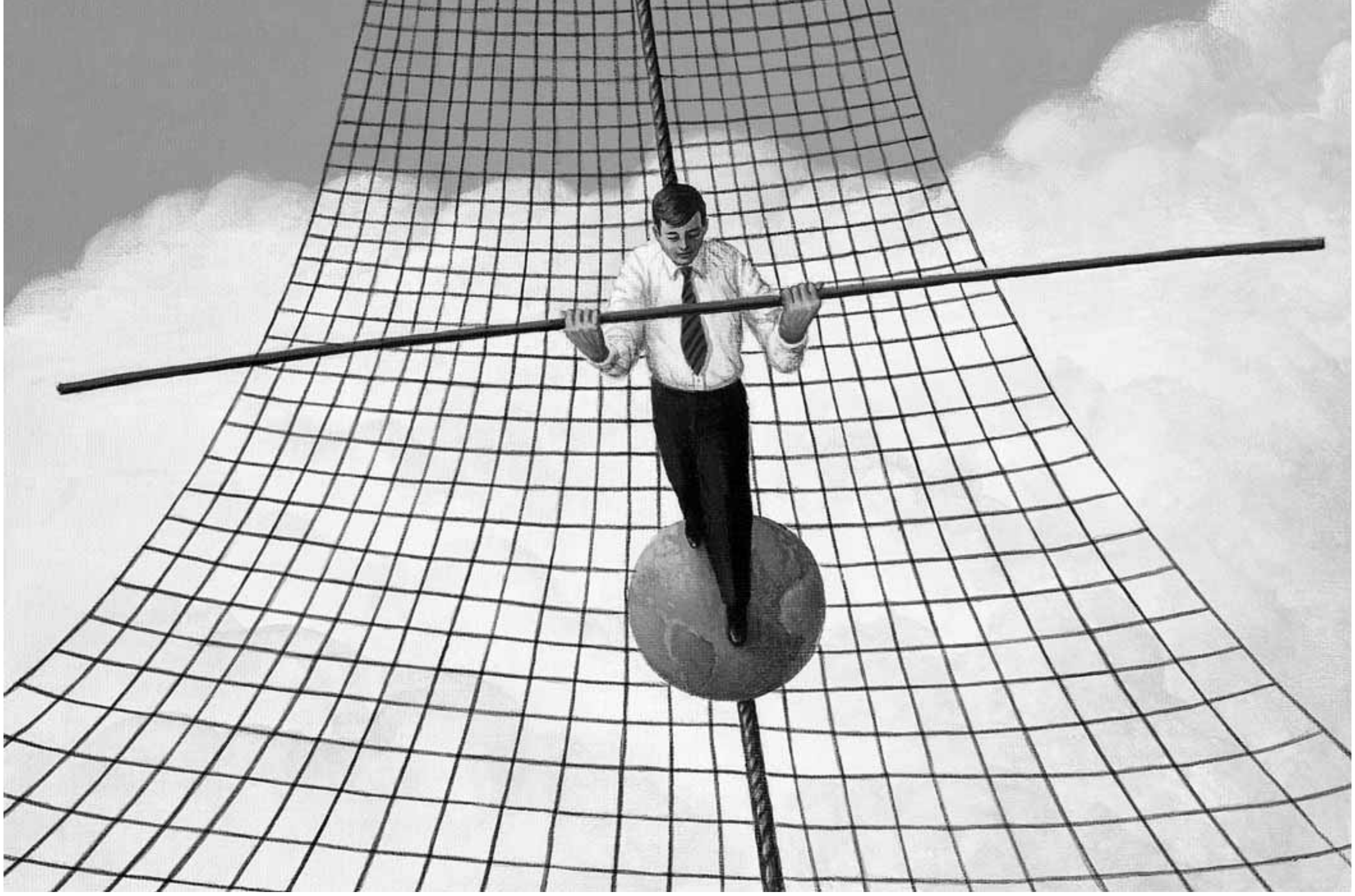


Unlocking the Potential of a Safety Management System

Chief executive officers have comprehensive guidance available to weave a strong safety net from their disparate safety programs. An SMS offers airlines a more realistic picture of operational risks and an objective method to allocate constrained resources, while eventually enabling regulators to focus on system-level oversight.

— FSF EDITORIAL STAFF

Since the transport minister of Canada announced in June 2005 that the country's airlines would be required to implement a safety management system (SMS) and to name an accountable executive ultimately responsible for safety, the conceptual shifts involved in an SMS have gained attention from many airlines around the world. An SMS has been described informally as a structure of systems to identify, describe, communicate, control, eliminate and track risks. Some proponents also visualize an SMS as a "roof" or "umbrella" overarching the many existing safety programs of a typical airline.

Transport Minister Jean-C. Lapierre said that Canadian goals for an SMS were "to increase industry accountability, to instill a consistent and positive safety culture and to help improve the performance of air operators. … This approach represents a systematic, explicit and comprehensive process for managing risks to safety … [complementing] the strong oversight program of inspections and audits already in place."[1]

The SMS also has been called "the first major effort to bring structure to safety programs in a standardized way"[2] and a "course toward a degree of self-regulation."[3]

In a landmark amendment to Canadian Aviation Regulations (CARs), an SMS was defined as "a documented process for managing risks that integrates operations and technical systems with the management of financial and human resources to ensure aviation safety or the safety of the public."[4]

The amendment said that an SMS for airlines in Canada (CARs Part VII, *Commercial Air Services,* Section 705, *Airline Operations*) includes the following:

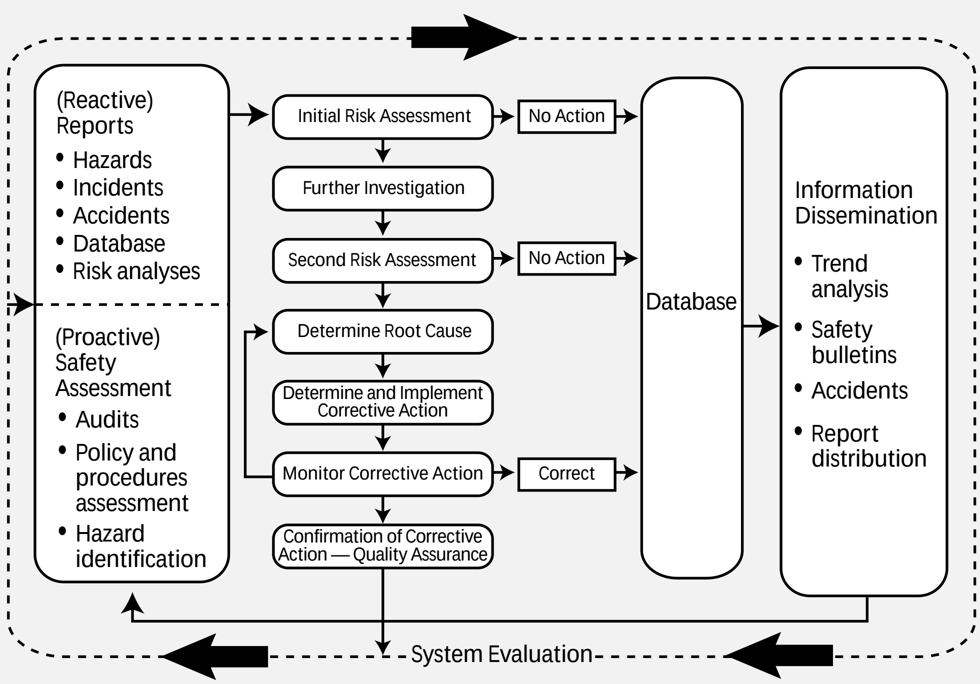
- "A safety policy on which the system is based;
- "A process for setting goals for the improvement of aviation safety and for measuring the attainment of those goals;
- "A process for identifying hazards to aviation safety and for evaluating and managing the associated risks;
- "A process for ensuring that personnel are trained and competent to perform their duties;
- "A process for the internal reporting and analyzing of hazards, incidents and accidents and for taking corrective actions to prevent their recurrence;
- "A document containing all SMS processes and a process for making personnel aware of their responsibilities with respect to them [Figure 1];
- "A process for conducting periodic reviews or audits of the SMS and reviews or audits for cause [i.e., for a specific reason] of the SMS; and,
- "Any additional requirements for the SMS that are prescribed under these regulations."

The amendment requires the following SMS components to be incorporated into the air operator's company operations manual and maintenance control manual:

- "A safety management plan that includes the safety policy that the accountable executive has approved and communicated to all

Figure 1

Safety Management System Process Flow



Source: Department of Transport, Canada

employees; the roles and responsibilities of personnel assigned duties under the quality assurance program …; performance goals and a means of measuring the attainment of those goals; a policy for the internal reporting of a hazard, an incident or an accident, including the conditions under which immunity from disciplinary action will be granted; and a review of the SMS to determine its effectiveness;

- "Procedures for reporting a hazard, an incident or an accident to the appropriate manager;
- "Procedures for the collection of data relating to hazards, incidents and accidents;
- "Procedures for analyzing data … during an audit … and for taking corrective actions;
- "An audit system …;
- "Training requirements for the operations manager, the maintenance manager and personnel assigned duties under the SMS; and,
- "Procedures for making progress reports to the accountable executive at intervals determined by the accountable executive and other reports as needed in urgent cases."

Transport Canada said that, although all airline employees make choices, an SMS generates greater awareness of the companywide consequences of some choices, including decisions that are distant in time and space from aircraft flight/ground operations.

"The aim is to break down communication barriers between different areas of an organization and to establish links between such areas of responsibility as marketing, maintenance and operations to facilitate the recognition that a decision in any part has an impact on all other parts and may create an unintended safety hazard," Transport Canada said. "Currently, safety is the responsibility of a safety officer who reports to management but who is ultimately not responsible for safety performance. With the introduction of SMS, the focus [of Transport Canada] will be at the systems level [where] inspectors will assess the effectiveness of an SMS within an organization. Therefore, SMS adds a layer of safety. Some air operators have already begun implementing these systems and have had positive results."

Among these operators, Transport Canada cited Air Transat, which voluntarily initiated an SMS in 2002 and has shown economic benefits exceeding costs. Transport Canada said that the same results are expected for other airlines.

"SMS involves a [transfer] of some of the responsibility for safety issues from the regulator to the individual organization," Transport Canada said in 2002. "[In this transfer,] the regulator oversees the effectiveness of the SMS and withdraws from a day-to-day involvement in the companies it regulates. The day-to-day issues are discovered, analyzed and corrected internally, with minimal intervention from Transport Canada."[5]

With respect to airlines, the initial requirements for an SMS in Canada only apply to operators whose operating certificate was issued under CARs Subpart 705 (airlines). Airlines that qualify for and elect an exemption (a method of delaying the date for full compliance) may comply with CARs through a four-phase process that begins with a gap analysis and a project plan, and continue to implement scheduled SMS elements to the satisfaction of Transport Canada between Sept. 30, 2005, and Sept. 30, 2008. Otherwise, the CARs required full compliance within 30 days of the amendment's publication.[6]

An implementation procedures guide provides a checklist for airlines to compare their existing overall management of safety programs to the required Canadian SMS elements. Moreover, the SMS assessment guide[7] used by civil aviation delegated officers of Transport Canada contains sample questions and SMS-scoring criteria. These and other guidance materials are available from the Transport Canada Internet site <www.tc.gc.ca>.

Beyond Canada, some senior managers and safety professionals have asked themselves whether their own advanced safety programs, taken as a whole,

An SMS generates greater awareness of the companywide consequences of some choices.

"The SMS should be a reflection of the organization's needs, rather than blind adherence to doctrine."

constitute an SMS. Unless the civil aviation authority has required specific elements of an SMS for airlines and verified compliance — under pending standards of the International Civil Aviation Organization (ICAO) — any answer could be premature. Nevertheless, comparisons with SMS-related recommendations of several countries would enable an airline to take advantage of the consensus on best practices.

ICAO Aims to Require an SMS

In December 2004, the Council of ICAO adopted *Strategic Objectives for ICAO for 2005–2010,* which includes one to "support the implementation of SMS across all safety-related disciplines in states." On Oct. 6, 2005, the ICAO Air Navigation Commission approved a related proposal to harmonize SMS-related provisions in Annex 6 — *Operation of Aircraft,* Part I — *International Commercial Air Transport – Aeroplanes* and Part III — *International Operations – Helicopters*; Annex 11 — *Air Traffic Services,* and Annex 14 — *Aerodromes,* Volume I — *Aerodrome Design and Operations.*[8]

Although subject to final review by the Air Navigation Commission for a proposed effective date of Nov. 23, 2006, the pending standards would distinguish between a "safety program" to be implemented by states and "an SMS" to be implemented by an aircraft operator, airport operator, air traffic service provider or maintenance organization. The safety program comprises "an integrated set of regulations and activities aimed at improving safety." An SMS is defined as "a systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures."

When the changes take effect, civil aviation authorities in contracting states would require aircraft operators (and the other types of aviation organizations) to implement a state-approved SMS. The standards require that the SMS:

- "Identifies actual and potential safety hazards [Figure 2, page 5];
- "Ensures that remedial action necessary to maintain an acceptable level of safety is implemented; and,
- "Provides for continuous monitoring and regular assessment of the safety level achieved."

Moreover, the standards require that "an approved SMS shall clearly define lines of safety accountability throughout the operator's organization, including a direct accountability for safety on the part of senior management."

Accompanying the SARPs will be the *ICAO Safety Management Manual,* already available in draft form from the ICAO Internet site <www.icao.int>. In the draft manual, ICAO said that integrated application of an SMS — embedding proactive safety processes throughout airline management — represents the best overall method of improving existing countermeasures against unsafe acts or conditions.

"Some organizations will require a formal SMS; … others may require most of the same functions to be performed, but perhaps with a less-structured approach," ICAO said. "They may also face resource limitations and be able to carry out only selected safety-management activities. … The degree of formality and rigidity in the SMS should be a reflection of the organization's needs, rather than blind adherence to doctrine. … It would be an overwhelming — if not impossible — task to implement all functions of an SMS simultaneously. … It is important that the organization reuse as many existing procedures as practicable, as there is no need to replace known and effective procedures and processes. … The design and implementation of an SMS will likely be a major change to the organization, capable of generating new safety hazards."[9]

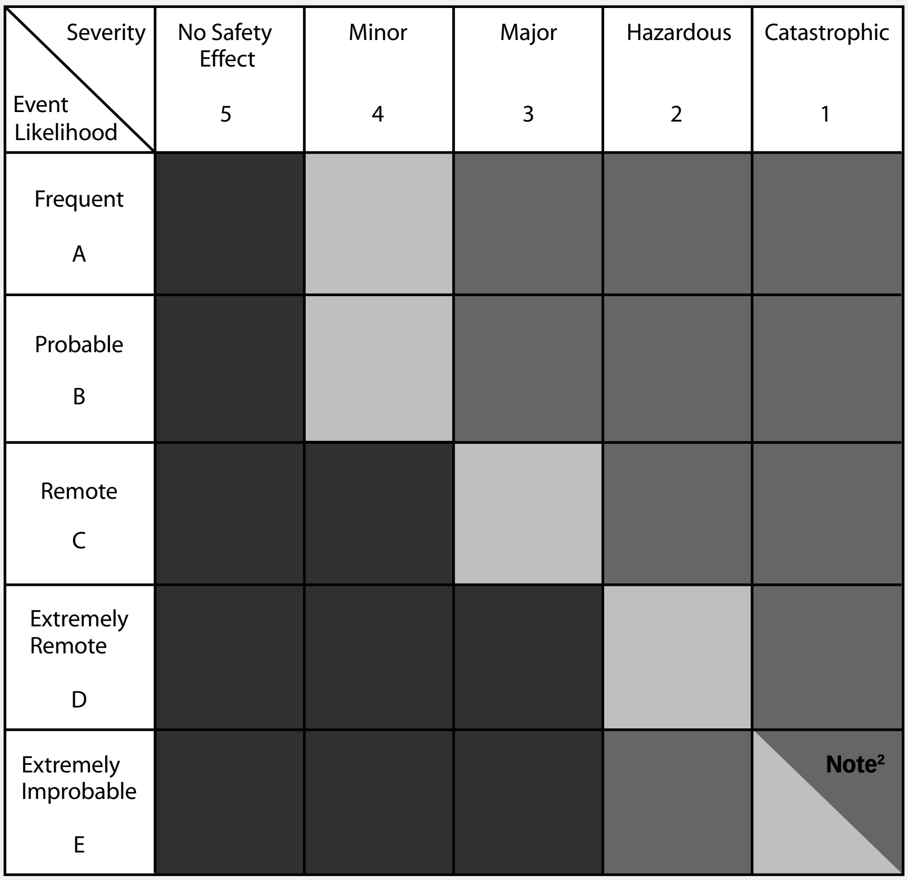
In August 2005, Dr. Assad Kotaite, president of the Council of ICAO, said that an SMS for airlines complements a broader strategy in which all contracting states must focus in an aggressive and coordinated manner on eliminating "systemic deficiencies" in the global air transport system.[10]

"The year 2004 was the safest in terms of fatalities since the creation of ICAO in 1944 and the second lowest in terms of the number of

Continued on page 6

Figure 2

Example of a Risk-assessment Matrix Used After Hazard Identification in a Safety Management System[1]



High Risk — Unacceptable risk. Tracking in a hazard-tracking risk-resolution system is required until the risk is reduced or accepted at the appropriate management level.

Medium Risk — Acceptable with review by the appropriate management level. Tracking in a hazard-tracking risk-resolution system is required.

Low Risk — Target level. Acceptable without review, restriction or limitation. Hazards are documented in a hazard-tracking risk-resolution system.

1. Principles of system safety, similar to those in the U.S. *Federal Aviation Administration [FAA] System Safety Handbook*, typically would be applied during the implementation of a safety management system (SMS) by an airline. Based on technical advice and data, senior management conducts SMS planning as a continuous-loop process; applies a systematic, forward-looking identification of hazards; and decides how to eliminate/control hazards — including the worst credible cases — after plotting their severity and likelihood on a risk-assessment matrix as a method of visualizing risk-acceptance criteria. Severity and event likelihood are assessed as precisely as possible using quantitative/qualitative definitions from the field of system safety and company/regulatory requirements; operational performance and cost are considered. The decisions about risk acceptability and hazard countermeasures also consider an established system-safety order of precedence.

2. In this FAA example of a risk-assessment matrix, a hazard involving a single-point failure or common-cause failure in this cell of the matrix would be unacceptable.

Source: U.S. Federal Aviation Administration

> "An SMS involves constant and aggressive seeking of risk information."

accidents, yet [August 2005 was] one of the worst [months] in history," Kotaite said. "ICAO and its contracting states recognize that it takes more than rules and standards to prevent accidents. … There must also be an unobstructed flow of safety-related information by everyone involved in air transport, at every level and across every safety discipline. At the same time, airlines and regulators must put in place [an SMS] that can make use of this information in order to take action before an accident occurs."

William Voss, director of the Air Navigation Bureau, said in 2004 that ICAO adopted its SMS strategy not only to prevent accidents but also as a response to increases in air traffic and the number of aircraft operators, a global shortage of qualified technical personnel (partly caused by the aging work force) and ICAO audit findings that 23 percent of contracting states did not provide sufficient financial resources for their civil aviation authority.[11]

Like Transport Canada, ICAO believes that airlines can experience benefits from an SMS comparable to the benefits experienced by Air Transat, which had a 72 percent decrease in irregular operating costs (saving more than US$1 million per month, compared with the period prior to SMS implementation), while improving employee morale, reducing incidents and increasing overall awareness of operations, Voss said.

Conceptual Shifts Affect Oversight

The framework for implementing an SMS involves the following conceptual shifts:

- From prescriptive regulations to performance-based regulations;
- From highly specialized and technically trained inspectors with significant resource requirements to system auditors and analysts who focus on areas of greatest risk; and,
- From an aviation industry that responds to regulatory requirements to an industry that becomes a partner in safety with civil aviation authorities.

Under conventional reactive strategies for preventing accidents, "constant catching up is required to match human inventiveness for new types of errors," said George Firican, ICAO European–Mediterranean and North Atlantic regional officer.[12] "Traditionally, safety has been about avoiding costs. Current thinking and research show that safety, efficiency and productivity are positively linked. … An SMS involves constant and aggressive seeking of risk information through hazard/incident reporting systems for identifying latent unsafe conditions, safety surveys to elicit feedback from front-line personnel, flight data analysis for identifying operational exceedances and confirming normal operating procedures, [and] operational inspections and operational audits to identify vulnerable areas. The safety officer [in recent years] … had, in effect, no authority to make changes that would enhance safety. The safety officer's … effectiveness depended on the ability to persuade management to act."

ICAO has cited the following SARPs from its annexes as early precedents for an SMS for airlines:

- A standard in Annex 6 (Part I) requiring an accident-prevention program and a flight safety program for operators;
- A standard in Annex 11 requiring safety-management programs in air traffic services, including the acceptable level of safety and safety objectives that became effective Nov. 27, 2003; and,
- A recommended practice in Annex 14 for an SMS for airports and a standard requiring an SMS for airports that became effective Nov. 24, 2005.

An often-cited European precedent in the evolution of SMS has been Joint Aviation Requirements–Operations (JAR-OPS) that require that "the operator must have nominated an accountable manager acceptable to the [civil aviation] authority who has corporate authority for ensuring that all operations and maintenance activities can be financed and carried out to the standard required by the authority." JAR-OPS 1 also says that "an operator shall establish an accident prevention and flight safety program, which may be integrated with the quality system, including programs to achieve and maintain risk awareness by all persons involved in operations."[13]

Pilot Union Promotes an SMS for Airlines

The Air Line Pilots Association, International (ALPA) has been involved in SMS development in Canada and SMS advocacy in the United States since 2000, said Capt. Rick Clarke, director of the ALPA SMS Project and a United Airlines pilot. Initially, two ALPA staff members experienced in systems safety worked with representatives of Transport Canada and representatives of a Canadian airline who were involved in prototyping airline SMS requirements in Canada.[14]

"As part of our pilot-representation duty, we were helping the airline to implement an SMS with Transport Canada," Clarke said. "We then provided comments as Transport Canada began designing its SMS requirements, which went through the normal process of drafts, regulatory proposals and public comments. We encouraged Transport Canada to require an SMS for the benefit of the air carriers we represent. ALPA's Steering and Oversight Committee also came to an official organizational conclusion around that time that SMS implementations would lead to stronger, better air carriers in which employees and management have shared values and a good place to work."

In early 2004, ALPA representatives conducted separate training sessions at five Canadian airlines where ALPA represents pilots. Participants included airline CEOs and vice presidents from diverse departments, contract negotiators, directors of safety and operations, and pilots. ALPA was the session facilitator but did not represent Transport Canada, which was planning to issue regulatory amendments for comment, he said. The ALPA SMS Project team launched a three-pronged effort: airline SMS in Canada, airline SMS in the United States and adopting some SMS practices in ALPA's own safety structure.

"It became clear that the merits of an SMS would be just as valid for airlines in the United States as in Canada, so we began to encourage its adoption by the [U.S.] Federal Aviation Administration [FAA] and U.S. airlines," Clarke said. "We fully support an SMS at airlines."

Nevertheless, initial reactions often ranged from absence of interest and "not-invented-here" arguments to inertia reflecting satisfaction with existing airline safety programs, he said.

"We've spent a lot of time just letting people know that the SMS concept exists, which was the first step before we could talk about an SMS in detail," he said. "Our biggest role has been conducting a 'marketing' effort to get SMS knowledge on the street through ALPA papers and presentations. ALPA also has been part of an SMS focus group — with about a dozen representatives of the airline industry — that FAA Flight Standards began independently about three years ago. All of a sudden, there has been a lot more motion on SMS. When FAA demonstrates more interest — by issuing advisory circulars, for example — more people in the U.S. airline industry will take notice."

Clarke said that, from ALPA's perspective, a viable SMS has the following hallmarks:

- The SMS is driven by the chief executive officer, who establishes the policy and sets the SMS in motion;
- The airline has a nonpunitive reporting system for all employees — not just the pilots; and,
- The airline maintains a robust risk-management system.

"ALPA's SMS Project team looks for these to judge whether or not an airline has an SMS," Clarke said. "Most U.S. airlines already have important elements of an SMS in place — that is, they would not have to create an SMS from scratch. What many airlines would have to do, however, is to tie the elements together to take the best advantage of what they have. They often have risk-management systems and/or nonpunitive reporting systems

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Employees can work in unison rather than in silos in their hazard analysis.

for pilots, for example, but not many have a CEO-driven SMS. An SMS never would be finished, however; it would evolve continually as the airline evolves."

ALPA's *Background and Fundamentals of the Safety Management System (SMS) for Airlines* includes a large, multipage matrix that any airline can use to conduct an informal gap analysis, determining which ALPA-recommended SMS elements already are in place and which are not.

To persuade corporate CEOs or boards of directors, ALPA has stressed how an SMS would affect economic results, helping the airline to operate more safely, cost effectively and efficiently.

"To be 'lean and mean' — as every airline wants to be today — top-level management must make the best use of what they've got in resources, loss control and management," he said. "The objective is not to 'be safe;' it is to operate safely and effectively, making the best use of the dollars they have. With an SMS, integrated communication about risk management cuts across the lines of business in a corporation. Employees can work in unison rather than in silos in their hazard analysis — thinking through changes before they implement them, and controlling losses.

"An SMS has to reflect the operating environment and the company culture. An extreme example might be recognizing that an airline operating in the U.S. Pacific Northwest or beginning transpolar operations for the first time has a whole different flight regime than one flying in the Florida Keys and the Bahamas. An SMS also helps identify what losses the company is experiencing — not at the level of losing an airplane, but seeing accidents as the 'tip of the iceberg' of precursor events that extend down to a broken tow bar, a baggage cart rolling over a person's foot, or many other preventable events that increase costs."

ALPA's team has talked with some U.S. airline safety professionals who favor an SMS and have been considering how to help their CEOs to design and implement an SMS, he said. ALPA recommends that the CEO tap the risk-management expertise of the vice president of safety or safety director and technical specialists. Nevertheless, the resulting SMS cannot "live" in the safety department, but must permeate the entire company from the top down.

"These safety professionals seem to be trying to tie together the existing elements at their airlines," Clarke said. "But others either see an SMS as a threat, believing that an SMS will take away something from their current work, or as the opposite, a chance to begin building their own SMS empire; these ideas are totally wrong concepts of an SMS."

ALPA expects SMS implementation by airlines eventually to improve safety oversight by Transport Canada and FAA, he said. Unlike conventional event-based oversight (for example, a ramp inspection of an individual pilot's license and medical certificate) by a civil aviation authority, process-based oversight within an airline would demonstrate that all pilots meet regulatory requirements. Similarly, the SMS demonstrates that the airline appropriately investigates accidents, conducts hazard analysis and manages risk (see "Facing Explosive Growth in Aviation, China Sees SMS as Safety Cornerstone," page 9).

"In the future, process-based oversight typically would not involve full-blown, white-glove FAA inspections, which typically require senior management to set aside about three weeks to answer questions from an audit team," Clarke said. "Those inspections are expensive and interfere with the airline's operation. Instead, in process-based oversight, FAA inspectors would begin by determining if the airline has a viable, working SMS. They then would look at information in the SMS and ask questions like, 'Are they getting reports from employees? How do they handle incident reports?' They would look at the airline's electronic files and see if the airline followed up on safety-related events [Figure 3, page 10]. If the SMS works, the airline passes. If the SMS is fake, or elements do not work, that would bring more inspectors to the airline."

IOSA Program Integrates an SMS

SMS is part of the Six-Point Safety Program endorsed by the Operations Committee of the International Air Transport Association (IATA) for

Facing Explosive Growth in Aviation, China Sees SMS as Safety Cornerstone

Anticipating continued growth of about 20 percent annually in commercial air traffic, the General Administration of Civil Aviation of China (CAAC) expects the implementation of a safety management system (SMS) by airlines to become a significant part of its strategy, said Ma Tao, deputy director general, CAAC Flight Standards Department.[1]

"In 2005, 150 aircraft were delivered to Chinese airlines, and we estimate that 100 per year will be added until 2010," Ma said. "SMS will be very, very important in China to reduce rates of accidents and incidents — a key way to maintain a higher safety standard in the future. After deciding to require SMS, CAAC set up a leading group under the vice minister of safety. We are revising our regulations to say that all carriers will need to implement an SMS in the next few years."

The leading group developed and scheduled an SMS plan for China, translated information from other countries, visited airlines outside China that have implemented an SMS and conducted initial seminars.

"SMS is purely for Chinese air carriers to implement, not government regulators," Ma said. "We are all working on the same safety goal, but the government also will need to promote SMS, to help the airlines to set up this system. We hope that together we not only meet the standards of the International Civil Aviation Organization [ICAO], but help airlines and CAAC to gain the potential benefits in the future."

CAAC concurs with a widely held assumption that, in the future, civil aviation authorities worldwide will have insufficient resources for traditional operational oversight and that system-safety oversight provides a viable solution, he said.

"Certainly the airlines must take responsibility for their own safety, but one of the advantages of an SMS is that CAAC will be able to require more oversight to be accomplished through the air carriers," Ma said. "If a Chinese air carrier has a good SMS, we will not have to do the more detailed operational safety checks. The government then only would have to provide the system-safety oversight function."

So far, personnel from the Aviation Safety Office of CAAC have made several visits to Transport Canada, a pioneer in requiring that airlines implement an SMS; CAAC also invited Transport Canada representatives to China, and they have conducted several SMS seminars and training courses.

"Next, we will translate all SMS-related ICAO documents and manuals, then draft CAAC requirements, procedures and advisory circulars for Chinese air carriers and the Air Traffic Management Bureau," he said. "We do not yet have the final planning documents on SMS ready. After they are available, and after we change our regulations and provide advisory circulars to airlines, we will begin a trial SMS implementation involving one or two airlines to see how the implementation works for the airlines and CAAC. We already expect many difficulties — probably some involving differences in the cultures and experiences of aviation professionals in Asian countries and Western countries — so we hope we can have further communication worldwide with our counterparts in the countries leading in airline SMS, such as Australia, Canada and the United Kingdom."

The high demand for airline pilots also could be addressed when Chinese airlines implement an SMS.

"CAAC operations inspectors are required to be line pilots actively flying for airlines, unlike in countries that only require inspectors to have a pilot background," Ma said. "But given our great shortage of pilots in China right now, we cannot indefinitely continue having several hundred pilots work for CAAC in this oversight function. In the future, we will need fewer CAAC inspectors who are trained to provide more efficient system-level oversight — that is what will be provided by SMS in airlines. Similar SMS training courses will be very important for airline operations staff." ■

— FSF Editorial Staff

Note

1. Ma, Tao. Interview by Rosenkrans, Wayne. Moscow, Russia, Nov. 9, 2005. Flight Safety Foundation, Alexandria, Virginia, U.S.

2006; other elements are safety auditing, infrastructure safety, safety data management and analysis, flying operations safety and cargo safety. The goal is a 25 percent reduction in the accident rate for the Western-built commercial jet fleet by 2008.[15]

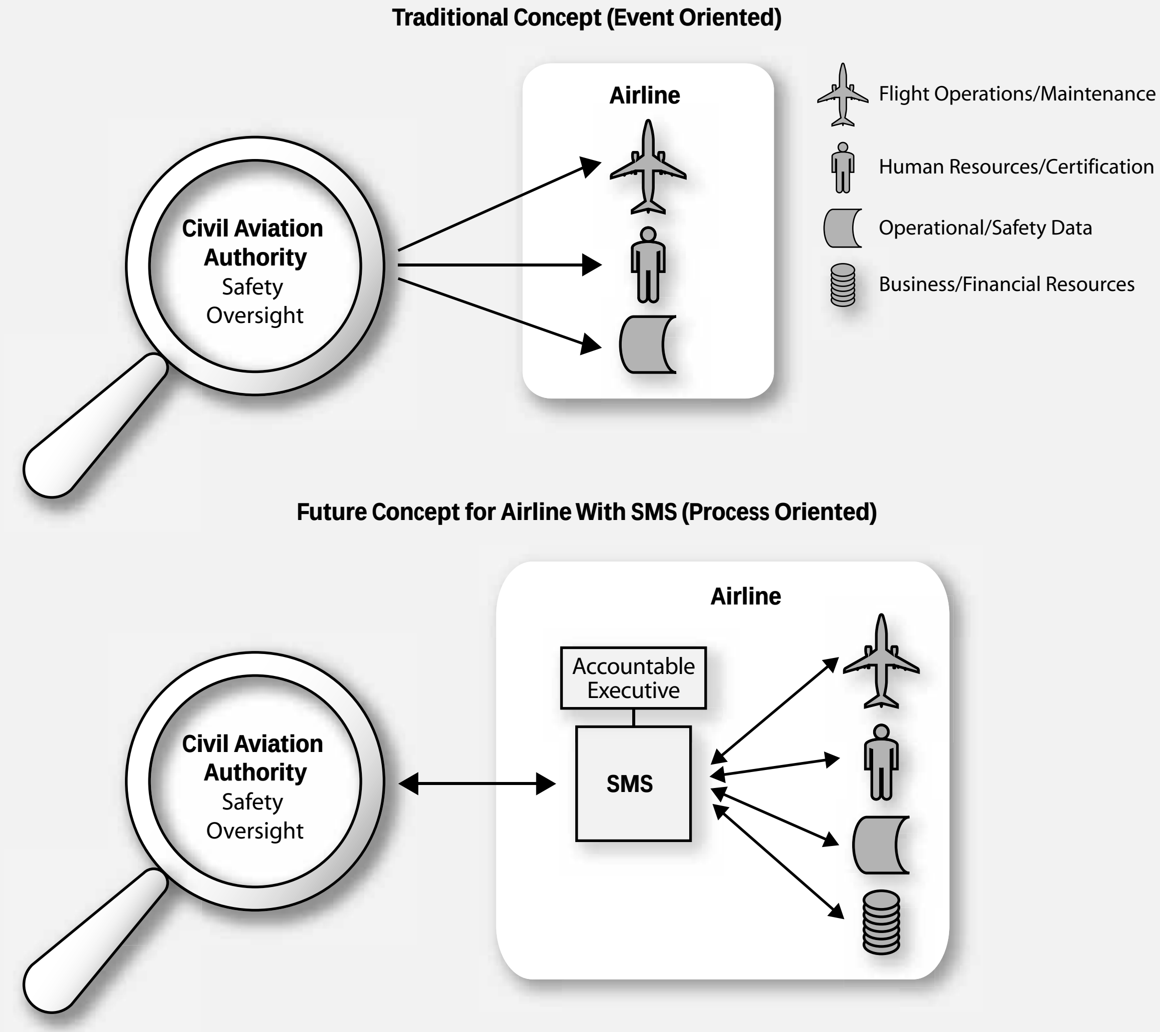
"We have to rethink how we do safety, and we have adopted a multidisciplinary businesslike approach to safety, setting specific and quantifiable goals and delivering safety solutions," said Günther Matschnigg, senior vice president, safety, operations and infrastructure, for IATA. SMS is one aspect of an exchange of safety information under a memorandum of cooperation with ICAO, which has developed its safety program for states; IATA has developed a complementary implementation of an SMS for airlines, Matschnigg said.

IATA's SMS guidance — *Safety Management Systems: The Senior Airline Manager's Implementation Guide*, published in October 2005 — also was prompted by a recognition that many senior managers of airlines want to consider an SMS in the context of the IATA Operational Safety Audit (IOSA), said David Mawdsley, director of safety for IATA.[16,17]

"Since we launched the IOSA program, more than 125 airlines have been audited," Matschnigg said. "We have 80 airlines on the register, and more than

Figure 3

Relationship Envisioned Between Regulator and Airline With a Safety Management System (SMS)[1]



1. The International Civil Aviation Organization defined a safety management system (SMS) as "a systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures" in a proposal to amend SMS-related provisions in Annex 6 — *Operation of Aircraft*, Part I — *International Commercial Air Transport — Aeroplanes*, to the Convention on International Civil Aviation.

Source: Flight Safety Foundation

50 audits scheduled. Audits have been completed in all regions of the globe."

The guide's recommended practices were prepared by a task force partly to help clarify for airlines the relationship of an SMS to existing quality-management systems.

"One driver for us was the need to publish the best possible description of an SMS in the IOSA context," Mawdsley said. "Another driver was the volume of literature already produced by ICAO, pilot associations and others. An SMS is a way of maintaining a businesslike approach to safety with continuous improvement. An SMS requires feedback from all operational areas that directly impact safety within an integrated system to track safety issues, understand them, take remedial action and capture the lessons in documentation."

Like other IATA documents, the guide is cross-referenced to the section in the *IOSA Standards Manual* on corporate organization and management systems, which discusses issues such as quality assurance, operational safety planning and control, and risk-management programs.

One objective for the guide was to tailor recommended practices to the practical interests of the airline operations manager of a medium-size airline or smaller airline.

"The key question to address was 'What do I — as manager of an airline — need to do to implement an SMS?'" Mawdsley said. "IATA sees a strong link between safety and operational efficiency; a good SMS leads to good efficiency. Through our propagation of the SMS concept, we eventually want all IATA airlines to have a working SMS that is understood by all the people inside each airline."

IATA's guide differs from some other SMS literature not only by its IOSA references but also by integrating security with safety and quality assurance.

"Security and safety involve incidents, problems and concerns that need analysis and follow-up action to prevent them from happening again," Mawdsley said. "IOSA fundamentally is about quality-assurance systems, so we found it necessary to consider security in an SMS, and we advocate that airlines follow a similar strategy."

IATA also is developing a global internal SMS — called the IATA Safety Management Support System — to integrate with the SMS of an individual airline and monitor its operations, he said.[18]

Some SMS Elements Originate at U.K. CAA

Before ICAO and Transport Canada brought to the forefront their concepts of an SMS for airlines, the U.K. Civil Aviation Authority (CAA) recommended voluntary adoption (see "FSF Seminars Document SMS Evolution," page 12). By the 1990s, SMS concepts had been used by the railroad industry, the petrochemical industry and the nuclear power industry. In 1999, U.K. CAA's Safety Regulation Group, in consultation with the aviation industry, published an introductory document that later evolved into Civil Aviation Publication (CAP) 712, *Safety Management Systems for Commercial Air Transport Operations.*[19]

CAP 712 contains the following basic premises with respect to airlines (some recommendations also apply to maintenance organizations):

- An SMS is defined as "an explicit element of the corporate management responsibility which sets out a company's safety policy and defines how it intends to manage safety as an integral part of its overall business";
- SMS is as important to an airline as a financial-management system;
- Implementation of an SMS by individual airlines is promoted but not mandated;
- SMS includes a positive corporationwide safety culture;
- Airlines take a pragmatic approach that builds an SMS on existing procedures and practices, especially quality management, linking them to the formal framework;
- The ideal safety culture is one that is "supportive of the staff and systems of work, [that] recognizes that errors will be made and that it is not apportionment of blame that will resolve the problems … [and that will] encourage open reporting, seek to learn from its failures and be just in dealing with those involved";
- Inclusion of safety-related controls over purchasing and contractor selection and oversight; and,
- Inclusion of emergency-response planning in the SMS framework.

U.K. CAA reiterated in 2003 that there was no single recognized standard in civil aviation for defining a typical SMS.[20]

Australia Moves Toward Requiring an SMS

In Australia, regulatory requirements for implementation of an SMS by air transport operators are projected to take effect in the first quarter of 2008, according to the Civil Aviation Safety Authority, Australia (CASA).[21]

CASA previously has published three guides to voluntarily implementing an SMS that include guidance for air transport operators.[22] Voluntary SMS in Australia has included, but has not been limited to, the following elements: the commitment of top-level management to safety, systems for timely reporting of hazards, action to proactively

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FSF Seminars Document SMS Evolution

During the past 10 years, presentations at the Flight Safety Foundation International Air Safety Seminar (IASS) — part of the joint meeting with the International Federation of Airworthiness International Conference and the International Air Transport Association — have highlighted the evolving concept of a safety management system (SMS). The following excerpts show similarities to current discussions:

- In 1995, Capt. Colin Sharples said, "Back in 1987, a Townsend Thoresen roll-on/roll-off passenger and freight ferry capsized four minutes after leaving Zeebrugge [Belgium] harbor bound for Dover [England]. A total of 187 passengers and crew lost their lives. The subsequent inquiry found 'the board of directors did not appreciate their responsibility for the safe management of their ships … and they must accept a heavy responsibility for their lamentable lack of direction.' … For the future, [an SMS] will require [companies] to determine safety objectives at board level. … Described by the U.K. Health and Safety Executive (HSE), [an SMS] is composed of four elements: a safety case, internal audit process, a deficiency-rectification loop [and] a safety culture. … The accountability for safety must rest at the highest level within the company, with the chief executive obviously being involved in setting the tone and clearly specifying the level of safety required."[1]

- In 1995, Michael Overall said, "Particularly where safety margins may come under pressure [from competition and the drive to reduce costs], it is vital that the safety implications of change are identified, thoroughly assessed and properly managed. … Safety monitoring by the regulator tends to focus on outcomes, end products and facilities. The inherent weakness of this system is that, at least in part, it relieves the regulated organization from its responsibility to think through the safety issues, evaluate them and decide how to manage the risks. … By probing, in a structured way, the activities of an organization against its own SMS, the regulator can gain a much better insight into the underlying safety competence of the organization than [the regulator] ever could through the traditional forms of regulatory oversight."[2]

- In 1997, Doug Akhurst and Mike Vivian said, "Lessons to be learned from [accidents in several high-consequence industries include:] early warning signs have been ignored or missed or previous incidents have been ignored or missed; previous incidents have been forgotten … there is a duty to identify the worst case and assess the risk of that happening; and there is a need for clear, published safety policies which have to be provided with adequate resources. … Consideration should be given to the difficulties of reconciling [an SMS] philosophy, with the associated and necessary detailed documentation which that system requires, and an ever-increasing litigious society in which professionals seek to practice defensive techniques."[3]

- In 1997, Terry Kelly said, "Will [disparate] safety-management programs, even the very good ones, assure the effective management of safety in these times of dynamic technological, operational and organizational change? This paper posits that they will not. … The next step lies in the development and implementation of fully integrated [SMS] into aviation operations. … A strong safety culture, par excellence, would reside in the company which readily collects safety information, rigorously analyzes it, acts aggressively on the findings, and tracks and analyzes its own progress in identifying, analyzing and resolving its own safety problems. … [Nav Canada's] finance, human resources [and] even the legal departments actively participate in, and are accountable for, the attainment of safety objectives — just as operations [departments] have always been responsible for meeting company financial goals."[4]

- In 1998, Overall said, "The test of success [in SMS implementation] is when the board really treats safety with no less priority than any other aspect of corporate management, and does not merely say that it does. … Investigations frequently show that individual accountabilities for safety in aviation organizations are often inadequately defined, ambiguous, incomplete and sometimes duplicated at different levels. … There are three major challenges … maintaining a systematic framework for the SMS; achieving a 'critical mass' of the SMS development [i.e., finding the resources] within a reasonable time scale; [and,] maintaining a continuous buildup of commitment across the organization." [5]

- In 1998, Clifford Edwards said, "In many companies, members of the management team are neither aware of their personal accountabilities for safety nor have they identified all the hazards that exist in their organizations. … The approach to safety currently taken is somewhat piecemeal, treating safety in different functions as if it were separate and of no interest or benefit to the rest of the company. A positive and well-led integrated approach, with structures to support it, is required."[6]

- In 2000, Sharples said, "Whereas a commercial or financial objective can be very focused, with results obvious for all to see, safety is not easily defined. It is not possible to score or chart how safe an airline is. … An SMS is a formal process for managing safety. Although it must be supported and promoted from the top of a company, it is the work force that will make it happen."[7]

- In 2001, Peter Hunt said, "In [the U.K. Civil Aviation Authority (CAA)] Operating Standards Division, we do not want to mandate SMS. … An SMS identifies and prioritizes the use of resources to manage risk, and should lead to gains in efficiency. Many — perhaps all — operators will find that their existing processes and procedures can be linked into the framework of a formal SMS. So it's evolution, not revolution."[8]

- In 2002, Simon Witts said, "So where does safety management fit in the 'real world?' … We took the opportunity as we were creating a new airline — British Airways CitiExpress — to model a new structure on Civil Aviation Publication 712 [*Safety Management Systems for Commercial Air Transport Operations — A Guide to Implementation*, published by U.K. CAA]. … The work to date … has broken down a number of 'traditional' barriers between operations and engineering, and it has given everyone a single purpose in safety. … Our [SMS] offers a combined industry–regulator approach to safety while respecting the demarcation lines."[9]

- In 2004, Joseph Boyd and colleagues said, "An SMS shifts ultimate responsibility for corporate safety efforts from middle management to the company's chief executive. As a result of this change, a corporation's effectiveness in identifying and acting on weaknesses is greatly enhanced. … Commonly, managers perceive that safety is the opposite of the operational orientation. In other words, the perception in some organizations is that 'being safe' takes away from the operational reality of airline operations. … SMS moves safety from the periphery into the core of the business — keeping the company efficient through loss control and best use of resources."[10]

- In 2004, Ma Tao said, "An annual 'safety check' for operations cannot monitor real safety conditions, cannot forecast safety trends, cannot find the potential hazards and cannot find the root causes of accidents. … Now in China, many airlines have the ISO [International Organization for Standardization] 9001 quality management system certificate, but they manage quality and safety in two systems: the quality management system and SMS. In fact, the two systems should be combined. … It will be [easier] to organize training and implementation, and will not confuse the staff."[11] ■

— FSF Editorial Staff

Notes

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manage risks and continuous feedback for evaluation of the effectiveness of safety actions.[23] The guides include case studies of aircraft accidents and a case study of the SMS at Qantas Airways. Promoting airline adoption of an SMS was an acknowledgement that CASA cannot regulate every source of risk, CASA said.

"In the final analysis, it is the individual operator, the individual engineer, the individual flight crewmember who has the immediate responsibility for delivering a positive safe outcome for individual flights on a day-by-day basis," said Bruce Byron, CEO of CASA. "Anyone who has managed an aviation operation will understand that there are a multitude of other factors that affect safety risks and that are not covered by regulation."[24]

Moreover, an SMS at an airline has been framed as a due-diligence defense against corporate-liability claims and individual-liability claims after accidents.

"Increasingly, Australian law is placing responsibility for safety at the senior management level of organizations," CASA said. "Clearly, management can no longer remain legally aloof from the actions of employees. … Once hazards start to be identified, senior management [also] must be prepared to commit resources to address those hazards. If hazards are not properly addressed, enthusiasm for the SMS will quickly wane."[25]

FAA Builds an SMS for Air Traffic Organization

According to FAA's *Flight Plan 2006–2010*, current activities for the design, development and phased implementation of an SMS initially affect the Air Traffic Organization (ATO), applying system-safety methods to the delivery of air traffic services and meeting the current and pending standards of ICAO Annex 11. Targeted changes to the U.S. National Airspace System are the initial focus of these safety risk management processes, which also will be implemented throughout FAA "to assess safety risk and to monitor the effectiveness of safety risk-mitigation strategies," according to the *Flight Plan*. In May 2005, FAA requested funding to continue the implementation of the ATO SMS. Advisory circulars have not been issued about the implementation of an SMS by U.S. airlines.[26]

"The SMS will hold FAA accountable for the same level of safety it requires of the aviation industry," the FAA ATO said.[27]

The ATO SMS follows a broader FAA safety-management policy that governs change processes, contracting, technology acquisitions and other activities. The principal policy governing system safety is FAA Order 8040.4, *Safety Risk Management*, which "establishes the safety risk management policy and prescribes procedures for implementing safety risk management as a decisionmaking tool within [FAA] … [and the FAA] Safety Risk Management Committee."[28]

FAA also has envisioned, under a strategic program called the System Approach for Safety Oversight, opportunities for sharing with the aviation industry data, processes and common tools that would support risk identification and mitigation; this would be expected to occur during the 2006–2016 time frame and parallel the restructuring occurring in a number of U.S. airlines.[29]

"We're working to provide better service to the aviation industry, which is going through a difficult period of economic turbulence," said Marion C. Blakey, FAA administrator. "But even with this resurgence in passenger numbers [a projected 7 percent increase at the 35 busiest U.S. airports in 2006, compared with 2000, a record year], fundamental restructuring is under way as the aviation industry battles bankruptcy at virtually every corner."[30]

Leadership Helps an SMS Succeed

Leadership and accountability should be viewed as key factors in implementing an SMS, especially in developing the airline safety culture, said William O. McCabe, director of DuPont Aviation.[31] A strong safety operating discipline — led from the top, with clear line-management accountability — provides the foundation, McCabe said.

"The safety leadership must be visible to the employee," he said. "In DuPont Aviation, for example, we have clear accountability standards regarding personal safety leadership that all management layers of the DuPont Company have to meet. There is no hiding."

Typical safety-leadership demands that must be met include the following, he said:

- Conduct planning, integration of activities and challenging goal-setting that support corporate safety policies and principles;
- Establish clear standards and high expectations of safe behavior, including line-manager accountability;
- Provide safety professionals to help line managers;
- Demonstrate effective oversight of employees' working conditions and safety behaviors, including correction of unsafe behaviors;
- Engage employees in developing best practices for risk management;
- Foster robust employee-manager communication and motivation about safety;
- Conduct proactive injury/accident-reduction activities, including effective audits and reevaluations;
- Investigate and prepare timely reports for all types of safety-related events; and,
- Continuously develop best practices through safety training.

While DuPont has one of the world's lowest industrial-injury rates, most injuries and accidents that have occurred in the company have been caused by unsafe actions and behaviors, including management behaviors, McCabe said. For example, a line manager may give a directive that places an employee at greater risk.

"From our history of business competition in very hazardous industries, we have learned to employ our robust operating discipline — comparable to crew resource management in an aircraft — proactively recognizing interdependence and mutual accountability to keep each other safe. Our company safety culture, like our business culture, comprises the same elements of strong leadership, the right structure and action focused clearly on core values and critical operating tasks. When all members of the work force follow such leadership and truly feel this accountability from top to bottom, they integrate their efforts to achieve the safety goals."

Other corporate aircraft operators have become familiar with SMS concepts through common audit procedures. For example, the basis for audits under the International Standard for Business Aircraft Operations (IS-BAO) is a company's SMS, according to the International Business Aviation Council. The IS-BAO, introduced in 2002 as a voluntary code of best practices with accredited auditors (including Flight Safety Foundation auditors), requires that corporate flight departments implement an SMS to effectively manage risks.[32]

In summary, the proposed SARPs for ICAO Annex 6 are expected to influence how civil aviation authorities practice safety-risk management and how the implementation of an SMS by the accountable executive of an airline builds unprecedented synergy from current and future safety efforts. Meanwhile, the rapidly expanding literature of civil aviation authorities and safety specialists in several countries provides a clearer picture of the future for airlines that have an SMS — and examples of SMS implementation that airline senior managers can compare with their oversight of companywide risk-management activities. ■

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9. The draft *ICAO Safety Management Manual* said, "The Western world's approach to management is often based on an emotionally detached reality, which is considered to be 'scientifically' based. It assumes that human cultures in the workplace resemble the laws of physics and engineering, which are universal in application. This assumption reflects a Western cultural bias. … For safety management, understanding this context is an important determinant of human performance and its limitations. … People of different nationalities differ, for example, in their

response to authority, how they deal with uncertainty and ambiguity, and how they express their individuality. They are not all attuned to the collective needs of the group (team or organization) in the same way."

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28. FAA. Order 8040.4 *Safety Risk Management.* June 26, 1998. This policy says, in part, "The FAA shall use a formal, disciplined and documented decision-making process to address safety risks in relation to high-consequence decisions impacting the complete product life cycle. The critical information resulting from a safety risk management process can thereby be effectively communicated in an objective and unbiased manner to decisionmakers, and from decisionmakers to the public. All decisionmaking authorities within the FAA shall maintain safety risk management expertise appropriate to their operations, and shall perform and document the safety risk management process prior to issuing the high-consequence decision." In FAA terminology, a *high-consequence decision* is a "decision that either creates or could be reasonably estimated to result in a statistical increase or decrease in personal injuries and/or loss of life and health, a change in property values, loss of or damage to property, costs or savings, or other economic impacts valued at [US]$100 million or more per annum." A *product life cycle* is "the entire sequence from precertification activities through those associated with removal from service."

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Global Data Show Continued Reduction of Accident Rates for Large Commercial Jet Airplanes

Eight of the 17 hull-loss accidents during the first 11 months of 2005 involved no fatalities. Hull-loss accidents categorized as CFIT, approach and landing, and loss of control increased compared with the previous year.

— JAMES M. BURIN

The numbers of controlled-flight-into-terrain (CFIT) accidents and loss-of-control (LOC) accidents, the two biggest killers in civil air transport, increased in 2005 compared with 2004, but were still consistent with a long-term downward trend for hull-loss accidents[1] involving large Western-built, commercial jet airplanes worldwide. The influence of 2005 data on the trend for approach-and-landing accidents in the same airplane category was ambiguous.

Figure 1 (page 18) shows the hull-loss rates for CFIT,[2] LOC[3] and approach-and-landing[4] accidents for airplanes with maximum takeoff weights of more than 60,000 pounds/27,000 kilograms from 1993 through Nov. 30, 2005. Figure 1 also shows the long-term trends for the three accident categories using three-year moving averages.[5] (Because worldwide departure data were not available for Eastern-built airplanes — those built in the Soviet Union or the Russian Federation — accident rates were calculated only for Western-built airplanes.)

Nevertheless, the numbers of accidents in all three categories increased in the first 11 months of 2005 compared with 2004. In addition, there were 662 fatalities in hull-loss accidents, a large increase over the 165 fatalities for the same period in 2004.

There were 17 hull-loss accidents (of all types) involving large commercial jets worldwide in the first 11 months of 2005. (The accident totals include Eastern-built jets as well as Western-built jets.) They represented an increase from the numbers for 2003 and 2004, which were 15 and 16, respectively (Figure 2, page 19). The annual number of hull losses in the period 1993 through Nov. 30, 2005, was highest in 1993 (32 accidents), followed by 28 in 1996.

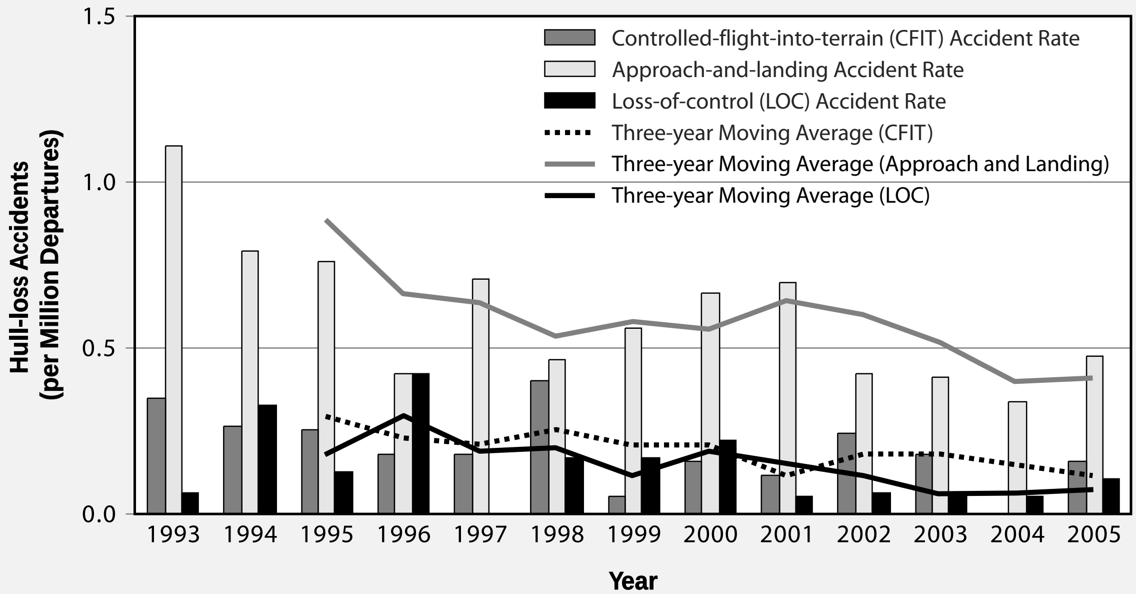
The rate of hull-loss accidents for Western-built jets from Jan. 1, 2005, through Nov. 30, 2005 — 0.83 per million departures — remained lower than in most of the 1993–2004 period, however. That rate varied from a high of 1.66 per million departures in 1993 to a low of 0.76 per million departures in 2004. The rate has been declining since 1999, when it was 1.17 per million departures.

Eight of the 17 (47 percent) hull-loss accidents (involving both Eastern-built and Western-built jets) occurring between Jan. 1, 2005, and Nov. 30, 2005, involved no fatalities. The remaining nine accidents (53 percent) accounted for the 662 fatalities. Five hull-loss accidents were responsible for 91 percent of the fatalities. They included a Boeing 737-200 accident during approach in Kabul, Afghanistan, on Feb. 3 (104 fatalities); a B-737-300 accident en route at Grammatikos, Greece, on Aug. 14 (121 fatalities); a McDonnell Douglas MD-82 accident en route at Machiques, Venezuela, on Aug. 16 (160 fatalities); a B-737-200 accident during takeoff at Medan-Polina, Indonesia, on Sept. 5 (102 fatalities); and a B-737-200 accident during the climb phase at Lissa, Nigeria, on Oct. 22 (117 fatalities).

The 60 CFIT hull-loss accidents from 1993 to Nov. 30, 2005, for both Eastern-built and Western-built jets, averaged five per year for the full years 1993–2004, shown in Figure 3 (page 19). The three CFIT accidents that occurred between Jan. 1, 2005, and Nov. 30, 2005, were an increase from 2004, in which there were none, but were fewer than in 2002 and in 2003. The highest annual numbers of CFIT hull-loss accidents occurred in 1998 (nine accidents) and in 1993 (eight accidents).

Figure 1

Controlled-flight-into-terrain, Approach-and-landing, and Loss-of-control Hull-loss Accident Rates, Western-built Commercial Jet Airplanes, 1993 Through Nov. 30, 2005



Note: Data are for Western-built commercial jets with maximum takeoff weights of more than 60,000 pounds/27,000 kilograms. Worldwide departure data were not available for Eastern-built aircraft.

Sources: Airclaims, AvSoft, Boeing Commercial Airplanes

The three CFIT hull-loss accidents occurring between Jan. 1, 2005, and Nov. 30, 2005, involved the B-737-200 at Kabul, Afghanistan; a B-707-300 at Entebbe, Uganda, on March 19, with no fatalities; and a B-737-200 at Pucallpa, Peru, on Aug. 23, with 40 fatalities.

Approach-and-landing hull-loss accidents (Eastern-built jets and Western-built jets) numbered 10 from Jan. 1, 2005, through Nov. 30, 2005 (Figure 4, page 20). Six of those 10 accidents caused no fatalities. The 10 represent an increase compared with six in 2004 and nine in 2003. The greatest annual number of approach-and-landing hull-loss accidents in the 12 years preceding 2005 was 18 in 1993.

The three CFIT hull-loss accidents in the first 11 months of 2005 were also categorized as approach-and-landing accidents, and were responsible for all but three of the fatalities in the approach-and-landing accident category. The other fatal approach-and-landing hull-loss accident involved a B-707-300 at Tehran, Iran, on April 20, with three fatalities.

Two LOC hull-loss accidents occurred from Jan. 1, 2005, through Nov. 30, 2005, one more than in each of the three previous years (Figure 5, page 20). They involved the MD-82 at Machiques, Venezuela, and the B-737-200 at Medan-Polina, Indonesia. ■

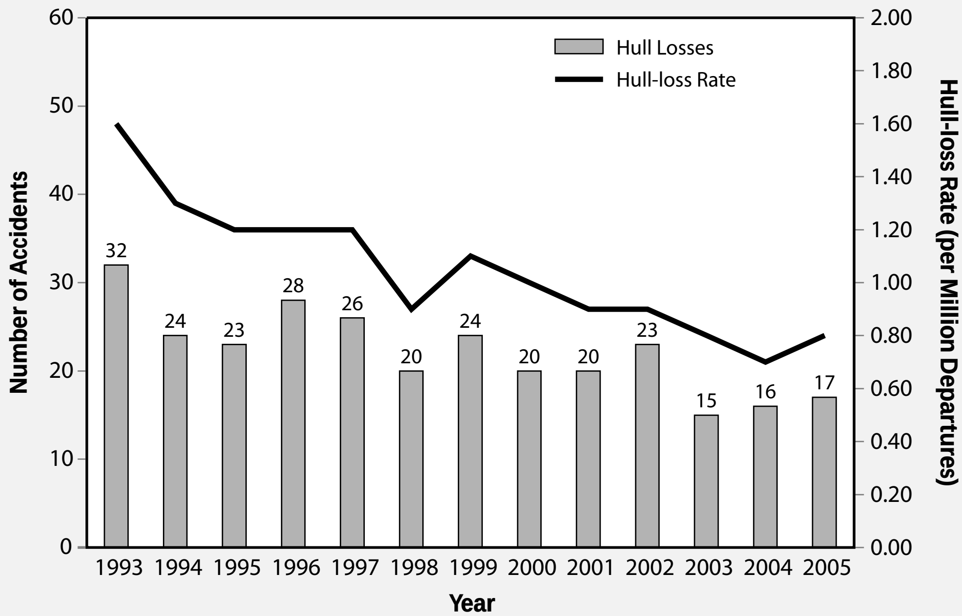
[FSF editorial note: James M. Burin is director of technical programs for Flight Safety Foundation. Data for this article were from sources including Airclaims, AvSoft, Boeing Commercial Airplanes, Honeywell and the Russian Federation Interstate Aviation Commission.]

Notes

1. Boeing Commercial Airplanes defines a *hull loss* as "airplane damage that is substantial and is beyond economic repair. Hull loss also includes events in which [the] airplane is missing; search for the wreckage has been terminated without it being located; [or the] airplane is substantially damaged and inaccessible."
2. *Controlled flight into terrain* (CFIT), as defined by the Flight Safety Foundation CFIT Task Force, occurs when an airworthy aircraft under the control of the flight crew is flown unintentionally into terrain, obstacles or water, usually with no prior awareness of the crew.
3. For this article, a *loss of control accident* was defined as "an accident in which an aircraft is unintentionally put into an unrecoverable position due to either flight-crew, aircraft or environmental factors, or a combination of these factors."
4. The *approach-and-landing phase of flight* begins when an airworthy aircraft under the control of the flight crew descends below 5,000 feet above ground level (AGL) with the intention to conduct an approach and ends when the landing is complete or the flight crew flies the aircraft above 5,000 feet AGL en route to another airport.
5. A *moving average* is an average that is recomputed periodically in a time series by including the most recent data and eliminating the oldest data.

Figure 2

Hull-loss Accidents and Rates, Commercial Jet Airplanes, 1993 Through Nov. 30, 2005

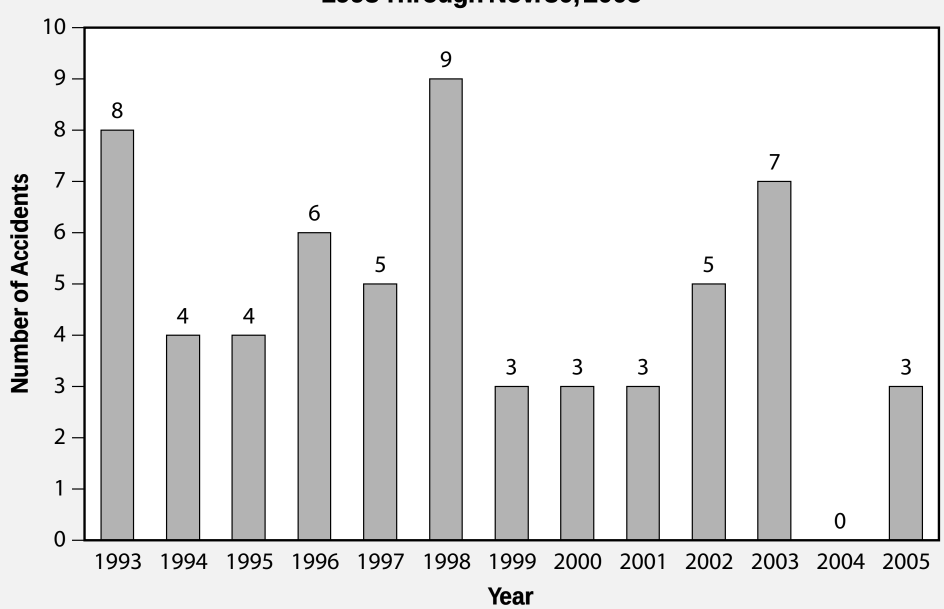


Note: Accident-rate data are for Western-built commercial jets with maximum takeoff weights of more than 60,000 pounds/27,000 kilograms. Worldwide departure data were not available for Eastern-built aircraft. Accident data are for Eastern-built and Western-built commercial jets in the same weight category.

Sources: Airclaims, AvSoft, Boeing Commercial Airplanes

Figure 3

Controlled-flight-into-terrain Hull-loss Accidents, Commercial Jet Airplanes, 1993 Through Nov. 30, 2005

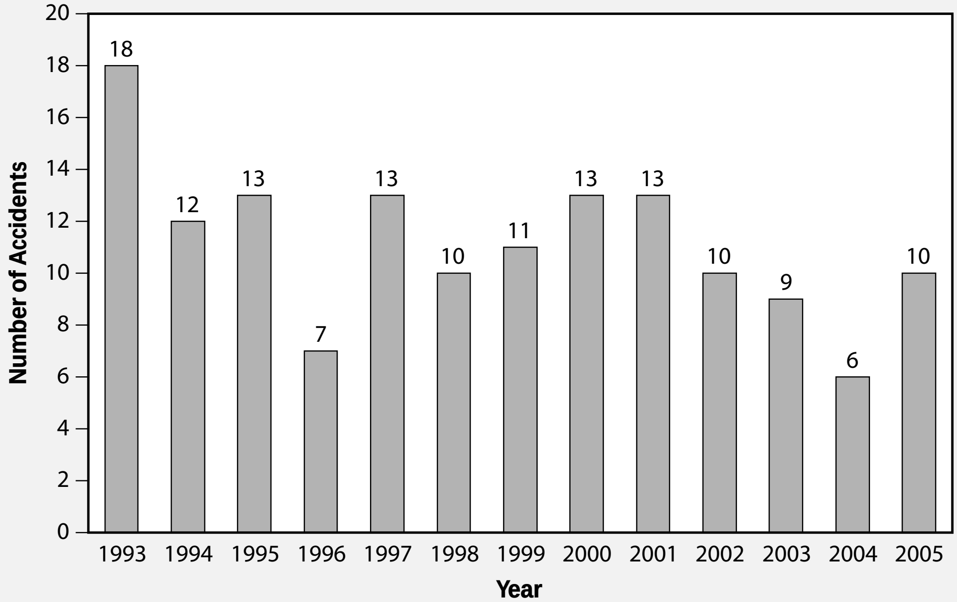


Note: Data are for Eastern-built and Western-built commercial jets with maximum takeoff weights of more than 60,000 pounds/27,000 kilograms.

Sources: Airclaims, AvSoft, Boeing Commercial Airplanes, Honeywell, Russian Federation Interstate Aviation Commission

Figure 4

Approach-and-landing Hull-loss Accidents, Commercial Jet Airplanes, 1993 Through Nov. 30, 2005

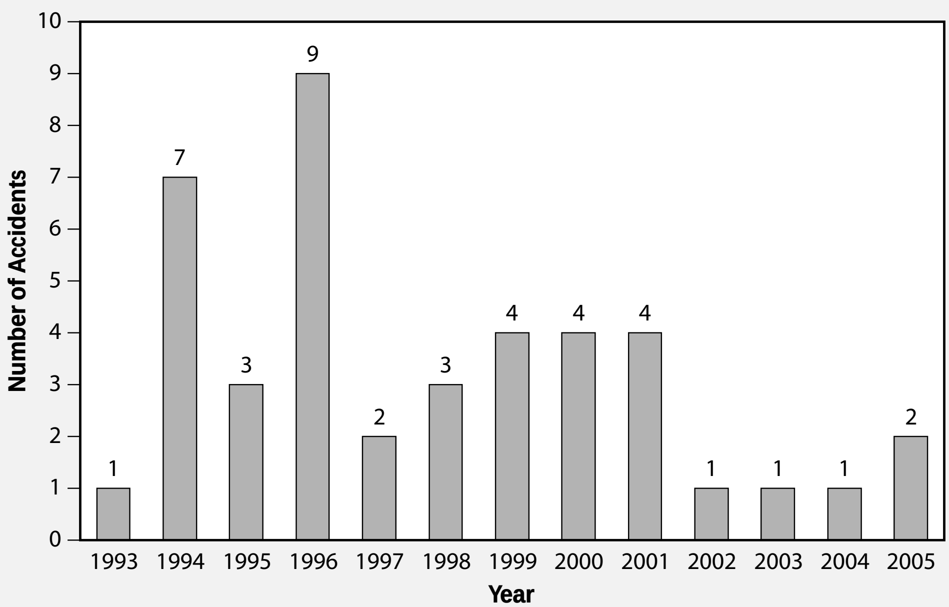


Note: Data are for Eastern-built and Western-built commercial jets with maximum takeoff weights of more than 60,000 pounds/27,000 kilograms.

Sources: Airclaims, Boeing Commercial Airplanes, Russian Federation Interstate Aviation Commission

Figure 5

Loss-of-control Hull-loss Accidents, Commercial Jet Airplanes, 1993 Through Nov. 30, 2005



Note: Data are for Eastern-built and Western-built commercial jets with maximum takeoff weights of more than 60,000 pounds/27,000 kilograms.

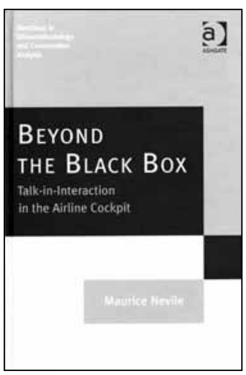
Sources: Airclaims, Boeing Commercial Airplanes, Russian Federation Interstate Aviation Commission

STATS

Cockpit Talk Offers Keys to Understanding Pilot Interaction

The social interaction among pilots in the cockpit establishes identities, coordinates talk activity and non-talk activity, and integrates cockpit communication with communication from controllers.

— FSF LIBRARY STAFF



Books

Beyond the Black Box: Talk-in-Interaction in the Airline Cockpit. Nevile, Maurice. Aldershot, England: Ashgate, 2004. 264 pp. Figures, references, index, glossary.

How pilots talk to, and interact with, one another determines how well they establish what is going on in their environment, who is doing what and the next actions they will perform.

"[This book] explores how, through processes of 'talk-in-interaction,' pilots develop and make available to one another their situated and moment-to-moment understandings as they work together as a flight crew to perform necessary activities and tasks to fly their plane," the author says. "The term 'talk-in-interaction' reflects an interest here in not just talk, that is, verbal aspects of interaction, but pilots' use of a range of available resources as they make, and interpret as meaningful, contributions to their ongoing work together."

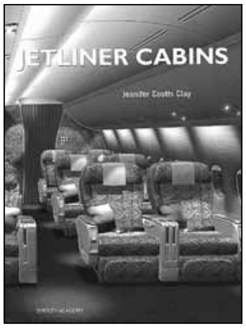
The book's title reflects the author's intention to explore cockpit interaction at normal times, not just in the crisis situations recorded by the cockpit voice recorder (popularly called the "black box") before an accident.

"This book asks, 'How is an accountably adequate airline flight produced and recognized?'" the author says. "In responding to this question, the book shows how every airline flight is not just a mechanical and technological triumph, and some would say miracle, but is also the outcome of human performance: Every airline flight is an interactional accomplishment."

The frequent transcriptions of cockpit communications go well beyond the conventions of accident reports, in which the time is followed by an identification of the speaker and the words spoken. A system developed for conversational analysis is used in the book's transcriptions to show additional dimensions of the talk, such as inflections, speed, length of pauses and overlapping talk (see "Analysis of Crew Conversations Provides Insights for Accident Investigation," *Flight Safety Digest*, October 2005).

Part I of the book examines the question of how cockpit identities are established through *pronominal language*. That is, pilots' choice of personal pronouns — such as "you" and "your" versus "we" and "our" — presents their understanding of "who's who" in the cockpit as they perform tasks.

In Part II, based in part on cockpit video recordings, the author discusses how pilots coordinate their talk with their non-talk activities.

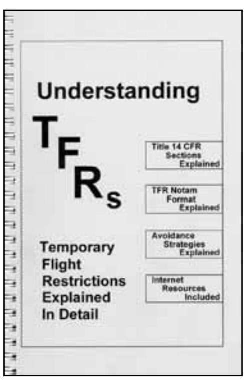


"Part II reveals the extraordinary precision with which pilots coordinate these non-talk activities with their talk, and explores the significance of this precise coordination for the conduct of their work as airline pilots," says the author.

Part III "looks at how pilots integrate their talk within the cockpit, to each other, with their talk beyond the cockpit, to air traffic controllers," the author says. "Although they are physically and visibly removed from the cockpit, controllers are nevertheless relevant participants in cockpit talk-in-interaction, and their contributions can directly impact upon the pilots' work."

A final chapter discusses possible specific implications of the findings for the commercial aviation industry, for related research fields such as human factors and for accident investigation.

"It is a sobering thought, for researchers and passengers alike, that airline pilots must necessarily simultaneously engage in the skilled performances of both interaction and piloting a plane," the author says. "Just how they do so is the interest of this book."



Understanding TFRs. Miller, Jerry. Montoursville, Pennsylvania, U.S.: Find-it Fast Books, 2005. 42 pp.

In the United States, airspace may be closed to traffic under temporary flight restrictions (TFRs) authorized by U.S. Federal Aviation Regulations (FARs) Part 91, *General Operating and Flight Rules*. TFRs are imposed for a limited time because of unusual conditions. These can include security concerns, stadiums where sports contests or special events are taking place, disaster-relief areas, the proximity of the president or vice president, and military operations.

This spiral-bound booklet explains the various rationales for TFRs; describes how to interpret the format of a notice to airmen (NOTAM) that establishes a TFR; describes the eight types of TFRs; and lists numerous Internet resources concerning TFRs. There is also a section on special use airspace where restrictions are permanent, such as the Washington, D.C., air defense identification zone and the flight-restricted zone.

Jetliner Cabins. Clay, Jennifer Coutts. Chichester, England: Wiley-Academy, 2004. 192 pp. Figures, bibliography, index, photographs.

For the passenger who must spend many continuous hours in an enclosed space, the design of an airliner cabin and its seating can have a profound effect on the quality of the experience.

This volume, replete with color photographs, describes the ways in which airlines from the 1980s through the early 21st century have attempted to please their customers through cabin appearance and amenities.

Most passengers will never see a first-class cabin except while passing through during boarding or exiting the airliner, but those who do, as shown in this book, travel in as much luxury as décor, service and technology can provide. The author says that features introduced in recent years include "cabin environments that are lighter, fresher and more gracious; the installation of 'furniture' that is both useful and elegant — for example, work tables, bars, consoles and sideboards; galleys that are more efficient and offer healthier food and beverage choices; [and] an increase in storage options for passengers' carry-on articles." Probably the most popular upgrade, though, is fully reclining seats that become much like actual beds, set in individual pods.

First-class travel is largely a perquisite for loyal customers who have accumulated many frequent-flier miles, but business class (or a first/business hybrid in two-class service) is the most important revenue producer for many long-haul airlines, the author says. Here, too, carriers have called on their designers' ingenuity.

"When customers buy business-class tickets, they expect to be able to travel in *comfort*," says the author. "In the business-class cabin, they want to feel free to manage their flying time effectively, and to do this, they require a reasonable amount of space where they can work, sleep, eat and relax."

Some of the first-class cabin features, in a slightly less grand format, are now standard in business or hybrid cabins: well-upholstered seats that allow stretching out and in some cases completely reclining; and many types of passenger-commanded adjustments for lumbar support, calf support, leg rest and in-seat gooseneck reading lights. Airlines also have installed elaborate entertainment systems, self-service bars and business workstations.

Because of airline-business economics and the laws of physics, economy-class passengers will probably never obtain the upgrade most would choose above all others — increased seat pitch (i.e., the distance between a point on one seat and the equivalent point on the seats forward and aft). Nevertheless, even in the "back of the plane," recent innovations have included individual seat-back entertainment monitors with multiple channels; winged, adjustable headrests; toiletry kits; improved seat contouring; and, the author says, "imaginative meal options that go beyond the old-style 'leather or feather' — that is, beef or chicken."

The book also discusses and illustrates cabin lighting designs, including "mood lighting" that varies during the flight ("from dawn to dusk and from restaurant to lounge"); meal presentation; accessibility for handicapped passengers; the growing use of leather seat covers; new carpet materials and treatments; and what are known in airline customer-service departments as "minor miscellaneous items," such as headrest covers, blankets, cushions, children's play items and cocktail napkins.

Changing fashions in cabin interiors also get their due. The author says that in the past 20 years, the once-prevalent earth tones, reds and oranges have given way to the widespread use of blue.

Reports

Fatality and Injury Rates for Two Types of Rotorcraft Accidents. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-05/17. Final report. October 2005. Palmerton, David. 9 pp. Figures, tables, references. Available via the Internet at <www.faa.gov/library/reports> or through the National Technical Information Service.*

The report is based on a study analyzing helicopter accidents involving fatalities and injuries to determine if certain types of accidents are inherently more dangerous because of factors related to rapid-evacuation capability. Four categories of accidents were analyzed: those involving a fire, those not involving a fire, those in which the helicopter rolled over and those in which no rollover occurred. Analysis focused on the differences between rollover accidents versus non-rollover accidents and fire accidents versus non-fire accidents. The study sample included 2,704 accidents, including 662 injury accidents and 320 fatal accidents, drawn from the FAA Accident/Incident Data System.

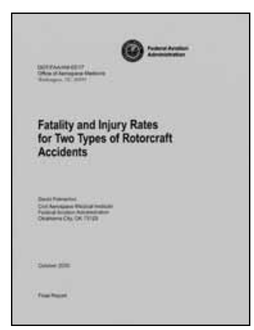
Researchers hypothesized that rollover accidents create evacuation delays that produce more fatalities, particularly in situations involving a rollover and a post-accident fire, because evacuation delays tend to expose occupants to toxic fumes for a longer time than if the rotorcraft remains upright.

The study found, however, that rollover accidents produced a higher injury rate and non-rollover accidents produced a higher fatality rate.

"It appears as if the no-rollover condition produces greater impact forces, preventing the rotorcraft from bouncing and rolling; consequently, the higher fatality rate," said the report.

There was a higher fatality rate in accidents involving fire than in those not involving fire, but there was essentially no difference in the injury rate.

"The reason fire produced more fatalities, but not injuries, is not immediately obvious, although a likely explanation would be that the impact/rollover forces primarily injured occupants, while accidents involving post-crash fires included the effects of both crash dynamics and the heat/toxic byproducts associated with the fire," said the report.


Federal Aviation Administration

Fatality and Injury Rates for Two Types of Rotorcraft Accidents

Regulatory Materials

Mandatory Requirements for Airworthiness. U.K. Civil Aviation Authority (CAA). Civil Aviation Publication (CAP) 747. Issue 2. Aug. 31, 2005. 421 pp. Tables. Available via the Internet at <www.caa.co.uk> or from The Stationery Office.**

A CAP is the primary means by which CAA notifies operators of the continuing airworthiness requirements with which operators of U.K.-registered aircraft must comply. Issue 2 provides a single point of reference for all mandatory information on continuing airworthiness, including airworthiness directives (ADs).

The latest iteration of this CAP includes amendments through Amendment 8/2005 (August 2005). Additional products and amendments to reflect manufacturers' products have been included in Section 1, Part 2; one AD has been revised in Section 1, Part 3A; two new ADs have been added to Section 2, Part 3B; and Appendix 1, Generic Requirement no. 12 has been deleted because it is now superseded by a European Aviation Safety Agency (EASA) policy letter.

Runway Length Requirements for Airport Design. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5325-4B. July 1, 2005. 42 pp. Figures, tables, appendixes. Available from the U.S. Department of Transportation.***

The standards and guidelines in the AC are FAA recommendations for use in the design of civil airports, but are mandatory for airport projects funded by the U.S. government.

"Airplanes today operate on a wide range of *available* runway lengths," the report says. "Various factors, in turn, govern the *suitability* of those available runway lengths, most notably airport elevation above mean sea level, temperature, wind velocity, airplane operating weights, takeoff and landing flap settings, runway surface condition (dry or wet), effective runway gradient, presence of obstructions in the vicinity of the airport and, if any, locally imposed noise-abatement restrictions or other prohibitions."

Chapters include guidance about runway lengths for airplanes with maximum takeoff weights less than 12,500 pounds (5,670 kilograms), airplanes with maximum takeoff weights from 12,500 pounds to and including 60,000 pounds (27,216 kilograms), and airplanes with maximum takeoff weights more than 60,000 pounds. Aspects of design rationale such as landing flap settings, airport elevation, temperature, wind and runway-surface conditions are discussed.

[This AC cancels AC 150/5325-4A, *Runway Length Requirements for Airport Design*, dated Jan. 29, 1990.]

Transport Canada Civil Aviation Guidelines: Maintenance Control Manuals. Transport Canada TP 14408E. Aug. 1, 2005. 42 pp. Appendix. Available from Transport Canada.****

A maintenance control manual (MCM) is developed by an aircraft operator to describe how it will comply with Canadian Aviation Regulations (CARs). The MCM is a Transport Canada–approved document that contains information to ensure the efficiency of the maintenance control system.

This guidance document is intended to help operators write an MCM by identifying which regulations must be addressed, explaining the intent of the regulations and providing practical examples.

A typical explanation is that for CAR 726.08(1)(c), *Description of air operator*: "The description of the organization must include the size, location of facilities, aircraft operated and what type of service is offered to the public. This is helpful to determine if the policies contained in the manual are appropriate with the size and complexity of the operation."

Nouvelles Procédures de Radiotéléphonie Dans L'espace Français Métropolitain (*New Radiotelephone Procedures in French Metropolitan Airspace*). Direction Générale de l'Aviation Civile (DGAC) AIC A 16/05. Oct. 6, 2005. 2 pp. In French. Available from Service de L'Information Aéronautique.*****

Following the establishment of very-high-frequency (VHF) communication channels at 8.33 kilohertz (kHz) in French metropolitan airspace above Flight Level (FL) 245 (about 24,500 feet), some users encountered procedural problems. These included (1) confusion between the terms "frequence" and "canal" (frequency and channel) and (2) uncertainty about how to enter a six-digit frequency when the VHF equipment permitted entry of only five digits — for example, how to distinguish between 132.050 and 132.055.

To resolve these problems, the International Civil Aviation Organization (ICAO) published an amendment to Annex 10 (Volume II, section 5.2.1.7.3.4) that became effective on Nov. 24, 2005.

This DGAC document describes the procedures based on that amendment, and is intended for the use of air traffic controllers and airspace users.

Specification L-854, Radio Control Equipment. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5345-49B. Sept. 15, 2005. 22 pp. Tables. Available from the U.S. Department of Transportation.***

This AC provides specifications for the equipment in radio control systems to be used for remote control of airport lighting facilities from aircraft, from a ground location or from both. The system elements include radio receivers, radio transmitters, encoders and decoders.

Specifications for three types of L-854 systems are included: Type I (air-to-ground), Type II (ground-to-ground) and Type III (air-to-ground and ground-to-ground).

[This AC cancels AC 150/5345-49A, dated Aug. 8, 1986.]

Specification for Discharge-type Flashing Light Equipment. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5345-51A. Sept. 19, 2005. 28 pp. Tables. Available from the U.S. Department of Transportation.***

This AC includes specifications for discharge-type flashing-light equipment used in runway-end identifier lights (REILs) and for an omnidirectional approach-lighting system (ODALS).

Among the changes in this version of the AC are the addition of new types to designate systems that can be operated from an airport 120-volt/240-volt alternating current (AC) circuit; the addition of new types to designate systems that can be operated from a 6.6-ampere constant-current series circuit; expanded criteria for control voltages; revised lightning-protection criteria; upgraded environmental tests; and others.

[This AC cancels AC 150/5345-51, Change 1, dated Jan. 4, 1982.]

Safety and Interoperability Requirements for Initial Domestic Flight Information Service–Broadcast. U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 20-149. Aug. 31, 2005. 17 pp. Figure, appendixes. Available from the U.S. Department of Transportation.***

This AC supports the introduction and use of flight information service–broadcast (FIS-B) weather data link products and other aeronautical data link products for enhanced situational awareness. The document identifies safety requirements and interoperability requirements for continued airworthiness of aircraft FIS-B systems.

The AC is intended for manufacturers and installers of FIS-B equipment and software, FIS providers, applicants for FAA design approval of FIS-B systems and FAA aircraft certification office staff who evaluate FIS-B systems. The document supplements AC 20-140, *Guidelines for Design Approval of Aircraft Data Link Communications Equipment.* ■

Sources

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

** The Stationery Office (TSO)
P.O. Box 29
Norwich NR3 1GN U.K.
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*** U.S. Department of Transportation
Subsequent Distribution Office, M-30
Ardmore East Business Center
3341 Q 75th Ave.
Landover, MD 20785 U.S.
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Captain's 'Irrational' Performance Prompts Call for Stress Training

The incident report said that the pilot failed to establish a stabilized approach and that he conducted a landing with excessive airspeed and with an incorrect flap setting.

— FSF EDITORIAL STAFF

The following information provides an awareness of problems through which such occurrences may be prevented in the future. Accident/incident briefs are based on preliminary information from government agencies, aviation organizations, press information and other sources. This information may not be entirely accurate.

AIR CARRIER

Flight Occurred on Captain's Last Day of Work

Boeing 737. No damage. No injuries.

The flight from England to Sweden, "from the passengers' point of view, was uneventful," the incident report said.

Nevertheless, from the beginning of the descent until touchdown, the airplane "was operated at times outside normal operator and manufacturer's parameters," and the landing was conducted above the recommended airspeed and with an incorrect flap configuration, the report said.

The report said that the captain was the pilot flying (PF) and that this was his last day of work for the operator before he was to return to his native Australia.

"The flight continued normally as programmed in the flight management computer (FMC) until top of descent (TOD) was reached," the report said. "The mode control panel (MCP) attitude selector would normally be set to descent, but the PF inexplicably maintained 'ALT HOLD,' which effectively kept the aircraft at its cruise level."

The PF later said that after he had begun the descent and had flown the airplane to Flight Level 100 (approximately 10,000 feet), he recognized that the airplane was "high above the standard profile" and increased the rate of descent.

"The PNF [pilot not flying] recalled that this nose-down pitch angle may have exceeded 10 degrees with an accompanying increase in airspeed, up to 270 knots … , with flap 5 selected," the report said. "Concurrently, the ground-proximity warning system (GPWS) alarm sounded once, and later a second time, during the latter part of the approach."

The PF said that although the PNF "brought the excess in speed to his attention several times," he continued to believe that he "would be able to rescue the approach." He failed to achieve a stabilized approach, and airspeed at touchdown was about 180 knots — 30 knots to 40 knots higher than the normal touchdown speed. The high airspeed precluded use of more than flap 10. After taxiing to the gate (stand), the PNF said that the flaps should be inspected or checked, and the PF replied, "No, I'll look at them." After the flight, the crew made no logbook entries that might have resulted in an investigation of whether any structural limit exceedances had occurred and no report to the company operations department.

The captain continued as PF for the return flight to England, which the PNF described as normal and in compliance with standard operating procedures.

Later, the captain told investigators that he decided incorrectly to begin the approach and then to continue the approach. He said that he "did not have the excess mental capacity to timely correct the error" and that his inability to concentrate was "directly attributable to physiological and psychological fatigue," the report said.

"He added that he was having marital difficulties during the previous six months and his family had returned to Australia," the report said. "He was based in the [United Kingdom] at the time, and this separation event played heavily on his mind during this period, affecting … his ability to eat and sleep normally. Two days before the incident flight, a further marital disagreement occurred, which did not help matters … . He [said that he] now knows that he 'should have called ill for the flight, but at the time, I didn't want to let down the company, and on the day, you always think you will be fine.'"

He apologized to the operator and to the PNF, and said that his mistakes were "not deliberate" and that in his 4 1/2 years with the operator, he had "never had a report, never mind an incident."

The captain also said, "I cannot understand, myself, how it was possible for me to show such poor judgment. I can only imagine that certain personal stresses and tiredness affected my ability to think rationally. I do not offer this as an excuse but merely an insight into my deficiency for logical thought."

The report said, "The behavior of the PF on the descent … was irrational, contrary to all his flight [training] and CRM [crew resource management] training and inexplicable, even to himself at the time."

As a result of the investigation, the Irish Air Accident Investigation Unit recommended that the operator "develop a CRM training module emphasizing the insidious nature of stress as it affects the performance of a pilot's flying capabilities. This should also include the recognition of pilot subtle incapacitation and intervention to highlight the necessary level of assertiveness required, particularly on the part of first officers when the captain is the pilot flying."

The operator began developing the recommended training module "immediately after this event," the report said.

Increasing Cabin Altitude Prompts Emergency Landing

Airbus A321. Minor damage. No injuries.

Twelve minutes after takeoff from an airport in England on a flight to Ireland, as the airplane was being flown through approximately 26,600 feet, the captain observed that the indicated cabin altitude was 9,500 feet. He called air traffic control and leveled the airplane, but the cabin altitude indication increased to 10,000 feet. The captain donned his oxygen mask and requested a descent to Flight Level (FL) 200 (approximately 20,000 feet).

A cabin-pressure warning appeared on the electronic centralized aircraft monitor (ECAM) as the depressurization continued. The crew performed recall/memory actions in accordance with the quick reference handbook and the flight crew operations manual, the first officer donned his oxygen mask, and the captain requested a descent to FL 100.

At FL 100, the ECAM warning cleared, the flight crew removed their oxygen masks and the captain briefed the flight attendants and passengers (passenger oxygen masks had not deployed because cabin altitude had remained below 14,000 feet) and told them that the flight was being diverted to an airport in Wales.

After a normal landing, maintenance personnel inspected the airplane and found that a metal clamp that attached the forward bellows to the left air conditioning condenser unit was broken and that the bellows had separated from the condenser unit and had ruptured. In addition, the pack outlet check valve was broken, and the blowout panel was open, the report said. (The blowout panel is designed to open if an "overpressure condition" occurs in the air conditioning bay during flight.)

The investigation found that, during the previous flight, the crew had heard a noise from the forward hold area, and ground personnel had observed that the blowout panel was open. The panel was reset, and the airplane was released for the incident flight.

"A more exhaustive search on the ground could have revealed the loose bellows and broken clamp," the report said.

The report said that causes of the incident were the fractured clamp, which "set up an oscillation in the airflow through the pack outlet check valve, which caused the valve flap to impinge on the valve stops. Foreign inclusions in the flap casting were a contributing factor [to] its subsequent fracture and failure."

The failure of the ground inspection before the incident flight to identify the ruptured bellows also was cited as a cause.

AIR TAXI/COMMUTER

Inspection Reveals Missing Elevator Rivets

Raytheon Beech 1900D. Minor damage. No injuries.

Daytime visual meteorological conditions prevailed for the takeoff from an airport in the United States. The captain said that during the takeoff roll, when the airspeed reached 100 knots and the first officer said "V_1, rotate," the captain pulled on the control yoke with both hands and the yoke did not move. (V_1 is defined in part by the U.S. Federal Aviation Administration as "the maximum speed in the takeoff at which the pilot must take the first action [e.g., apply brakes, reduce thrust, deploy speed brakes] to stop the airplane within the accelerate-stop distance.")

"The captain then pulled significantly harder, and the yoke moved quickly aft," the preliminary accident report said. "The airplane 'jumped' into the air, but the captain was able to maintain controlled flight."

The captain said that throughout the 28-minute flight, the elevator trim continued to move toward a nose-up position; as a result, the flight crew increased nose-down trim "every one [minute] to two minutes," the report said. The report said that the landing at the destination airport was uneventful.

Preliminary examination of the airplane found that "several rivets were missing at the right side elevator hinge point," the report said. The investigation was continuing.

Lightning Strikes Airplane in Traffic Pattern

Embraer EMB 145EP. Minor damage. No injuries.

The airplane was being flown from Scotland to England when the captain observed "weak returns of cumulonimbus cloud activity" on the airplane's weather radar. The captain maneuvered the airplane — primarily by visual means — to avoid the weather.

He received radar vectors to enter the downwind leg of the traffic pattern at the destination airport, and "just as the aircraft entered cloud," it was struck by lightning. The airplane was at 7,000 feet, and conditions included neither turbulence nor significant precipitation, the report said.

The first officer then observed a left engine overtemperature indication, and both flight crewmembers said that operating parameters for the left engine were decreasing. There were no warning indications, they said.

After telling air traffic control about their difficulties, they performed checklist procedures for engine failure and single-engine approach, and conducted a single-engine landing.

Examination of the airplane revealed lightning strike damage on the left side of the airplane. A borescope examination of the left engine was conducted, and the two full-authority digital engine control (FADEC) units were removed and replaced. The two FADEC units were inspected and found to be undamaged. The engine performed normally during a test.

"Since post-incident testing and examination of the engine revealed no mechanical damage which was likely to have made it prone to surging, the only reasonable explanation for the initial reduction of N_1 [low-pressure rotor (or fan) speed] coincident with the increase in fuel flow is a disruption of the intake airflow," the report said. "The subsequent continuing reduction in spool speeds … led to an automatic engine shutdown."

Faulty Compressor Blamed for Cabin Smoke

De Havilland DHC-8 Dash 8. No damage. No injuries.

During takeoff from an airport in Scotland, the takeoff warning horn sounded, and the flight crew rejected the takeoff. The pilots taxied the airplane off the runway and checked all settings and selections, which were correct for takeoff.

As they taxied for another takeoff attempt, the flight crew and cabin crew detected a burning odor, and the cabin crew saw smoke in the cabin. The captain stopped the airplane on the taxiway, and passengers deplaned using the forward passenger door.

An examination of the engine found that a piece of the right engine compressor inner support had separated; as a result, a compressor oil seal was damaged and oil contaminated the engine bleed air.

After the accident, the engine manufacturer issued a service bulletin to require borescope inspections of compressor inner supports. If an inspection reveals cracks, the engine must be re-inspected within 65 operating hours; if an inspection reveals a missing piece, the engine must be replaced, the report said. In addition, the compressor inner supports have been redesigned "in an attempt to reduce the fretting and vibration which may have led to cracking of the original component," the report said.

The investigation found no cause for activation of the takeoff warning horn.

Airplane Strikes Terrain During Go-around in IMC

Short Brothers SD3-60. Substantial damage. Two serious injuries.

The airplane was being flown on the fourth leg of a six-leg charter cargo flight to airports in Canada and the United States. The fourth leg involved an approach in night instrument meteorological conditions (IMC) to an airport in Canada.

The crew conducted a localizer back course approach. The captain took control from the first officer when the airplane was three nautical miles to four nautical miles (six kilometers to seven kilometers) from touchdown because the first officer "had difficulty maintaining the back course localizer," the accident report said. The crew landed the airplane about 2000 local time, about one-third of the way down the snow-covered runway. After touchdown, the captain selected full reverse thrust and observed that braking action was poor and that the airplane was not decelerating as quickly as the crew had expected.

"[The captain] observed the end of the runway approaching," the report said. "After five [seconds] to eight seconds of full-reverse application, he called for a go-around, and the power levers were advanced to maximum takeoff power.

"With little runway remaining and without referencing the airspeed indicator, the captain rotated to a takeoff attitude; the aircraft became airborne prior to the end of the runway. The captain attempted to fly the missed approach; however, after the aircraft flew past level terrain at the end of the runway, it descended and the tail struck the airport perimeter fence."

The airplane then struck the ground and a line of trees.

An investigation found that the crew had conducted the approach using 15 degrees of flap, in accordance with outdated company advice that had been superseded by a revision issued two months before the accident, which provided for a slower, flap-30 approach.

The report said that the crew "most likely did not reference the AFM [aircraft flight manual] performance chart 'Effect of a Slippery Surface on Landing Distance Required' to determine that landing the aircraft on the 4,000-foot [1,220-meter], snow-covered runway with flap-15 was inappropriate."

When the captain applied full reverse thrust, he "was no longer operating the aircraft in accordance with the AFM, as reverse thrust is authorized for ground maneuvering only," the report said. "With the runway end lights rapidly approaching, he called for a go-around at a point on the runway where it would have been prudent to continue full braking and remain on the ground."

The report said, in its findings on causes and contributing factors, that the crew "planned and executed a landing on a runway that did not provide the required landing distance" and "most likely did not reference the AFM] performance chart … to determine that landing the aircraft on the 4,000-foot snow-covered runway with flap-15 was inappropriate."

The report cited three other causes and contributing factors:

- The captain, "after landing long on the snow-covered runway and applying full reverse thrust … attempted a go-around [and] rotated the aircraft to a takeoff attitude, and the aircraft became airborne in ground effect at a slower-than-normal speed;
- "The aircraft had insufficient power and airspeed to climb and remained in ground effect until striking the airport perimeter fence, rising terrain and a line of large cedar trees; [and,]
- "The flight crew conducted a flap-15 approach, based on company advice in accordance with an all-operator message (AOM) issued by the aircraft manufacturer to not use flap 30. This AOM was superseded … by AOM no. SD006/04, which canceled any potential flap-setting prohibition."

Ground Loop Follows Landing in 'Erratic Winds'

Piper PA-46-500TP Meridian. Substantial damage. No injuries.

The pilot said that he was conducting a visual approach to Runway 11 at an airport in the United States when the pilot of the twin-engine airplane preceding him conducted a go-around because of "erratic winds" at the approach end of the runway. The pilot of the accident airplane said that he also decided to conduct a go-around because of the wind.

"During the second approach, he became distracted maintaining a safe distance from the [other airplane]," the accident report said. "He said that during the landing, the winds shifted from a right crosswind to a left crosswind and then to a left-quartering tail wind."

The pilot said that he overcorrected for the airplane's drift to the left during the touchdown and landing roll. The airplane rolled off the runway to the right and ground-looped.

An aviation routine weather report (METAR) about 20 minutes before the accident and 30 nautical miles (56 kilometers) east of the accident site reported winds from 110 degrees at 10 knots; one hour before the accident, the winds were from 110 degrees at 11 knots, gusting to 15 knots. Thirty nautical miles northeast of the accident site, a METAR about 20 minutes before the accident reported winds from 140 degrees at 12 knots; one hour before the accident, winds were from 180 degrees at 13 knots, gusting to 17 knots.

The accident pilot said that during the approach and landing, there were cloud "buildups in the area, and turbulence was continuous, light to moderate."

Pilot Cites Hydroplaning in Go-around Accident

Cessna 525ACJ2. Substantial damage. No injuries.

Daytime visual meteorological conditions prevailed for the flight to an airport in the United States, and an instrument flight rules flight plan had been filed. The pilot said that he had obtained a weather briefing for the destination airport and that no rain was forecast. As he began a descent to 11,000 feet, the automated weather observing system (AWOS) did not mention rain.

When he requested a visual approach, the air traffic controller told him that "there was weather to his front" and instructed him to intercept the localizer to Runway 32, the accident report said. The pilot observed rain showers on his weather radar display, told the controller that he did not want to continue the visual approach and received clearance for the localizer approach. When the airplane was five nautical miles (nine kilometers) from the runway, the pilot observed rain showers crossing the final approach course. The pilot slowed the airplane to 115 knots and flew the airplane through the rain; the airplane touched down at the 1,000-foot marker.

As the pilot extended the flaps to 60 degrees and applied the brakes, the airplane began to hydroplane and drift right. The pilot initiated a go-around with 2,300 feet (702 meters) of runway remaining. The airplane became airborne about 300 feet (92 meters) before the end of the runway, climbed slowly and struck the localizer antennas. The pilot flew the airplane to traffic pattern altitude, conducted a low pass and asked airport personnel if they could see any obvious damage; no damage was apparent, and he conducted a normal landing.

Airport officials said that the 5,500-foot (1,678-meter) runway was in good condition and was crowned (higher) along the centerline to facilitate drainage. The runway was not grooved.

Door Separates During Flight

Raytheon Beech B300 Super King Air. Minor damage. No injuries.

During descent from Flight Level (FL) 220 (approximately 22,000 feet) after a flight in Australia, as the pilot flew the airplane through FL 175, he heard "a loud muffled thud and then air noise" and saw that the cabin door had separated from the airplane, the incident report said.

The cabin-door warning light illuminated, and the cabin oxygen masks deployed. The pilot, assisted by a safety pilot, performed emergency checks and landed the airplane at an airport.

The door was found in a paddock five days after the incident. The report said that the external door handle was not in the locked position, and the latch bolts were not fully extended. Before takeoff, the safety pilot had checked the locking mechanism and had reported no problems.

The locking-mechanism indicating system included green-line indicators on each forward latch bolt and rear latch bolt; alignment of the green-line indicators with stationary arrowhead symbols indicated that the door was locked.

The report said, "It was possible to move the door-locking handle to a high-resistance position, where the green-line indicators on the latch bolts appeared to line up with the stationary arrowheads in the inspection windows, but the door-locking mechanism was not fully engaged. At that position, if the top latch-hook sense switch was short-circuited due to the proximity of the sense-switch terminal and the mounting nut, the door warning light would be extinguished. This condition would provide the crew with no indication that the door was not correctly locked."

Airplane Strikes Terrain During Special VFR Departure

Centre Est Aeronautique DR250. Destroyed. Two fatalities.

The airplane was being flown at midday from Ireland to Belgium, and the pilot had obtained a special visual flight rules (VFR) clearance for the first portion of the flight, which he planned to conduct at 6,500 feet. Weather conditions at takeoff included visibility of 4,500 meters (2.8 statute miles) in rain, and broken clouds at 700 feet and 1,200 feet.

Soon after takeoff, the pilot acknowledged an air traffic control request that he report when the airplane was 10 nautical miles (19 kilometers) from the departure airport. There were no further recorded communications from the pilot. Eight minutes after takeoff, authorities received an emergency telephone call about an airplane accident on the grounds of a cricket club; the accident airplane was identified soon afterward.

The preliminary accident report said, "Eyewitness reports and analysis of the wreckage distribution [have] determined that the aircraft was seen to spin out of cloud with a significant portion of the starboard [right] wing missing. … The cause of the starboard wing separation has yet to be determined."

The investigation was continuing.

Engine Fails After Takeoff

Aeronca 7AC Champ. Substantial damage. One serious injury.

The airplane was being "flight-tested" in preparation for being offered for sale. After the third takeoff of the day from an airport in the United States, at about 200 feet above ground level, the engine stopped producing power.

The pilot then "allowed the aircraft to descend at an excessive rate," and it struck the ground, the preliminary report said.

The investigation into the cause of the power failure was continuing. The airplane had not undergone an annual inspection since 1973.

ROTORCRAFT

Horizontal Stabilizer Separates During Flight

Hiller Aviation UH-12E. Substantial damage. No injuries.

The helicopter was being flown in agricultural operations in Australia when the pilot experienced a loss of tail-rotor authority, and the helicopter struck the ground. The horizontal stabilizer was found about 150 meters (492 feet) from the main wreckage site — an indication of in-flight separation from the helicopter, the report said.

An investigation found that the horizontal stabilizer spar tube failed at the location where the spar tube passed through a collar in a doubler attached to the inner rib of the stabilizer.

The horizontal stabilizer had been inspected when the helicopter was rebuilt about two years before the accident, and no problems were reported. Further examination revealed that the horizontal stabilizer spar tube had fractured because of fatigue cracking. The crack began at "a number of locations where the tubing had been reduced in wall thickness by wear," the accident report said. "It was apparent that the wear of the tubing was associated with small-scale repeated movement between the stabilizer tube and the doubler attached to the stabilizer's inner rib."

Faulty Fuel-flow Data Cited in Power Loss

Enstrom F-28-UK. Destroyed. One minor injury.

The private pilot was flying the helicpter on the return leg of a domestic flight in England when the engine stopped producing power. As the pilot conducted an emergency landing, the helicopter's tail struck rising ground behind the helicopter; as a result, the tail rotor and the rear portion of the tail boom separated from the helicopter, which struck the ground.

An inspection of the helicopter found no fuel in the fuel system. The accident report said that the engine's power loss was a result of fuel exhaustion.

"The pilot had departed with what he believed to be sufficient fuel on board, based on an incorrectly assumed fuel-consumption figure," the report said. "This belief was reinforced by indications on the helicopter's fuel flow [gauge] and fuel quantity [gauge]."

The report said that the helicopter flight manual did not contain appropriate fuel-consumption data. The Lycoming engine manual contained information on fuel consumption, but the pilot did not have a copy. The report said that, as a result, the pilot had "incorrectly based his fuel planning on the consumption rate witnessed on the aircraft's fuel-flow gauge during previous flights. …

"Historically, the fuel-quantity indications on many light aircraft have proved to be inaccurate."

As a result of the investigation, the U.K. Air Accidents Investigation Branch recommended that the U.S. Federal Aviation Administration instruct the manufacturer to "include useful information on fuel consumption rates in all their rotorcraft flight manuals." ■

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