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Rejected takeoff considerations

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Water's role in excursions

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THE JOURNAL OF FLIGHT SAFETY FOUNDATION

AUGUST 2013

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JETLINER ADVANCES BOOST Survivability

Anyone seeing the pictures of the smoldering wreckage of Asiana Flight 214 on a San Francisco runway [on July 6] and hearing the terrifying passenger stories had to wonder how anyone could have survived. Yet only two passengers were killed of the 307 people aboard. (*Editor's note: A third passenger died several days later.*)

We have seen a number of frightening aviation incidents over the past few years — such as Air France Flight 358 in 2008 in Toronto, British Airways Flight 38 in 2011 in London, and most recently Lion Air Flight 904 last April in Indonesia — in which every passenger survived.

It's not a miracle that passengers walk away from accidents such as these. Aviation safety professionals, both in the industry and with the government, have worked for decades not only to mitigate the risk of an accident, but also to make those accidents which occur more survivable.

They have taken what has been learned from past accidents and worked closely with the aircraft manufacturers to build into the design safety improvements that will increase passenger survivability.

Safety Changes

Fire-resistant materials in the cabin, along with seats that are designed to withstand 16 times the force of gravity, immediately come to mind.

After a terrible collision of two airliners on the ground in 1991 at Los Angeles International that led to 34 deaths by fire and smoke inhalation, the National Transportation Safety Board (NTSB) reiterated past recommendations for fire resistant materials in the cabin.

The NTSB started calling for seats that are designed to withstand a 16g impact in the 1970s after investigating accidents where this was a major factor.

The normal and emergency exit doors on aircraft also have been made to operate more easily and will spring out of the way to allow a faster escape.

Good record

The Boeing 777 was first put into service in 1995 and has had a stellar safety record. It incorporates all of the technological advances that have been developed over the years that were designed with passenger survival in mind.

According to the Federal Aviation Administration's regulations, in order for an aircraft to be certified for flight, the manufacturer must show that all the passengers are able to evacuate in 90 seconds with half of the exits blocked.

It appears that in this crash the passengers mainly exited through the four doors on the left side of the aircraft, showing the importance of paying attention to the cabin crew during the safety briefing and following all instructions during an emergency.

We take aviation safety for granted now, but accidents can still happen. Approaches and landings rank in the top three areas of accidents worldwide. But as we can see from this accident and others like it, approach and landing accidents are also very survivable.

We have no answers yet about Asiana 214. The NTSB has just started what will be a thorough investigation. But one thing we can be certain of is that as the NTSB determines the actual cause and makes official suggestions to mitigate future risk, improving passenger survivability will be a top priority.

(This column first appeared in USA Today *and is reprinted here with permission.)*

Capt. Kevin L. Hiatt
President and CEO
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AeroSafetyWORLD

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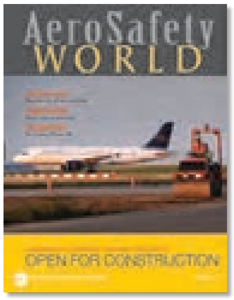

About the Cover
Openness to best practices enhanced safety during
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BE Prepared

Expect the unexpected. Plan for the worst. Be prepared. These are all variations on a theme running through much of the material that has crossed my desk recently.

In last month's *AeroSafety World (ASW)*, Mark Lacagnina's cover story examined the May 2010 crash of an Afriqiyah Airways Airbus A330-200 while on approach to Tripoli, Libya, the airline's home base, on a flight from Johannesburg, South Africa. All but one of the 104 passengers and crew died as a result of the accident.

In its report on the accident, the Libyan Civil Aviation Authority (CAA) said the crew conducted an approach briefing that covered some details, but that other "essential points" were not discussed. "The fact that the approach briefing was incomplete indicates that … the crew did not anticipate any special difficulty in the conduct and management of the approach," the CAA report said.

As with most accidents, there were numerous causal and contributing factors. The report says the copilot may have inadvertently entered incorrect data into the flight management system, causing the aircraft to begin its descent too early. Hesitation in taking corrective action was cited, as were possible fatigue and spatial disorientation. But what struck me was that a report of fog from another flight crew likely surprised the crew and "led the captain to focus his attention on the outside to acquire visual reference points, rather than on coordinating and monitoring the flight parameters," the report said, adding that the management of tasks during the approach deteriorated very quickly. In other words, he was distracted by the unexpected.

In "Continued Takeoffs" in this issue of *ASW* (p. 17), Wayne Rosenkrans writes about takeoff risk factors and runway excursions. In his article, he quotes from a training aid published a few years ago by the U.S. Federal Aviation Administration that says, "The infrequency of [rejected takeoff events] may lead to complacency about maintaining sharp decision-making skills and procedural effectiveness. … In spite of the equipment reliability, every pilot must *be prepared* to make the correct go/no go decision on every takeoff — just in case. … For optimum crew effectiveness, [pilots] should share a common perception — a mental image — of what is happening and what is planned [based on] communications, situational awareness, workload distribution, cross-checking and monitoring" (emphasis added).

In other words, know your options before the unexpected happens so you are better prepared when it does.

Frank Jackman
Editor-in-Chief
AeroSafety World

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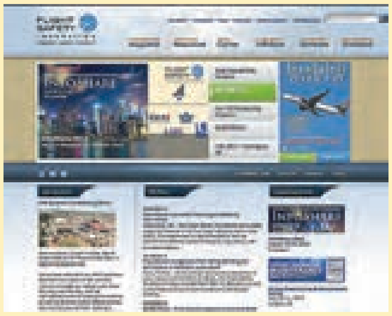

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JULY 31–AUG. 2 ➤ Airport Wildlife Hazard Management Workshop. Embry-Riddle Worldwide. Dallas. <training@erau.edu>.

AUG. 12–16 ➤ Aircraft Performance Investigation. Southern California Safety Institute. San Pedro, California, U.S. Denise Davalloo, <denise.davalloo@scsi-inc.com>, <www.scsi-inc.com/API.php>, +1 310.940.0027, ext.104.

AUG. 19–22 ➤ ISASI 2013: Preparing the Next Generation of Investigators. International Society of Air Safety Investigators. Vancouver, British Columbia, Canada. Ann Schull, <isasi@erols.com>, <www.isasi.org>, +1 703.430.9668.

AUG. 29–30 ➤ International Aviation Safety Management Infoshare. Flight Safety Foundation. Singapore. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/meeting/infoshare2013>, +1 703.739.6700, ext. 101.

SEPT. 4–6 ➤ Human Factors in Aviation Maintenance. Southern California Safety Institute. Long Beach, California, U.S. Denise Davalloo, <registrar@scsi-inc.com>, <www.scsi-inc.com/HFAM.php>, +1 310.517.8844, ext.104.

SEPT. 9–11 ➤ NextGen Ahead Air Transportation Modernization Conference. Aviation Week. Washington. <aviationweek.com>.

SEPT. 12–13 ➤ Flight Safety 2013. Flightglobal. London. Hannah Bonnett, <hannah.bonnett@rbi.co.uk>, <www.flightglobal.com/events>.

SEPT. 16–20 ➤ Investigation in Safety Management Systems. Southern California Safety Institute. Long Beach, California, U.S. Denise Davalloo, <registrar@scsi-inc.com>, <www.scsi-inc.com/ISMS.php>, +1 310.517.8844, ext.104.

SEPT. 24–26 ➤ MRO Europe 2013. Aviation Week. London. <aviationweek.com>.

SEPT. 25–27 ➤ ALTA Aviation Law Americas. Latin American and Caribbean Air Transport Association. Miami. <www.alta.aero/aviationlaw/2013/home.php>, +1 786.388.0222.

SEPT. 29–OCT. 1 ➤ SMS/QA Symposium. DTI Training Consortium. Disney World, Florida, U.S. <symposium@dtiatlanta.com>, <www.dtiatlanta.com/Symposium2013.html>, +1 866.870.5490.

OCT. 10 ➤ ACAS Monitoring Dissemination Workshop (SESAR Project 15.04.03). Eurocontrol. Langen (Hessen), Germany. Stanislaw Drozdowski, <stanislaw.drozdowski@eurocontrol.int>, <bit.ly/10ok2HE>.

OCT. 14–16 ➤ SAFE Association Annual Symposium. SAFE Association. Reno, Nevada, U.S. Jeani Benton, <safe@peak.org>, <www.safeassociation.com>, +1 541.895.3012.

OCT. 15–16 ➤ Icing Conditions: On-Ground and In-Flight. European Aviation Safety Agency. Cologne, Germany. Carmen Andres, <asc@easa.europe.eu>, <webshop.easa.europa.eu/icing>, +49 221.89990.2205.

OCT. 15–17 ➤ Safeskies Australia 2013. Canberra, Australian Capital Territory. Doug Nancarrow, <office@safeskiesaustralia.org>, <www.safeskiesaustralia.org>, +61 (0) 2 9213 8267.

OCT. 18–19 ➤ Aviation Training Congress China. People's Government of Shaanxi Province, Civil Aviation Administration of China and China Council for the Promotion of International Trade. Xi'an, Shaanxi Province, China. Richard Ding, <pyxis@pyxisconsult.com>, <www.cdmc.org.cn/2013/atcc>, +86 21 5646 1707.

OCT. 18–19 ➤ China International General Aviation Convention 2013. People's Government of Shaanxi Province, Civil Aviation Administration of China and China Council for the Promotion of International Trade. Xi'an, Shaanxi Province, China. Li Bona, <15332462337@126.com>, <www.gashow.cn>, +86 029-85395014

OCT. 21–25 ➤ Unmanned Aircraft Systems. Southern California Safety Institute. Long Beach, California, U.S. Denise Davalloo, <denise.davalloo@scsi-inc.com>, <www.scsi-inc.com/unmanned-aircraft-systems.php>, +1 310.940.0027, ext.104.

OCT. 21–25 ➤ Helicopter Accident Investigation. Southern California Safety Institute. Long Beach, California, U.S. Denise Davalloo, <registrar@scsi-inc.com>, <www.scsi-inc.com/HAI.php>, +1 310.517.8844, ext.104.

OCT. 22–24 ➤ SMS II. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Beth Wigger, <maimail@mitre.org>, <bit.ly/YJofEA>, +1 703.983.5617.

OCT. 22–24 ➤ 2013 NBAA Business Aviation Convention & Exhibition. National Business Aviation Association. Las Vegas. <www.nbaa.org/events>.

OCT. 29–31 ➤ 66th International Air Safety Summit. Flight Safety Foundation. Washington, D.C. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/aviation-safety-seminars/international-air-safety-seminar>, +1 703.739.6700, ext. 101.

NOV. 3–8 ➤ CANSO Global ATM Safety Conference. Civil Air Navigation Services Organisation. Amman, Jordan. Anouk Achterhuis, <events@canso.org>, <www.canso.org/safetyconference2013>, +31 (0) 23 568 5390.

NOV. 13–15 ➤ 10th ALTA Airline Leaders Forum. Latin American and Caribbean Air Transport Association. Cancún, Mexico. <conferencesandmeetings@alta.aero>, <www.alta.aero>.

DEC. 2–5 ➤ 7th Triennial International Aircraft Fire and Cabin Safety Research Conference. Philadelphia, Pennsylvania, U.S. Cynthia Corbett, <cynthia.corbett@faa.gov>, <www.fire.tc.faa.gov/2013Conference/conference.asp>.

DEC. 3–4 ➤ Safety in Air Traffic Control. Flightglobal. London. Stephanie Kluth, <stephanie.kluth@rbi.co.uk>, <www.flightglobal.com/events>, +44 (0) 2086523989.

FEB. 19–20, 2014 ➤ European Business Aviation Safety Conference. Aviation Screening. Munich, Germany. Christian Beckert, <info@ebascon.eu>, <www.ebascon.eu>, +49 7158 913 44 20.

APRIL 1–3, 2014 ➤ World Aviation Training Conference and Tradeshow (WATS 2014). Halldale Group. Orlando, Florida, U.S. Zenia Bharucha, <zenia@halldale.com>, <halldale.com/wats#.Ub4RyhYTZCY>, +1 407.322.5605.

APRIL 16–17, 2014 ➤ 59th annual Business Aviation Safety Summit (BASS 2014). Flight Safety Foundation and National Business Aviation Association. San Diego. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/bass>, +1 703.739.6700, ext. 101.

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Safety News

Asiana Crash


© Eugene Anthony Rah/Reuters

An Asiana Airlines Boeing 777-200 crashed short of the landing runway at San Francisco International Airport after a flight from Seoul, South Korea. Three of the 307 people in the airplane were killed and dozens were injured in the July 6 accident, and the airplane was destroyed. The U.S. National Transportation Safety Board's (NTSB's) investigation of the accident was continuing.

Preliminary NTSB findings noted that, in the seconds before the airplane struck a sea wall just short of the runway, its airspeed dropped to about 30 kt below the target threshold speed of 137 kt.

The airplane was being flown by an experienced 747 pilot undergoing initial operating experience in the 777, under the supervision of an instructor pilot who was conducting his first trip in that capacity, the NTSB said.

It was the first accident involving an airliner in the United States since Feb. 12, 2009, when a Colgan Air Bombardier Q400 crashed during approach to Buffalo Niagara (New York, U.S.) International Airport, killing all 49 people in the airplane and one person on the ground (*ASW*, 3/10, p. 20). It also was the first crash of a major airline's aircraft in the United States since Nov. 12, 2001, when an American Airlines Airbus A300 crashed after takeoff from Kennedy International Airport in New York, killing all 260 people in the airplane and five people on the ground.

Separation Standards

Citing five recent incidents in which air carrier aircraft on go-arounds came dangerously close to other landing or departing aircraft, the U.S. National Transportation Safety Board (NTSB) recommended new requirements to ensure safe aircraft separation.

The NTSB said, in a safety recommendation letter to the U.S. Federal Aviation Administration (FAA), that it was "concerned that existing FAA separation standards and operating procedures are inadequate to prevent such events and need to be revised."

The FAA should establish new separation standards similar to those governing aircraft departing from intersecting runways or on intersecting flight paths, the NTSB said.

FAA requirements specify that air traffic controllers must separate aircraft that depart from intersecting runways or on intersecting flight paths "by ensuring that the departure does not begin takeoff roll until … the preceding aircraft has departed and passed the intersection, has crossed the departure runway or is turning to avert any conflict [or] a preceding arriving aircraft is clear of the landing runway, completed the landing roll and will hold short of the intersection, passed the intersection or has crossed over the departure runway."

Requirements also call for timed separation intervals behind heavy aircraft.

"However … there is no requirement for controllers to provide the same protections for the potential go-around flight path of a landing aircraft even though, in the event of a go-around, the arriving aircraft effectively becomes a departure. … There appears to be no safety justification for treating the situations differently," the NTSB said.

In the five incidents cited by the NTSB, the "nature of the geometry of the encounters and the unexpected nature of the go-arounds" made it impossible for controllers to provide effective instructions to the pilots to ensure that the aircraft would avoid each other. Instead, the pilots performed "impromptu evasive maneuvers … during critical phases of flight," the NTSB said.

Four of the five incidents cited occurred between April and July 2012; the fifth occurred in January 2006. No injuries were reported in any of the incidents, and none of the airplanes was damaged.

Runway Safety Campaign

The Civil Air Navigation Services Organisation (CANSO) has begun a new campaign — focusing on airport personnel and air navigation service providers (ANSPs) — to improve runway safety by reducing unstable approaches.

The campaign offers runway safety checklists for airports and ANSPs, and recommendations for pilots and air traffic controllers. The Runway Safety Maturity Checklist — intended for use by ANSPs, airlines, airport operators, regulators and aeronautical telecommunication and radio navigation providers — is designed to help "benchmark their levels of maturity with regard to managing runway safety risks," CANSO said. "The checklist identifies key elements of risk control and uses a series of questions to assess the maturity of an organization against each element."

CANSO cited data from the International Air Transport Association that showed that an unstable approach was cited as a contributing factor in 17 percent of accidents between 2008 and 2012.

"Air traffic control plays an important role in contributing to safe, stable approaches and reducing the risk of runway excursions," said CANSO Director General Jeff Poole. "This includes ensuring that controllers appreciate what is required for a pilot to achieve a stabilized approach, issuing proper clearances and providing timely and accurate weather information."

An earlier campaign to promote runway safety — the Runway Safety Initiative, involving about 20 organizations in the worldwide aviation community and coordinated by Flight Safety Foundation — produced sets of countermeasures to address veer-offs and overruns and emphasized the importance of stabilized approaches. The Runway Safety Initiative's final report, *Reducing the Risk of Runway Excursions*, was released in 2009 (see "Continued Takeoffs," p. 17).

Aero Club/Wikimedia Commons

Investigating the Investigators

Australian lawmakers, challenging the Australian Transport Safety Bureau's (ATSB's) conclusion that the Nov. 18, 2009, ditching of an emergency medical services flight resulted primarily from the pilot's actions, has asked the ATSB to re-open its investigation.

Ditching –
Israel Aircraft Industries
Westwind 1124A, VH-NGA

The Australian Senate's Rural and Regional Affairs and Transport References Committee said, in a report released in May, that the ATSB has defended its conclusions "without … a solid evidentiary base."

The report added, "The ATSB repeatedly deflected suggestions that significant deficiencies with both the operator [Pel-Air], … and CASA's [the Civil Aviation Safety Authority's] oversight of Pel-Air … contributed to the accident. The committee takes a different view and believes that ATSB processes have become deficient."

The crew of the Israel Aircraft Industries Westwind 1124A ditched the airplane off Norfolk Island — where they had planned a refueling stop during their trip from Apia, Samoa, to Melbourne, Australia — rather than risk a flameout while attempting another approach in darkness and deteriorating weather. All six occupants survived the impact and escaped from the Westwind before it sank (*ASW*, 10/12, p. 38).

The Senate committee said in its report that members were "surprised by the [ATSB's] near-exclusive focus on the actions of the pilot and lack of analysis or detail of factors that would assist the wider aviation industry" and "troubled by allegations that agencies whose role it is to protect and enhance aviation safety were acting in ways which could compromise that safety."

The report also said that the committee had "strong concerns about the methodology the ATSB uses to attribute risk." That methodology "appears to defy common sense by not asking whether the many issues that were presented to the committee in evidence but not included in the report" could add to understanding of the crew's actions, offer lessons for the aviation industry and help prevent a similar incident in the future.

EC225 Repairs


calflier001/Wikimedia Commons

The European Aviation Safety Agency (EASA), citing the 2012 ditching of two Eurocopter EC225 Super Pumas in the North Sea, has issued an airworthiness directive (AD) calling for action to prevent failures of the main gear box (MGB) bevel gear vertical shaft.

AD 2013-0138-E describes what the EASA calls "a set of modifications and inspections which aim at monitoring and detecting vertical shaft crack conditions and reducing the likelihood of any shaft crack initiation."

The new AD follows an emergency AD issued in November 2012 in response to a May 2012 ditching that occurred after a warning indication of a loss of MGB oil pressure and an additional alarm indicating problems with the MGB emergency lubrication system.

Subsequent inspections revealed a crack in the lower vertical shaft of the MGB bevel gear; the crack caused the vertical shaft to stop driving the main oil pump and its backup, the EASA said. The crack was traced to "an oxidation pit found in the chamber of the vertical shaft welding stop hole," the EASA said.

Capacity Problems

An increasing number of European airports will be operating at or near capacity by 2035, causing not only an increase in delays but also an inability to accommodate 1.9 million flights — 12 percent of total demand, Eurocontrol says.

In its fourth *Challenges of Growth* study, Eurocontrol said that, under the most likely scenario, more than 20 European airports would be operating at 80 percent or more of capacity for at least six hours a day in 2035. In comparison, three airports fell into that category in 2012.

The study suggested several steps to ease the problem, including adjusting flight schedules, construction of new runways and other infrastructure, and the increased use of larger airplanes.


Jnpet/Wikimedia Commons

Flight Training Proposals

Applicants for an air transport pilot license or a position as a pilot in multi-crew operations would be required to complete training in "multi-crew cooperation," according to a proposed change in Australia's Civil Aviation Safety Regulations.

The Civil Aviation Safety Authority (CASA) included the new requirement in its proposed revision of Part 61 standards for flight crew licensing, which specify the flight training and knowledge required for all licenses, ratings and endorsements. Proficiency checks for ratings and English language proficiency requirements also are included.

CASA says that, in addition to the proposed multi-crew cooperation training, the draft calls for two other significant changes in existing requirements. One change would require flight tests as a prerequisite for an air transport pilot license, low-level rating or night vision imaging system rating. The other change would require pilots seeking a private or commercial pilot license with a helicopter rating to complete basic instrument training.

CASA planned to accept comments on the proposals until Aug. 2 and to issue final regulations late this year.

In Other News …

The European Commission (EC) is proposing to extend until 2024 the mandate of the Single European Sky Air Traffic Management Research (SESAR) Joint Undertaking — a move the EC says is intended to demonstrate its commitment to the **Single European Sky** project. … The U.K. Civil Aviation Authority has begun reviewing fire protection at **helicopter landing sites** to determine whether current requirements are appropriate and to harmonize requirements aimed at airports, temporary helicopter landing areas, offshore helidecks and hospital landing sites. CAA Chief Executive Andrew Haines says the goal is "to assess all potential risks and take account of the availability of new technology for detecting and controlling fires."

Compiled and edited by Linda Werfelman.

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Safety risk management and a collaborative approach mitigate the risks.

WORKING SAFELY ON AN OPERATIVE RUNWAY

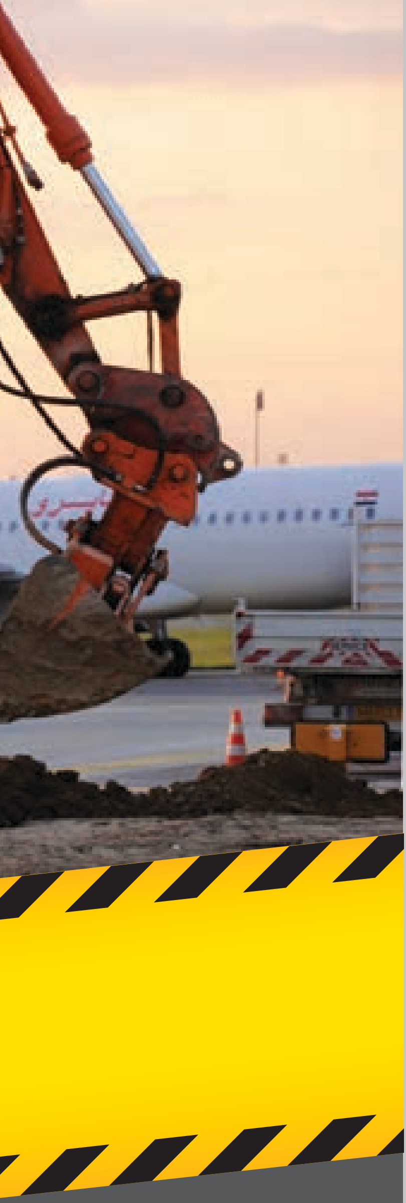
BY GAËL LE BRIS

Construction projects in an airport movement area introduce numerous hazards and complexities, as illustrated by a case study at Paris Charles de Gaulle Airport (CDG).

To increase the safety and capacity of strategic taxiways crossing the southwest part of the airside, more than 7.0 acres (2.8 hectares) of pavement are being reconstructed at CDG through a four-year, six-phase program that started in 2010. The project included modifying the design of the entrance taxiways of Runway 08L (THR08) along the runway more than 2,400 ft (732 m) from the threshold. This operation was undertaken from April to June 2012 in a unique phase (called THR08 Reconstruction Program Phase 2), which required balancing safety standards, compliance with certification specifications, preservation of the operational robustness, and limiting constraints on the construction project.

Safety and Performance Challenges

Due to the size of the project and the nature of the construction, it was not realistic to complete the work at night with the runway closed. Only two options were available: closing Runway 08L/26R during the entire Phase 2, or operating the runway with a displaced threshold to make available a sufficient area to perform a large majority of the work, especially stages that cannot conveniently be interrupted (e.g., pouring concrete with slip forms).



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The large number of airplane arrivals and departures was not compatible with a lengthy closure of one of the two long runways dedicated to takeoffs.

Moreover, a 24/7 closure would significantly degrade the operational robustness of the runways system.[1] Indeed, in case of any incident on the second 13,780-ft (4,200-m) runway, the airfield capacity would be dramatically lower than required to accommodate daily flights. In addition, the heaviest long-haul flights would not be able to take off at their required takeoff weight. And finally, the two remaining 8,860-ft (2,700-m) outer runways would be too short for many airliners if their flight crews requested an emergency return just after takeoff.

So only the second option — a shortened Runway 08L/26R — could meet both operational and safety requirements.

Formal Risk Analysis

Following the recommendations of the International Civil Aviation Organization (ICAO),[2] safety management systems (SMS) became mandatory in France in 2008. The related SMS regulation necessitates assessing the impacts on safety of any change to airport operations. During the six years preceding THR08 Phase 2, CDG and the airside community developed a mature process of safety risk management (SRM), for which Phase 2 was an opportunity to effect a complex and critical modification.

The formal SRM of Phase 2 started one year before the construction. The work group included the air traffic control tower (ATCT), project management support, the prime contractor[3] and different activities of the Airside Operations and Facilities Department of the airport operator. Airlines were involved later, with the creation of a Pilots-for-SRM Pool that brought human factors expertise into the process.

A comprehensive airport SRM can be divided into five main steps: identification of hazards and risks, assessment of the risks' acceptability, determination of appropriate mitigation measures, definition of an implementation plan, and preparation of a verification program for safety assurance.

If the SMS acquires and archives information about all safety events occurring on the airfield, these records usually do not date back more than a couple of years, because this practice started to be common only seven years ago. So the safety risk manager has to fill in the missing data using other accessible resources like external databases (e.g., air transportation safety organizations). As we will explain, it is also often relevant to search for inputs from other airports to succeed in reducing the most critical risks.

An overview of risk mitigation performed for Phase 2 comprises addressing the risks of an aircraft colliding with construction equipment after overrunning the runway end safety area (RESA) and of construction activity penetrating the protected approach slopes. One of the key events used during the risk analysis occurred in 2008 at CDG, when the threshold for Runway 09R was temporarily displaced by 4,050 ft (1,234 m) to allow for a partial resurfacing. The remaining available length of the runway was separated from the construction area by blast fences.

Because of the failure of a Boeing 737-800 flight crew to take into account the shortened takeoff runway available (TORA), they took off from Runway 27L, collided with the plastic separator delineating the runway end and then flew low over the fences. Therefore, the possibility must be considered that any flight crew could take off believing that the full runway is available.

The possibility of an aircraft overrunning the RESA also was assessed. A history of excursions after landing or after a rejected takeoff revealed two extreme trajectories. The first was a longitudinal overrun of an Airbus A340-600 at Toronto Pearson International Airport in 2005 that stopped beyond a hypothetical ICAO RESA. The second, in 2000, was the trajectory of a lateral excursion by a Boeing 747-200 beyond the instrument landing system (ILS) Category I runway protections at CDG. The addition of the data from these two runway excursions revealed an area at risk that runs beyond the RESA of Runway 26R westward, and to the southern edge of the parallel Taxiway Tango northward.

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Finally, the resulting countermeasures of the analysis for this critical risk were the implementation of a 787-ft (240-m) RESA at the temporary end of Runway 26R, banning of obstacles and human activity on the runway (including the closed section) when it was operational, and suspension of landings on Runway 08L/26R until the workers and mobile machines were moved beyond Taxiway Tango (in case an emergency situation necessitated a landing).

In addition, a prevention plan mitigated possible accident and incident precursors, particularly miscommunication of information to the flight crews. For that purpose, all the taxiway entries to Runway 26R were closed except the first one (Taxiway R1), which offered the longest TORA. Pilots' situational awareness was reinforced by an illustrated aeronautical information publication (AIP), the designation of Taxiway R1 with the prefix "WORKS" and installation of signage as a reminder of the shortened TORA.

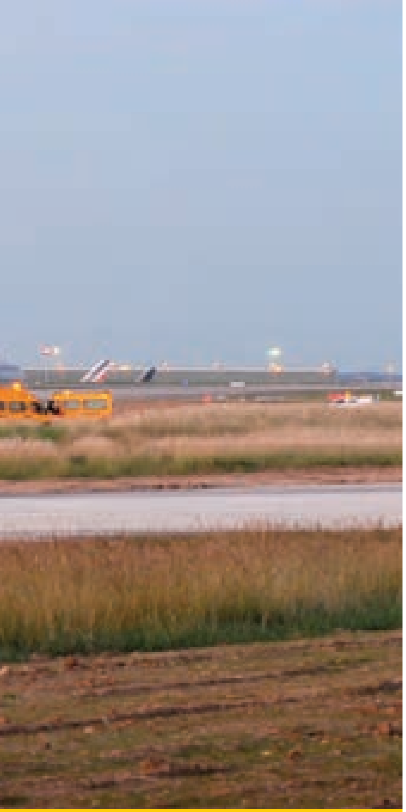
As noted, the risk analysis benefited from the study of safety events outside of CDG. Since April 2011, safety personnel at CDG have collected information about incidents and accidents worldwide. Although local records can be used to assess minor risks, they are inadequate for more-critical events. Indeed, catastrophic events are, fortunately, rare at a single airport and might include only a few types of accidents, requiring the addition of exogenous cases to create a benchmark case study. For Phase 2, more than 200 events were considered, and a dozen were integrated into the risk analysis. This approach allowed us to easily identify risks and precursors that we might otherwise have missed.

The Collaborative Approach

The THR08 Reconstruction Program involved a large number of stakeholders, sometimes with opposite interests and often with different organizational cultures and points of view. The complexity of Phase 2 made more challenging the need to reach consensus, using the differences as a strength, and having all partners working together to ensure the highest level of safety and operational performance.

Phase 2 also required the stakeholders to look more closely into each other's procedures and practices to understand how we work and interact. This effort also helped us to understand how we could improve the quality and efficiency of these interactions and develop responses to the risks we faced.

All of the preceding was facilitated by the implementation of the airport collaborative decision-making (CDM) standards[4] between the ATCT, the airport operator and the airlines, and best practices in airport productivity management, which taught all entities to share in the



The construction area at CDG was entirely closed, with particular attention paid to runway interfaces. All paved accesses were indicated by a continuous line of frangible plastic separators.

decisions. Phase 2 also was an opportunity to bring the project management support and the prime contractor more into the SMS. Their direct involvement in SRM meetings enhanced their comprehension of the safety objectives, and of our goals and constraints for the project. Today, these stakeholders even propose mitigation measures.

Operations Management

At CDG, the Airside Control Center (PCR) is responsible for monitoring operations on the movement area, and for overseeing the temporary operational changes. So the PCR is the key to real-time safety assurance, performing inspections of the construction area activities. During Phase 2, the airside operations specialists faced an exceptional number of mitigation measures to be verified. In addition, they had to monitor other major projects, including the extension of the centralized deicing facilities and the completion of a new concourse. This situation required a briefing of the staff on duty, and the addition of special supplements to the certification deviations inspection sheet.

During the nights when the installation and deconstruction of Phase 2 occurred, the PCR staffing was doubled, with one team dedicated to the usual duties and a second one dedicated to Phase 2. This was overseen by the activation of the CDM Command Center (or CDM Cell) in which the airport operator, the ATCT and the airlines decided together how to manage the irregular operations and adverse conditions.

"Plan B"

"Plan B" contingency actions were defined to guarantee the operational robustness of the runway during the work. For instance, the risk that the reduced-length Runway 08L/26R would not be reopened on time was anticipated through a recovery procedure based on the shorter parallel Runway 08R/26L.

Recalling the 747-400 takeoff collision with construction barriers and equipment at Chiang Kai-Shek International Airport, Taiwan, in 2000, the procedure called for the aircraft to proceed to the outer runway through lighted corridors across Runway 08L/26R, preventing the alignment of an aircraft on the wrong runway. To reinforce the visual information, plans were put in place for extra lighted crosses after the last corridor. This procedure was not activated at the time, but we use it now as a standard risk mitigation for prolonged inner runway closures.

Limits of Aeronautical Information

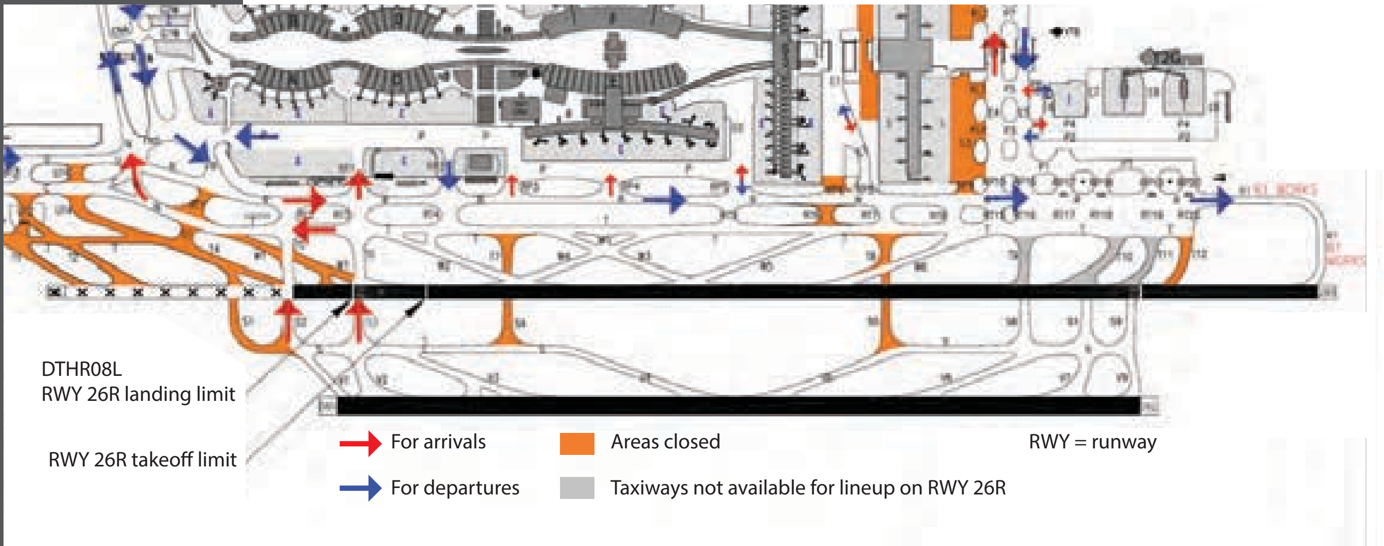
The airport operator and the ATCT made considerable efforts to communicate to the flight crews, going beyond the regulatory requirements. An AIP supplement including temporary ground movement control maps was published and then activated by a notice to airmen. Pilot briefings were performed and a reminder was included on the automatic terminal information service messages. Complementary materials were provided on the website portal of CDG's airport operations community. Finally, a special controller-pilot phraseology was used from preflight to takeoff alignment.

Despite these measures, the Safety Assessment of Foreign Aircraft inspections by the national Civil Aviation Safety Directorate found that more than a fourth of the flight crews inspected did not have the information provided by the AIP supplement around the first day of the threshold displacement. The controllers stopped three incursions on Runway 26R via the closed-entry taxiways, despite having cleared the aircraft crews involved for R1 WORKS.

The risk awareness of the controllers was increased by special briefings and a local temporary operational order. However, these incidents revealed that the regular aeronautical information alone, as defined by international standards and national or regional regulations, is not sufficient to guarantee correct and effective diffusion from the airport operator to the cockpit.

Beyond Phase 2

Phase 2 of the TH08 Reconstruction Program demonstrated the force of formal SRM as the main tool in managing airside changes



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Temporarily shortened Runway 08L/26R with closed taxiways during THR08 Reconstruction Program Phase 2 at CDG.

and as a major tool of airport project management. This process was inspired by reality on the ground and designed in a proactive and pragmatic way. To achieve the intended level of risk mitigation, safety risk managers may conduct their study in a continual feedback loop between the theory and the operations. Indeed, a risk mitigation plan is useless if it cannot be deployed and verified, or if this plan is not updated after a safety event reveals an insufficiency.

The merger of the airport operator's and ATCT's risk analysis, determined at CDG after Phase 2, created valuable synergies in time saving (no redundancies), hazards identification (complementary aspects of both approaches) and risk mitigation (coherent and comprehensive action plans).

For project management, the CDM spirit among the stakeholders significantly facilitated the information sharing and the reciprocal understanding of difficulties for each participant. One simple, efficient CDM action was involving the ATCT in the acceptance inspections at the beginning and the end of the construction. It was followed by a multiple-party approval of the modified movement area.

Finally, Phase 2 highlighted the relevance of exchanging experiences and best management practices inside the airport community and adding exogenous events to the risk analysis. For this purpose, we developed collaborations with other airports and institutions, especially in North America.

We met in 2012 with Jim Krieger, chairman of the Airport Construction Advisory Council (ACAC), with whom we compared the lessons learned from operations on temporarily shortened runways at CDG and Chicago O'Hare International Airport. In particular, we agreed that in facing the same hazards, similar responses spontaneously appeared at both airports[5] — proof, if needed, that safety is the common priority of our industry.

Gaël Le Bris is airside development manager for Aéroports de Paris at CDG. He is safety risk manager and leads the activity of economic and technical benchmarking for his department, with a special focus on establishing collaboration with the North American airport community.

Notes

1. CDG has two independent north and south complexes of two parallel runways.
2. ICAO. Amendment of Annex 14, Volume 1, *Airport Design and Operations*, Chapter 9.3. November 2005.
3. At Aéroports de Paris, these functions are internalized through two divisions of the parent company.
4. CDG was granted the Airport Collaborative Decision Making (A-CDM) certification by Eurocontrol in 2012. For further details about A-CDM, see the *Airport CDM Implementation Manual* of Eurocontrol.
5. Rosenkrans, Wayne. "What's on Your Runway?" *AeroSafety World* Volume 7 (July 2012), pp. 16–19.

Two flight crews suddenly had little or no runway to spare.

CONTINUED Takeoffs

BY WAYNE ROSENKRANS

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A business jet accident and a serious incident involving a large commercial jet had in common the flight crews' decisions to continue takeoffs after they suddenly became aware of non-normal circumstances, according to the final reports issued in early 2013 by accident investigation boards.[1,2] In each case, the exact circumstances fell outside some generic lists of predominant risks and causal factors previously emphasized by safety specialists (see "Guidance on Rejected Takeoff Considerations," p. 18), such as U.S. Federal Aviation Administration (FAA) analysis of rejected takeoff (RTO) events.

"The infrequency of RTO events may lead to complacency about maintaining sharp decision making skills and procedural effectiveness," the FAA *Takeoff Safety Training Aid* says. "In spite of the equipment reliability, every pilot must be prepared to make the correct go/no go decision on every takeoff — just in case.

"For optimum crew effectiveness, [pilots] should share a common perception — a mental image — of what is happening and what is planned [based on] communications, situational awareness, workload distribution, cross-checking and monitoring. … A review of actions for a blown tire, high-speed configuration warning or transfer of control are examples of what might be appropriate for before-takeoff (or before–engine start) review. … Meaningful communication, however brief, regarding a non-normal situation during takeoff and RTO can often mean the difference between success and disaster."

Tailwind Incident

In Australia, the first officer was the pilot flying during the takeoff of a Qantas Airways Boeing 737-800 on Runway 06 at Perth Airport, Western Australia. Late in the takeoff run, the wind direction and speed suddenly changed to a tailwind that caused the airplane to become airborne near the end of the runway without the margin of safety expected from prior calculation of the takeoff distance required. An Airservices Australia fact sheet lists the Perth Airport Runway 06/24 length as 2,163 m (7,096 ft). No damage or injuries were reported when the event occurred at about 1618 local time on Dec. 4, 2012. The captain was the pilot monitoring.

"Approaching the takeoff reference speeds[3] of V_1 and V_R [rotation speed], the airspeed stopped increasing and did not start increasing again for several seconds," said the report by the Australian Transport Safety Bureau. "The captain noticed that the wind vector on the navigation display was showing a tailwind of about 20–25 kt. The captain disconnected the auto-throttle and 'fire-walled' the thrust levers [selected maximum thrust].

"During the initial climb, the first officer performed a wind shear escape manoeuvre. … Just after the aircraft became airborne, the wind was recorded at 282 (degrees true) and 25 kt. No wind shear warnings were recorded. Recorded latitude, longitude and radio altitude data showed that the aircraft passed over the end of Runway 06 (threshold of Runway 24) at a height of about 10 ft above ground level. … As the performance calculations had assumed nil [zero] wind for takeoff, the aircraft failed to achieve the predicted takeoff performance."

Analysis of quick access recorder data for the flight "showed that the airspeed stagnated at 134 kt for 3-4 seconds just below the V_1 speed of 137 kt, the auto-throttle was disconnected and maximum thrust was set."

Investigators determined that at the time of the takeoff, cumulonimbus cloud activity was present about 20–30 nm [37–56 km] north of the airport, and also found there were "no indications of an impending wind change before takeoff." The flight crew during climb advised air traffic control (ATC) about the tailwind component that they had seen displayed. "Takeoffs were then temporarily suspended from Runway 06 and aircraft departed using Runway 03," the report said.

The flight crew had monitored the current automatic terminal information service message, issued about five minutes before lineup for takeoff. It reported wind from 060 degrees magnetic at 8 kt — that is, a direct headwind. Before lining up for takeoff, the captain observed that windsock 1 indicated a headwind component. The first officer told investigators that windsock 2 also had indicated a headwind component. Neither pilot was able to observe any of the airport's three windsocks from the Runway 06 threshold (Figure 1, p. 19).

The temperature was 37 degrees C (99 degrees F), and visual meteorological conditions prevailed. "The anemometer experienced a significant wind change at 1618 that would have resulted in tailwind conditions at least near the northern part of Runway 06," the report said. Investigators' computations showed that the crew otherwise should have been able to safely conduct a takeoff on Runway 06.

Guidance on Rejected Takeoff Considerations

Flight Safety Foundation, as coordinator, and the International Air Transport Association published in July 2009 the findings and recommendations of the Runway Safety Initiative (*ASW*, 8/08, p. 12) based partly on excursion data from 1995 through March 2008.[1] Only about one-fourth as many excursions occurred during takeoff — 63 percent of them overruns — as occurred during landing. Turboprops accounted for 41 percent of these takeoff excursions, jet transports for 36 percent, business jets for 17 percent and other fleets for 6 percent. The most common risk factor in takeoff excursions was a rejected takeoff (RTO) initiated at a speed greater than V_1 (see definition in "Continued Takeoffs," Note 3, p. 21). Loss of directional control by the pilot was the next most common risk factor, followed by rejecting the takeoff before V_1.

Other takeoff risk factors ranked as significant by the initiative were: The flight crew fails to consider rejecting the takeoff; the crew performs an RTO with inadequate time to avoid a veer-off; premature rotation occurs (that is, prior to reaching V_R); rotation is not attempted; no rotation occurs because V_R is not reached; the pilot is unable to rotate the airplane; rotation occurs above $V_{R;}$ piloting technique fails to counteract crosswind; the flight crew fails to comply with standard operating procedures; improper checklist use occurs; the pilot-in-command fails in supervision of the first officer; a failure of crew resource management occurs; the aircraft weight calculation is incorrect; sudden engine power loss occurs; degraded engine performance occurs; tire failure occurs; and/or thrust asymmetry occurs.

Earlier insights about when and how to safely conduct RTOs were based on data from airline operations compiled by the U.S. Federal Aviation Administration (FAA).[2] For the period 1959–2003, the FAA's estimates from the available data were that 143,000 RTOs occurred in worldwide airline operations — 6,000 a year — and that in 97 cases, or about four per year, the outcome was an accident or incident. The conclusion was that RTOs were uncommon, with typical operations resulting in one RTO per 3,000 takeoffs and one runway overrun accident or incident during takeoff per 4.5 million takeoffs.

— WR

Notes:

1. Flight Safety Foundation. "Reducing the Risk of Runway Excursions: Report of the Runway Safety Initiative." May 2009.
2. FAA. "Pilot Guide to Takeoff Safety." Section 2, *Takeoff Safety Training Aid,* 1994 (last update February 2008). The other sections include "Takeoff Safety Overview for Management," "Example Takeoff Safety Training Program," "Takeoff Safety Background Data" and an optional video.

A reactive wind shear–detection system, incorporated in the 737's ground-proximity warning system, began at rotation to detect whether it was actually experiencing wind shear. A predictive wind shear–detection system, incorporated in the airplane's weather radar system, began scanning when the thrust levers were set for takeoff. "New warnings were inhibited after the aircraft reached 100 kt until it was over 50 ft above ground level," the report said. "This incident serves as a reminder to pilots that significant wind changes can occur during take-off, can be difficult to predict, and can occur in the absence of thunderstorm activity. The wind conditions at each end of a runway may differ significantly so that headwind conditions can exist at one end and tailwind conditions at the other end. Although it did not assist in this case, it is important to monitor the available windsocks before takeoff as it is the final opportunity to detect wind changes before the takeoff roll begins."

The report recommended review of one briefing note on wind shear <flightsafety.org/files/alar_bn5-4-wind-shear.pdf> from Flight Safety Foundation's *Approach and Landing Accident Reduction (ALAR) Tool Kit* as a resource for relevant takeoff-safety advice.

Sudden Tailwind During Takeoff Run

BoM = Australian Bureau of Meteorology

Note: None of the windsocks could be seen by the Boeing 737 flight crew from the Runway 06 threshold. The airfield anemometer at Perth Airport, Western Australia, registered a significant wind change during their takeoff run.

Source: Australian Transport Safety Bureau

Figure 1

Airborne After Overrun

In Switzerland, a copilot was conducting the takeoff of a Cessna Citation C525 on Runway 07 at Grenchen Regional Airport when the airplane failed to reach V_1 at the normally expected point along the 980-m (3,215-ft) runway. The Citation struck a runway-end identifier light, overran the runway, crossed a grass-covered meadow and a small perpendicular stream bed, then became airborne. It subsequently landed safely at a different airport.

The commander of this ferry flight under instrument flight rules (IFR) was the pilot monitoring when the takeoff occurred at 0853 local time on Feb. 16, 2011. There were no injuries to the two professional pilot–occupants. The aircraft operated by Swiss Private Aviation was described as "badly damaged, a runway end light was damaged and minor damage to nearby grassland was found," said the report by the Swiss Accident Investigation Board (SAIB).

The current Grenchen Regional Airport weather report (and investigators' determinations for the accident vicinity) included wind from 080 degrees at 6 kt, visibility 300 m (0.2 mi), fog and possibly light rain, cloud vertical visibility 200 ft above the ground, temperature and dew point 2 degrees C (36 degrees F), and poor visibility conditions due to fog.

A Grenchen ATC officer (controller) cleared the flight crew for takeoff from Runway 07 while the aircraft was parked at a stand. "The taxi checklist was completed on the short route to the Runway 07 holding position via Taxiway W," the report said. "This included, among other things, testing the functionality of the brakes, which was carried out by both crewmembers. No anomalies were found."

The fog precluded visual contact with any aircraft positioned along the line of sight between the tower and the end of Runway 07, so the ATC officer arranged for a runway inspection.

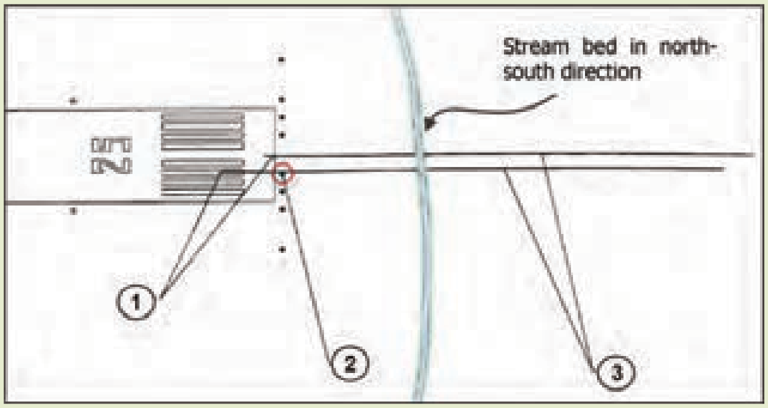
The ATC officer saw the Citation entering the runway and amended the initial clearance, instructing the crew to hold on the runway for takeoff clearance because the runway inspection was still in progress. "In view of the expected delay, the commander then set the parking brake," the report said. At 0853:43, the takeoff clearance was issued, updating wind data to 060 degrees at 6 kt.

"The commander then switched on the pitot heater and landing lights, pushed the thrust levers forward and handed control over to the copilot. He instructed the copilot, in view of the reduced visibility, to carry out a so-called standing takeoff. At a power setting with a low-pressure compressor speed N1 of approximately 90 percent of the rated speed, the copilot took his feet off the brake pedals, set takeoff thrust and steered the aircraft on the runway centerline. The set takeoff thrust was checked by both crewmembers."

The commander "had the impression that the aircraft's acceleration was lower than usual," the report said. "[The Citation] attained a speed of 80 kt before Taxiway E1 … i.e., rather late, but still within a framework which seemed acceptable to the commander. On reaching [V_R], in the copilot's estimation approximately 250 m [820 ft] before the end of the runway, the commander called out 'Rotate,' whereupon the copilot pulled on the control column.

"Both crewmembers immediately noticed that the nose of the aircraft was not lifting. After a repeated callout by the commander, he, too, pulled on the control column. On overshooting the end of the runway, the right main landing gear … struck a light, which was perceived by the crew as a distinctly noticeable impact."

Takeoff Continued After Runway Overrun



Note: Accident investigators found traces of locked brakes (1) at the departure end of the runway, that the Citation had damaged a runway-end identifier light (2) and that its wheel tracks (3) indicated crossing of a meadow and stream bed before liftoff.

Source: Aviation Division, Swiss Accident Investigation Board

Figure 2

Leaving the runway pavement, the landing gear wheels continued to roll on the meadow. "The copilot, according to his statement, had the feeling that it was no longer possible to continue the takeoff and briefly reduced power," the report said. "But at approximately the same time, the copilot noted that [the Citation] had already lifted off and applied full power again.

"At the same time, he asked the commander whether the takeoff process should continue. The [commander] answered the copilot's question in the affirmative, with the consideration that they would perhaps still have a chance to get the aircraft into the air."

Investigators' analysis of this stage determined that "a few seconds" had elapsed from the point of runway overrun — then more than 100 m (328 ft) across the meadow and stream bed — to the liftoff (Figure 2).

"The [ATC officer] heard a click on the radio frequency as [the Citation] approached the end of the runway," the report said. "She took up the binoculars and was still able to see the aircraft's strobe lights. Then she made sure on the radar screen that [the airplane] had actually lifted off."

Following normal climb procedure, the commander next reduced power to the maximum continuous thrust setting and retracted the flaps. "Then the crew realised that the parking brake was still set," the report said.

During his attempt to retract the landing gear, however, the commander observed a red gear-warning light. Extending the gear again resulted in three green indicator lights, so the crew left the gear extended for the remainder of the flight. After being handed off to an approach controller at about 3,500 ft, the flight crew requested and received IFR clearance to Zurich, their IFR alternate airport, where they landed uneventfully.

"Structural damage was found in the area of the nose gear and main gear, as well as to both rear wing spars," the report said. "Also, a certain asymmetry was ascertained in the dimensions of the aircraft."

Investigators used the accident airplane's flight management system to replicate the pilots' calculated takeoff field length for the conditions at Grenchen, obtaining 2,808 ft (856 m) as the result. "It is apparent that with 124 m [407 ft], the crew basically had a small safety margin available," the report said. "There is no evidence of the existence of any technical defects or limitations which could have caused or influenced the accident."

The operator's preflight checklist for this airplane did not refer to releasing the parking brake except just before taxiing from the parking stand. From 1997 to 2011, 11 incidents occurred involving takeoffs with the parking brake set, according to the airframe manufacturer's data for the aircraft type, the report said. "It seems reasonable to assume that on handing over control to the copilot, the commander was no longer aware of the set parking brake. Possibly, also, the delay due to the runway inspection may have played a part in this."

Because of their significant experience, both pilots had a mental picture of the normal acceleration of the accident airplane at Grenchen, the report said, noting, "On a takeoff on a relatively short runway, preconceived decisions and thus the willingness to abort takeoff roll early at the merest hint of a failure or adverse [effect] is essential."

The SAIB's safety recommendations in part addressed the need for a retrofit technical solution to warn flight crews when the takeoff roll is initiated with the parking brake set.

Notes

1. ATSB. "Significant wind change during takeoff involving Boeing 737, VH-VZL Perth Airport, Western Australia, 4 December 2012." ATSB Transport Safety Report, Aviation Occurrence Investigation AO-2012-168, May 17, 2013.
2. Aviation Division, SAIB. "Final Report No. 2156 of the Swiss Accident Investigation Board SAIB concerning the accident involving the C525 aircraft, registration HB-VOV on 16 February 2011 at Grenchen regional airport (LSZG)." April 25, 2013.
3. V_1 means 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. V_1 also means the minimum speed in the takeoff, following a failure of the critical engine at V_{EF}, at which the pilot can continue the takeoff and achieve the required height above the takeoff surface within the takeoff distance.

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BY ED BROTAK

Gripping Story

Airports and ATC struggle to estimate and maximize runway friction in a variety of weather conditions.

Runway excursions (REs) are among the most common event categories of accidents in air transport operations. According to the European Aviation Safety Agency's (EASA's) latest safety review, "There were 100 runway excursion accidents and serious incidents at EASA aerodromes between 2008 and 2012."

These are events in which an aircraft either veers off the runway surface or overruns the end of the runway. Most REs are caused by improper approaches that lead to aircraft control issues after touchdown.

The threshold crossing height, airspeed, descent rate and angle on the approach are usually involved. Sometimes strong, gusty crosswinds, tail wind and/or runway friction are involved (*ASW*, 7/13, p. 43). Once the aircraft touches down, its deceleration capability and flight crew actions also play a role. So most REs are associated with multiple factors.

If you change one factor, an RE might be avoided. Runway conditions, although not a primary cause of REs, are often a contributing factor. Compromised runway conditions make it more difficult for the flight crew to overcome the problems produced by an unstable approach. A recent study by Boeing (*ASW*, 11/12, p. 8) indicated that 94 percent of REs occurred on non-dry runways.

After the tire tread on the landing gear makes effective contact with the surface of the runway, friction between the two allows the pilots to decelerate the aircraft while maintaining control. Any "contaminant" that gets between the tire and the runway surface can lessen the frictional bond. This leads to longer stopping distances and, at worst, runway excursions. Any type of debris, such as rubber particle buildup from tires, can be problematic. Water from rain is one of the most common contaminants. In colder climates, winter weather elements such as frost, snow, slush and ice can also greatly affect runway friction.

How winter runway conditions are determined and reported to pilots remains a focus of ongoing study and debate. Many airports periodically measure runway friction with specialized devices for decision making by air traffic control and, in some countries, advice to pilots. The resulting so-called Mu (coefficient of friction) value generated can range from 100 (U.S. value) or 1.00 (International Civil Aviation Organization value) for the highest friction to 0 for the lowest friction. Any value less than 40 on an operational runway should be recorded and the information passed along to incoming aircraft pilots.

Values less than 20 would result in closing the runway. More commonly, runway braking action is reported by pilots who already have landed; this is usually considered the most reliable indicator of runway conditions at the time of landing. A pilot who deems that the "braking action conditions" are less than good is expected to fill out a runway condition report and provide a pilot report.

Pilots should keep in mind that runway friction can change very quickly when precipitation is occurring, sometimes within minutes. A major problem in reporting runway conditions by pilots is their subjective nature. Last year, the U.S. Federal Aviation Administration (FAA) also stopped recommending that airports provide runway friction measurements to pilots when snow or ice is on the runway, citing inconsistencies in the measurement process (*ASW*, 11/12, p. 13).

Finally, at some locations, airport personnel themselves have been authorized to make the determination of runway friction and pass the information along to pilots.

To further assist pilots in assessing U.S. runway conditions, the FAA classifies runways as being "dry," "wet" or "contaminated." "Dry" would seem self-explanatory, but a damp runway, one which appears discolored but not reflective, is considered "dry." Damp runways often are the result of dew or very light rain, or represent the final drying stage of a previously wet runway.

A "wet" runway is sufficiently moist to appear reflective, but is still not considered "contaminated." Braking action is reduced, but conditions are still acceptable. A 1/8-in (3-mm) depth of water is considered the threshold for "hydroplaning" or "aquaplaning," in which a layer of water comes between the tire and the pavement surface,

Photo illustration: Susan Reed;
base photo: © Jakub Gojda/Dreamstime.com

This Embraer 190 slid off a wet runway while landing at Santa Maria, Colombia, after a flight from Cali in July 2007.

© Andrew P. Smith/Reuters

and loss of directional control can result. Keep in mind that water depths less than 1/8 in can still reduce friction and increase stopping distance even without loss of control. Also, sometimes runways can be described as "flooded." In these cases, large areas of standing water are visible.

Because rainwater is a common contaminant of runways, a number of methods are used to reduce its negative impact on friction. The asphalt or concrete used for the runway is specially textured. The primary purpose of the macrotexture or roughness of the runway surface is to provide a path for water to escape from beneath the tires.

Pavement texture makes a significant difference in the friction of a wet surface. A rough macrotexture provides much better friction in wet conditions. The microtexture, the fine-scale roughness or feel of the surface, helps break through the residual water film left. Grooves also are often cut into the runway surface to facilitate drainage. The FAA standard groove is ¼ in (6 mm) deep and ¼ in wide, and the grooves are spaced 1½ in (38 mm) apart. Runways also are sloped or crowned for better drainage.

The goal is to keep water levels on the runway below the height of the textured surface, thus eliminating standing water. The drainage ability of a runway is affected by the cross slope, the surface texture, wheel ruts and two weather factors — crosswinds and rainfall intensity. The direction of the wind can help or hinder water flow off the runway. But one of the most important factors is the intensity of the rainfall. The key question for airport engineers is, at what rainfall rate would the drainage capacity of a runway be overwhelmed and the water level on the pavement exceed the texture depth of the surface, leading to standing water?

Unfortunately, with all of the variables, there is no way to directly correlate specific rainfall rates with resulting runway conditions. We can, however, make some general statements.

Convective showers or thunderstorms can generate rainfall rates that compromise runway conditions. An inch (25 mm) of rain in 15 minutes or less is not that unusual. The critical 1/8 in of water can fall within a minute or two. Convection associated with tropical cyclones also is known for producing excessive amounts of rain. The more typical winter storms and fronts without convection usually are associated with rainfall rates of less than 1 in per hour.

Weather radar is useful in determining rainfall rates because the colors used on the meteorologist's standard radar display represent the strength of the signal return, which is directly related to rainfall intensity. Green areas indicate less than 0.1 in (2.5 mm) per hour. Yellow areas mean up to 0.5 in (12.7 mm). Orange shows 1 in or more. Reds and then purples indicate rainfall rates of 2 in (5 cm) or more per hour.

Winter-type precipitation in the higher latitudes is even worse in terms of contaminating a runway. According to the FAA, "a contaminated runway has more than 1/8 in of slush, snow, or compacted snow, ice, or frost covering more than 25 percent of the required length and width of its surface." It takes very little time, sometimes only minutes, for 1/8 in of frozen precipitation to accumulate. And unlike rainwater, frozen precipitation will not drain off. The methods used to drain water from runways will be of little use in these situations. Only air or ground surface temperatures above freezing will create melting from below and runoff.

Although frost is included among runway contaminants, its typical depth, less than 0.04 in (1 mm), is usually less of a problem. Frost also differs from other cold weather contaminants because, technically, it's not precipitation that falls from clouds. Frost is a frozen deposit of water vapor as ice crystals on a surface that occurs when the surface temperature falls to freezing and reaches the dewpoint. It usually occurs under clear skies and light to calm winds. Rime ice, which is deposited when clouds with below-freezing temperatures move across a surface, is similar.

Winter precipitation types include snow, sleet and freezing rain. Each has its own unique properties. Snow comprises ice crystals. The consistency of snow is a function of temperature. With temperatures near freezing, the snow is usually wet and heavy, the good packing snow of snowballs and snowmen. At colder temperatures, the snow becomes lighter and drier and not as compactable.

As any skier can tell you, the consistency of the snow affects how the surface of the ski moves over it. Skiers use different waxes on the bottom of their skis to go faster in different conditions. This same principle applies to snow on runways. Cold, dry snow has more grip, at times becoming almost sticky. Wet, mushy snow has a higher water content and greatly reduces traction. When temperatures on the ground are above freezing, the snow on the ground can contain a percentage of liquid water that produces slush. Slush also greatly reduces friction.

Snowfall rates are important in determining how fast the coefficient of friction of a runway can be affected. In convective snow events (*ASW*, 10/10, p. 18), snowfall rates can approach 4 in (102 mm) per hour. At this intensity, a runway can be compromised within minutes. Snowfall rates also are critical in marginal situations when air temperatures are near, or even above, freezing and/or when the runway surface itself has above-freezing temperatures. In these situations, snow can still accumulate if the fall rate exceeds the melting rate. In other words, when the snow is piling up on top faster than it is melting from below, it can accumulate regardless of temperature.

Sleet, which is composed of small ice pellets, can accumulate quickly, but its granular nature makes it less of a problem for aircraft deceleration.

Clearly, the worst winter precipitation for runway excursion risk is freezing rain or glaze. In this case, liquid water droplets fall to earth and freeze on contact with any surface that has temperatures below 32 degrees F (0 degrees C). This can leave a layer of sheer ice on any paved surface. Often the layer of ice has some water on top of it.

Studies have shown that wet ice produces the most dangerous runway surface conditions. Four or five times the stopping distance that would be required on dry pavement can be needed. Wet ice on a runway often leads to unacceptable braking conditions and closing the runway.

To deal with winter precipitation, airports utilize a number of tools. For snow, old-fashioned snowplows and snowblowers help keep runways open. In addition, runway sweepers with rotary steel bristle brushes remove remaining snow. Unfortunately, these are very labor intensive and often slow processes. And if snowfall rates are too great, it becomes physically impossible to remove the snow fast enough to keep the runways clear and the airport must close until the snowfall lessens.

In icing situations, runways may be treated with sand, like highways. Or deicing/anti-icing chemicals can be sprayed on runways just as they are sprayed on aircraft to remove ice and/or temporarily prevent surface icing.

Some airports opt to treat runways ahead of time with "freezing-point depressant" chemicals to prevent ice accumulation. The cost of the chemicals and environmental concerns are factors in their availability as a mitigation, however. Easily the most ambitious recent attempt at solving the winter precipitation problem is with a heated runway system such as the one at the Denver International Airport. Geothermal energy also shows promise.

Edward Brotak, Ph.D., retired in 2007 after 25 years as a professor and program director in the Department of Atmospheric Sciences at the University of North Carolina, Asheville.

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BY LINDA WERFELMAN

Studies of in-flight medical emergencies aim to identify strategies for deciding when diversions are appropriate.

Enhanced guidelines for evaluating and managing the symptoms of ailing airline passengers and increased awareness of high-risk groups could reduce the number of "futile diversions," medical researchers say.[1]

A study published in the May issue of *Aviation, Space, and Environmental Medicine (ASEM)* also recommended the prescreening of some passengers recently discharged from hospitals, post-operative patients and people with specific terminal illnesses.

"Formulation of specific management guidelines for different symptom-based categories, grounded on evidence-based results, is the next step to establish specific action plans for flight attendants," the study said. "Actions should be clearly delineated, and the role of coordination of available medical volunteers and the ground-based physicians clarified."

In-flight medical kits with detailed guidelines on when and how to use specific medications and medical equipment also would aid both flight attendants and medical volunteers, the report said.

"The need for medical diversion is a balance between the proximity of ground resources and the availability of resources on board," the document added. "This decision [on whether to divert a flight] requires more specialized training for cabin crew [and] medical professionals and enhanced tools for communication with ground-based medical advice services."

The study examined data from 4,068 in-flight medical events that occurred at a large Hong Kong commercial airline from December 2003 through November 2008 and found that medical volunteers participated in 1,439 (35.4 percent) of the cases, including 39 (84.8 percent) of the 46 cases that resulted in an aircraft diversion.

Medical volunteers — who, in 77 percent of the cases, were doctors who had been flying as passengers — were more likely to be involved when the events were serious, the study said, noting that the airline's policy was to call for volunteers only if recommended by MedLink, a ground-based medical advisory service, or if the passenger was obviously critically ill.

The study was designed to determine how medical volunteers functioned during in-flight medical emergencies and to identify strategies that might result in "more appropriate diversions," the document said, noting, "Flight diversions are not only costly but also pose increased risks to the other passengers."

These increased risks come as the flight crew travels to an unexpected destination and conducts what may be an unfamiliar instrument approach. In addition to safety risks, flight crews may need to dump excess fuel before an emergency landing, which can damage the environment and increase fuel consumption; and a diversion may result in costly delays for passengers and the operator.

Records allowed for further review of 36 of the 39 diversions, and of that number, 12 passengers were released, 16 were hospitalized, and eight died during the flight (Figure 1). Of those who were hospitalized, half were suspected of having had a stroke, two had chest pain and two went into labor.

Of seven diversions handled without medical volunteers, three passengers were released after emergency room evaluation, three were hospitalized, and one died during flight. Of those who were hospitalized, one each experienced pain, "nonspecific" symptoms and bleeding with no injury.

Illustration: Susan Reed; photo: © Bailey/AirTeamImages

Diverted

The study's authors said they "cannot conclude that the presence of medical volunteers leads to more medical diversions. This remains an association, and there is no evidence to infer that volunteers directly cause more diversions."

They added that the ratio of "appropriate diversions" was the same for patients on flights that were diverted after the intervention of medical volunteers and for those on flights where the decision to divert was made without a volunteer's input.

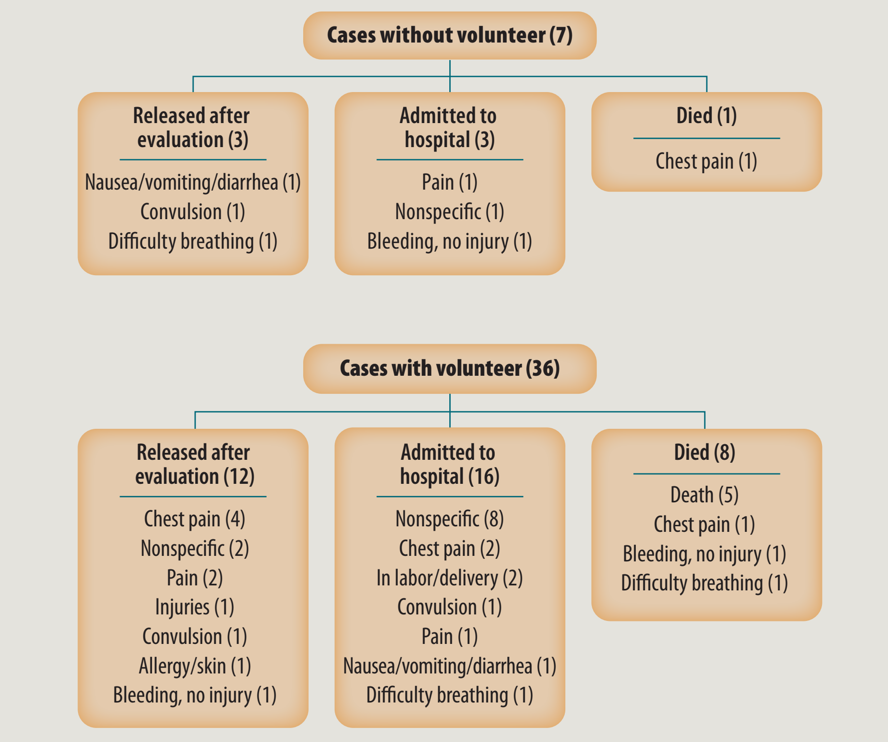
Overall, suspected strokes (categorized as "nonspecific") accounted for 25.6 percent of diversions, more than any other category, followed by chest pain (18.6 percent) and death (11.6 percent; Table 1, p. 28).

Therefore, the study said, "it may be useful to incorporate simple pre-hospital stroke scales … into the training of the cabin crew." Such assessment scales typically call for a simple evaluation of whether both sides of the face move equally or one side does not move, whether both arms can be moved equally or one arm drifts down, and whether speech is correct or the words are garbled or the passenger cannot speak.

In cases of chest pain, limited diagnostic equipment is available during flight, and treatment focuses on providing oxygen, aspirin and other medications to stabilize the passenger's condition.

In the third category, "death," all five diversions were diagnosed as cases of cardiac arrest. The study questioned whether a flight diversion is wise for patients who experience cardiac arrest during flight.

Symptom-Based Categorization of Diversions



Source: Hung, Kevin K.C.; Cocks, Robert A.; Poon, W.K. et al. "Medical Volunteers in Commercial Flight Medical Diversions." *Aviation, Space, and Environmental Medicine* Volume 84 (May 2013): 491–497.

Figure 1

Symptoms Associated With Medical Flight Diversions

Symptom Category	Diagnosis	Frequency (Percent)	Strategies
Nonspecific	Stroke	11 (25.6)	Stroke assessment, glucose test, conscious-level assessment
Chest pain	Acute coronary syndrome	8 (18.6)	Diagnosis, treatment of coronary artery disease
Death	Cardiac arrest	5 (11.6)	Cardiopulmonary resuscitation, use of automated external defibrillator, diversion protocol for cardiac arrest cases
Pain	Intracranial hemorrhage (1), Back pain (1), Kidney stone (1), Ectopic pregnancy (1)	4 (9.3)	Diagnosis and pain management
Convulsion	Convulsion	3 (7)	First aid, glucose test
Difficulty breathing	Asthma (1), Cancer (1), Cyanosis (1)	3 (7)	Use of oxygen, asthma treatment, monitor
Bleeding, no injury	Epistaxis (1), Antepartum hemorrhage (1), Vaginal bleeding (1)	3 (7)	First aid
Nausea/vomiting/diarrhea	Diabetic ketoacidosis (1), Vomiting (1)	2 (4.7)	First aid, glucose test
Labor/delivery	Labor	2 (4.7)	Basic delivery
Allergic/skin	Peanut/tomato allergy	1 (2.3)	First aid
Injuries	Head injury	1 (2.3)	First aid, conscious-level assessment
Excluded for categorization		3	
Total		**46 (100)***	

* Percentages do not total 100 because of rounding.

Source: Hung, Kevin K.C.; Cocks, Robert A.; Poon, W.K. et al. "Medical Volunteers in Commercial Flight Medical Diversions." *Aviation, Space, and Environmental Medicine* Volume 84 (May 2013): 491–497.

Table 1

"The chances of a successful resuscitation in non-VF [cardiac arrest not involving ventricular fibrillation] out-of-hospital arrest are extremely low, even on the ground, and therefore the decision to medically divert should be taken very carefully," the study said. "Considering the time it will take for the passenger to be taken to the hospital, diversion is only medically warranted if the patient responds to resuscitation, and not for every passenger with cardiac arrest."

Second Study

A separate study, published in the May 30 issue of the *New England Journal of Medicine*, reviewed 34 months of calls from five airlines to an unidentified medical communications center and found that the most frequent medical problems experienced by passengers were syncope (fainting) or presyncope (lightheadedness and weakness), 37.4 percent; respiratory symptoms, 12.1 percent; and nausea or vomiting, 9.5 percent.[2]

Hospitalizations most often were attributed to cardiac arrest, strokelike symptoms, obstetrical or gynecological symptoms and cardiac symptoms.

The study examined in-flight medical emergencies that prompted crewmembers to consult with medical experts on the ground — a situation that occurred at a rate of about 16 per 1 million passengers — or about one time in every 604 flights.[3] The 11,920 calls, made from Jan. 1, 2008, through Oct. 31, 2010, to experts on the ground, resulted in aircraft diversions in 875 (7.3 percent) of the cases.

Medical Volunteers

In 48.1 percent of cases, medical assistance came from physicians who were traveling as passengers. Nurses volunteered in 20.1 percent of cases, emergency medical services (EMS) providers in 4.4 percent, and other health care professionals in 3.7 percent of cases.

"Aircraft diversion and hospitalization rates differed according to the type of medical volunteer," the report added, noting that, by a very slight margin, physicians had the highest diversion rates — 9.4 percent. In comparison, diversion rates for EMS providers were 9.3 percent; for nurses, 6.2 percent; and for crewmembers, 3.8 percent.

Hospitalization rates were highest for EMS providers — 10.2 percent — compared with 9.3 percent for physicians, 8.7 percent for nurses and 4.7 percent for flight crewmembers.

In-flight treatment most frequently involved providing oxygen (in 49.9 percent of cases), intravenous saline solution (in 5.2 percent) and aspirin (in 5.0 percent), the study said.

Aircraft diversion was most closely associated with use of an automated external defibrillator (AED) and assistance from an EMS provider, the study added, noting that records showed that AEDs were applied to 137 patients (1.3 percent). For the 134 patients with medical records detailed enough to allow further analysis, researchers determined that AEDs were used when the primary symptoms were syncope or presyncope, and chest pain; they also were applied in 24 cases of cardiac arrest. Of these, a shock was delivered to five patients. In nine cardiac arrest cases, cardiac activity resumed while the AED was being used, and all but one of the nine survived long enough to be admitted to a hospital. Eighty-four of the 134 patients treated with AEDs had lost consciousness.

In 42.1 percent of cardiac arrest cases, the flight was not diverted, the study said; in some of these cases, an immediate diversion was not possible because the airplane was on a transoceanic flight or near its planned destination.

Follow-up information was available for 10,914 patients, indicating that 3,402 (31.2 percent) needed no additional care after landing. Emergency medical services personnel were summoned for 7,508 patients, including 2,804 (37.3 percent) who were taken to a hospital emergency room; of those for whom follow-up information was available, 901 patients (8.6 percent) were admitted to the hospital or left the emergency room against the advice of medical personnel.

Reasons for Hospitalization

The most common reasons for admission, the study said, were cardiac arrest; stroke symptoms; obstetrical or gynecological symptoms, most often bleeding that signaled a possible miscarriage; and other cardiac symptoms.

Records showed that 36 of the 10,914 passengers died, including 30 who died during flight.

Overall, the study estimated that 44,000 in-flight medical emergencies occur every year. Most of these are "self-limiting or are effectively evaluated and treated without disruption of the planned route of flight," the study said. "Serious illness is infrequent, and death is rare."

Consultations

Like the *ASEM* report, the *Journal* study noted that some airlines require flight attendants to consult with a ground-based physician before using the emergency medical kit in the airplane.

"Passengers' symptoms can often be managed in collaboration with the flight attendants, who are well versed in the equipment that the airplanes carry and in operational procedures," the study said. "When the need for evaluation or intervention exceeds their capabilities, flight attendants may seek health care professionals on the flight."

The study recommended establishing step-by-step procedures for coping with the most common in-flight medical emergencies — syncope, respiratory symptoms, nausea or vomiting, and cardiac symptoms.

For example, the study said that patients with syncope, who may initially be unresponsive and have low blood pressure, usually improve in about 15 minutes with no treatment other than fluids, administered by mouth or intravenously.

Cases of heart attack, stroke or "other factors that raise concern about time-sensitive conditions," including passengers with "persistently altered mental status," should prompt the crew to consider a diversion, the study said.

Challenges

Providing medical treatment during flight can be challenging, in part because of the limited availability of space and medical equipment, the study said.

Nevertheless, the document added, "diversion of a commercial airliner to an unscheduled destination for an ill passenger requires consideration of both medical and operational issues. The potential medical benefit should be assessed on the basis of the condition and its time sensitivity, the ability to stabilize the patient's condition with available supplies and the likely time savings with consideration of the time needed to land and the proximity of medical resources to specific airports. Immediate operational factors that may contribute to variability in airline practices include weather, fuel load and the potential need to drop fuel before landing, the availability of specific aircraft services at airports and air traffic control."

The study called for the "systematic tracking of all in-flight medical emergencies, including subsequent hospital care and other outcomes, to better guide interventions in this sequestered population."

Notes

1. Hung, Kevin K.C.; Cocks, Robert A.; Poon, W.K. et al. "Medical Volunteers in Commercial Flight Medical Diversions." *Aviation, Space, and Environmental Medicine* Volume 84 (May 2013): 491–497.
2. Peterson, Drew C.; Martin-Gill, Christian; Guyette, Francis X. et al. "Outcomes of Medical Emergencies on Commercial Airline Flights." *New England Journal of Medicine* Volume 368 (May 30, 2013): 2075–2083.
3. Participating airlines accounted for about 10 percent of passenger flight volume worldwide for the time period studied.

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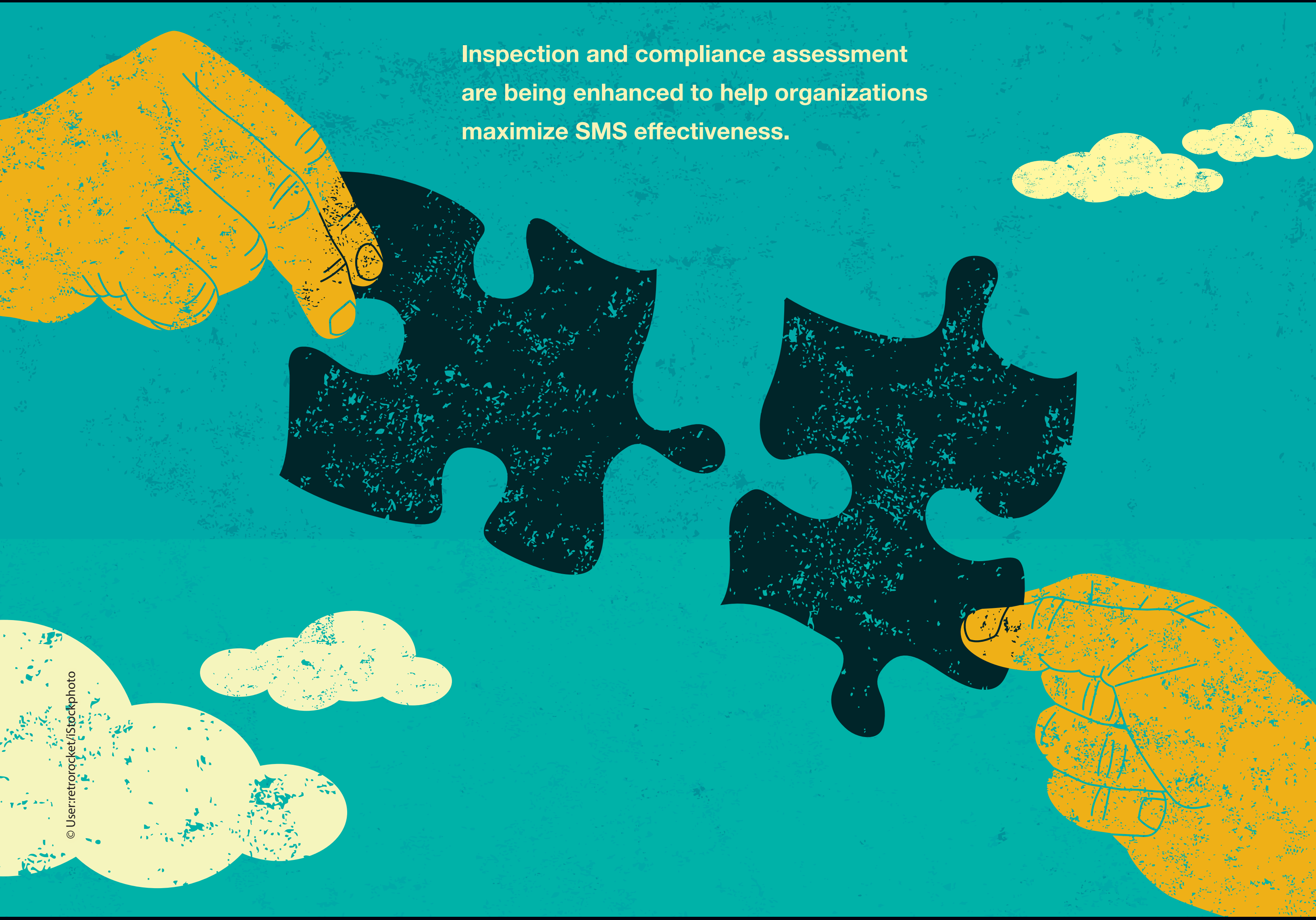
NEW ROLE FOR THE Regulator

BY SIMON ROBERTS AND THE SAFETY MANAGEMENT INTERNATIONAL COLLABORATION GROUP

Inspection and compliance assessment are being enhanced to help organizations maximize SMS effectiveness.



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State and regional civil aviation authorities are changing their approach to regulatory oversight with the evolution of safety management systems (SMS), and some have struggled with confusion and inconsistencies. Recognizing this, the Safety Management International Collaboration Group (SM ICG), a group of regulators, has responded with experience-based advice about the transition.

Members of the SM ICG have begun sharing experiences and lessons learned to provide better guidance on the interpretation of safety management requirements. One key objective is to deliver guidance on how to implement a state safety program (SSP) and SMS at both the state and operator levels. Essential to the successful implementation of SMS is the realization that SMS builds on years of prescriptive requirements written as a result of lessons learned from past events (reactively). This has produced a safe industry, but we must also ensure that we do not become complacent as the aviation system changes.

SMS continues our shared journey toward an even safer industry, in which prescriptive rules do not fit every organization or operation. However, if SMS is misinterpreted, this can create its own safety risk rather than the safety benefits intended.

As former Flight Safety Foundation President and CEO William R. Voss wrote in a recent article (*ASW*, 5/13, p. 7), SMS does not have to be complicated. At the same time, regulators need to protect the public while industry has a responsibility to offer safe products and services. Together, we must provide the right level of safety assurance in a proportionate manner that reflects the size, nature, inherent risk and complexity of the organization.

SMS at the operator level is about managing risk — current, future and third-party. Within the operator's system, third parties are extensively used for safety-critical services such as contracted maintenance, ground handling, fueling, deicing and aircraft loading.

The surveillance and oversight of these third-party organizations are paramount for states and operators, as such organizations not only generate risks but also manage and control some of the risks faced by the primary organization. This involves not only looking at how they meet the regulations but also at the effectiveness of the safety barriers they control and knowing the safety risks that could be transferred onto others. Important conversations on risk should take place between these organizations.

An effective SMS has to bring organizations together, as the management of risk often is shared. It also should bring the regulator and the regulated together in a collaborative relationship as part of the state safety program. The International Civil Aviation Organization (ICAO) SMS framework was a good starting point, but now that we understand SMS better, one question arises: Are the current regulations still fit for purpose?

More and more states are recognizing the need to address the total system rather than provide oversight to isolated parts. Indeed, many of the risks sit in the gaps and interfaces between different parts of the system. Safety management of the individual parts does not necessarily equal the safety management of the whole system.

Many of the risks sit in the gaps and interfaces between different parts of the system.

SMS requires a change of approach from industry and the regulators. As regulators, we want to see organizations implement an effective SMS that is adding safety value. This includes organizations having a better risk picture and a means to monitor their safety performance, so they know that they are taking the right actions for the risks they face. We also want to see the industry reduce its safety risks and get a return on its investment.

One of the greatest challenges for everyone is the shift in organizational cultures. An SMS will not be effective without the right safety culture, but this key point is missing from most SMS regulations. This is because culture is subjective and difficult to regulate. However, this should not stop the regulator from assessing safety culture (even subjectively) and providing that independent view to the organization's accountable executive and senior management. Moreover, this assessment should contribute to determining the level of surveillance needed for performance-based oversight.

As regulators move toward risk-based oversight or performance-based oversight, they need to consider not only how well an organization complies with regulations but also how well it understands and manages its safety risks and monitors its safety performance. As regulators, our confidence in the organization to manage safety is also based on our view of its safety culture.

It is not just the regulated organizations that need to ensure they have the right culture to enable their SMS to deliver. Each regulator is on its own journey, too. Inspectors need to consider the performance and effectiveness of the SMS in addition to compliance.

This requires a different way of thinking on the part of the inspector. Having a well-crafted safety management manual and delivering SMS training won't itself produce an effective SMS. It is how the organization manages safety in practice that adds most value.

Does it do what it says it does? Are these strategies effective? How does the inspector evaluate the effectiveness? It starts with the organization's risk register and focuses on the biggest risks. Do they reflect the same risks that the state has identified in its own SSP, and do they reflect those of similar organizations in the same sector? Has the organization identified its risks correctly? This is where the SSP feeds into the SMS oversight and the SMS oversight feeds back into the SSP.

The competencies expected of the regulatory inspector are changing. Inspectors are now being required to understand risk, safety performance, safety culture and human factors, and judge the performance and effectiveness of an SMS. They will need to acquire new skills and a shift in the culture of the inspection staff, which will take time.

Furthermore, the ICAO SSP/SMS frameworks have been around for a while, and there are still areas of confusion and inconsistent interpretation. We need to make sure that other states learn from those that have already been on the SMS journey and have uncovered issues and pitfalls on the way so others don't make the same mistakes. This was one key reason that the SM ICG was established.

The state safety program, in conjunction with the cumulative effects of individual organizations' SMS, can provide that extra layer of safety. However, this will only happen if it meets the original intent and doesn't get lost in unnecessary complexity and language that not everyone understands. We need to avoid the jargon of SMS and communicate so that everyone understands what safety management is trying to achieve.

We need to consolidate our understanding and our application of safety management before we move on to something new. We are a long way from reaping the full rewards of effective safety management. That doesn't mean we should give up, it just means we should manage our expectations about progress and celebrate each critical step forward on the SMS journey.

The Safety Management International Collaboration Group (SM ICG) is a joint partnership of many regulatory authorities for promoting a common understanding of safety management principles and requirements and facilitating their implementation across the international aviation community. Further information regarding SM ICG can be located at <www.skybrary.aero/index.php/Safety_Management_International_Collaboration_Group_(SM_ICG)>.

Inspectors are now being required to understand risk, safety performance, safety culture and human factors, and judge the performance and effectiveness of an SMS.

Worth the Wait

Continuing to build upon the late-1990s legacy of knowledge, intensive efforts in the past four years have propelled airplane upset prevention and recovery training (UPRT) from the milieu of a few subject matter experts to finalizing international standards and guidance for commercial air transport (*ASW*, 7/13, p. 27).

What's new is increased experience among airlines that — after working closely with other stakeholders to stem the risk of loss of control–in flight (LOC–I) — have become voluntary early adopters of UPRT, some receiving glowing responses from pilots who have completed this training.

Presenters and attendees filled in details of these developments, cited a few points of controversy and highlighted next steps on their agendas during the World Aviation Training Conference and Tradeshow (WATS 2013) in April in Orlando, Florida, U.S.

"Stall training [has] been required, for a private pilot license through type ratings, forever," said Paul Kolisch, a captain at Pinnacle Airlines. "Nonetheless, we continue to lose airplanes in the commercial fleet, and most [such accidents]

Upset prevention and recovery training gains endorsements from airline pilots.

BY WAYNE ROSENKRANS

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are following stall events and the loss of control–in flight. [Pilots] didn't need to get upside down or even close to it. But the airplane wasn't flying. And the pilots didn't recognize it. … We have to use our imaginations and be open to new possibilities that really, virtually, violate our traditional stall training."

Despite consensus recommendations of industry specialists behind the U.S. Federal Aviation Administration's (FAA's) August 2012 publication of Advisory Circular 120-109, "Stall and Stick Pusher Training," Kolisch said he still encounters skepticism and distrust about UPRT-related changes. "There are still people out there who say 'They don't apply to us,'" he told the conference. "Well, wings apply to you. And if they stop flying, they're a problem for you."

A significant discrepancy has endured, he said, between the 5,000-ft to 10,000-ft altitudes traditionally used in approach-to-stall training for airline pilots and the altitudes where actual stalls occurred in recent LOC–I accidents. Moreover, the traditional training had failed to emphasize that typical pilots instinctively react to a startle/surprise affecting their flight path with immediate control input to increase pitch. UPRT instructors address this response, telling simulator students, "That's what you're going to do; now here's how you recover," Kolisch said.

"In current practices, approach to stall is a scripted maneuver; it's limited to non-realistic scenarios and it's typically hand-flown," he said. "I call it *choreography.*" Updates to regulatory standards, official guidance and practical test standards overcome such weaknesses. Therefore, stall prevention, recognition and recovery can be accomplished today before an anomaly deteriorates to a violent, possibly unrecoverable, airplane upset, he said.

"The first thing you do is get the nose down," Kolisch said, paraphrasing the key message adopted by various stall and UPRT working groups. "If you don't get the nose down, the wings aren't flying long enough to level them. … [Training requirements also] should *not* mandate a predetermined value for altitude loss, nor mandate attaining an altitude during recovery.”

Pinnacle Airlines is an example of the airlines that have opted to implement the latest best practices. “No one comes out of our training without going through high-altitude and low-altitude stall training — most of it starting on the autopilot [to be] realistic,” Kolisch said. One point of potential confusion that must be overcome in low-altitude stall training, he said, involves flight crews hearing “PULL UP” alerts from the terrain awareness and warning system at the same time that stall recovery requires them to reduce angle-of-attack to reattach airflow to the wings so that responding

Preview of UPRT Enhancements to Instructor Operating Stations

Imminent flight simulation training device (FSTD) enhancements for teaching pilots upset recovery in large commercial jets include several currently under review by the U.S. Federal Aviation Administration (FAA) and already described in FAA interim guidance. An example of the technology being finalized within the flight simulation industry provides upgraded feedback to instructors/evaluators via four new displays intended for instructor operating stations (IOS) and debriefing rooms,[1] says Lou Németh, chief safety officer and captain, CAE.

During one session at the World Aviation Training Conference and Tradeshow (WATS 2013), he presented designers’ concepts of what this IOS feedback may look like and how it will work. So far, Németh said, one purpose for giving the airline industry previews of these displays has been to “dispel the myth … that simulators are not an effective tool for upset prevention and recovery training [UPRT].”

The four new IOS displays are tools that an instructor will use to provide feedback to the student during and after six standardized UPRT maneuver scenarios. The interim FAA guidance specifies that this feedback must indicate the fidelity of the simulation, the magnitude of student control inputs, and the aircraft operational limits that could affect the success of one or more maneuvers.

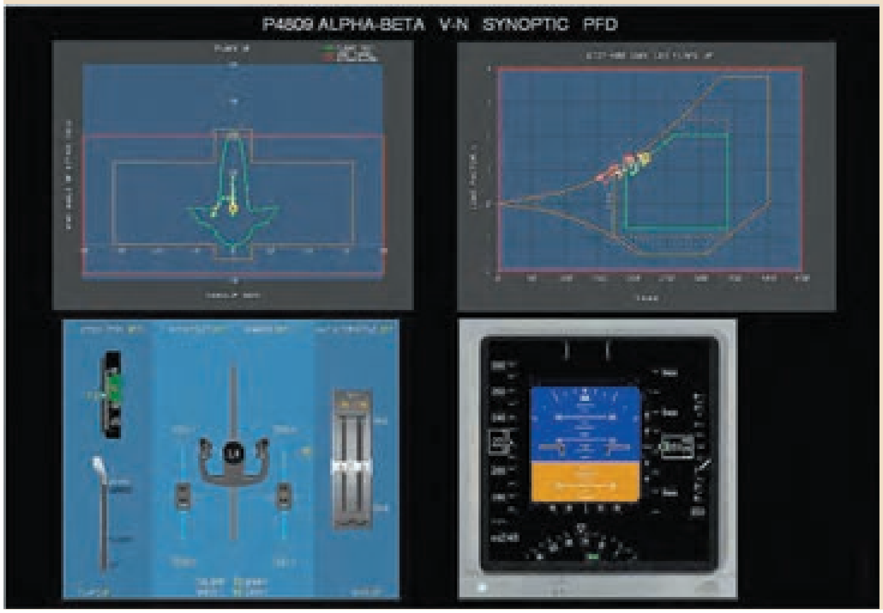
The FAA’s three minimum requirements for any FSTD used for this purpose (Figure 1) are a simulator validation envelope (the alpha/beta crossplot[2] on the IOS or equivalent alternate method); IOS display of flight control inputs while the student is performing maneuvers (especially any inputs that otherwise cannot be assessed by the instructor, such as rudder pedal displacement and control forces); and a method to inform the instructor of the relationship between the maneuver and aircraft operational limits. The latter typically would be a V-n diagram[3] showing how these limitations may affect the maneuver. Ideally, the FAA suggests, operators should install capability to record and play back all these dynamic parameters.

“Our graphs should give the instructor enough information to show whether or not the airplane was recovered within the airplane structural limits and the limitations as they’re defined by the *Airplane Upset Recovery Training Aid* [*ASW*, 7/13, p. 30],” Németh said. “The instructor has to look at all four of these” alongside data from flight control positions and flight instrument indications.

CAE predicts that typically these IOS upgrade tools will replay and freeze moments or frame sequences during debriefing animations of flight crew maneuvers/aircraft performance, and help simulator students understand the safe/unsafe outcomes.

“When you are doing UPRT, there’s so much going on over a short period of time that you need to be able to stop and look at it almost frame-by-frame to understand and show pilot performance and properly debrief the student,” Németh said. “Recorded data may be replayed because it’s so rich, and it happens so fast. The instructor can stop at the IOS and retrace the dots across the screen to see what

Figure 1



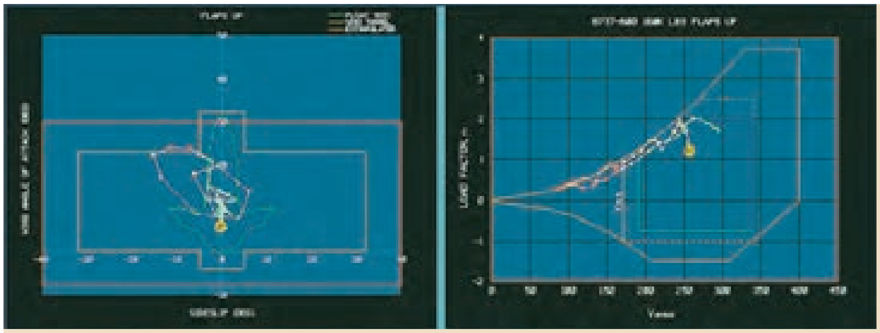
© CAE

to the alerts becomes possible. While showing a video of an airline crew's simulator session in this scenario, he said, "The GPWS [ground-proximity warning system] was telling them 'PULL UP.' Pulling up kills you."

Stick Pusher Training

For operators of stick pusher–equipped airplanes, UPRT elements should be implemented to avoid negative training, Kolisch said. Without this training, the typical response of a pilot who encounters the shaker or other indicators of stick pusher activation (firing) is to pull the control column.

Simulator instructors tasked with inducing surprises can tell you, "Don't pull, don't pull, don't pull — and you'll



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happened, to see where the flight controls were in every part of the maneuver on a second-by-second scroll."

For example, capturing the alpha-beta plot readily depicts the aerodynamic status of the airplane inside and/or outside the normal (green) aerodynamic envelope. "I maintain that a good upset recovery will stay inside that green envelope," Németh said.

Similarly, the V-n diagram shows that as a pilot's maneuver increases aerodynamic load in relation to the known structural limits, the stall speed increases along the diagram's coefficient of lift/drag curve. Plotting maneuver data as green, yellow and red dots traced over the V-n diagram helps the instructor and student to visualize and grasp the complex interaction of aerodynamic parameters.

On one of the new IOS displays, the control positions and primary flight display are supplemented by data for speed-trim status, trim indicator, speed brake status, rudder pedal deflection (percentage and the amount of force applied), g-meter (a device indicating aerodynamic load relative to standard acceleration of gravity [g]), autopilot on/off status, autothrottle status, and landing gear up/down status.

The differences among safe, unsafe and unsurvivable performance quickly become apparent when these feedback data immediately are available. The CAE presentation focused on two pilots' recovery performance during one of six standardized UPRT simulator scenarios, the nose-up maneuver.

In one slide, the UPRT-trained pilot's "maneuver started at just slightly under 2 g," Németh said. "The nose pitches up, the pilot unloads, moves the airplane toward the center of the envelope and then starts a dive recovery until the end of the recording. Each dot represents one second. The margin between where the pilot was and the positive-g stall is very important; this shows a good recovery. This shows that the pilot understood the relationship between g and stall, unloaded the airplane and moved the airplane away from the danger zones."

He compared the preceding safe performance on this maneuver with that of a similar type-rated airline pilot who had not completed UPRT. "The green dots at about 1.8 g are the start of the maneuver," Németh said, showing the corresponding slide (Figure 2). "The airplane is pitched up in the nose-high recovery maneuver and the unload is not as significant as the good recovery example. This pilot is in and out of the stall during the recovery. We can represent the difference — or the margin of safety — between where this pilot was and the safe recovery of the airplane as per the previous slide. There is no margin of safety, and he is in and out of the stick shaker in the recovery."

Simply counting dots on the display of the alpha-beta plot tells the story. The unsafe-maneuver pilot was in a stall for 15 seconds. "I know that because I can see that he was on the stall line on the V-n diagram, and he was in this red region on the alpha-beta plot," he said. Moreover, this pilot's unsafe effort even exceeded the simulator validation envelope — that is, the known range of fidelity to the actual airplane — of the FSTD's approved aerodynamic database.

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Notes

1. FAA National Simulator Program (NSP). "FSTD Evaluation Recommendations for Upset Recovery Training Maneuvers." *Flight Simulation Training Device Qualification Guidance 11-05.* NSP Guidance Bulletin, Dec. 20, 2011.
2. An alpha-beta plot graphs the wing angle-of-attack in degrees (alpha) on the vertical axis and the airplane sideslip in degrees (beta) on the horizontal axis. Flight envelope boundaries are overlaid based on flight test data, wind tunnel data and data from engineers' extrapolations. In Figure 1 and Figure 2, the irregular green-outlined shape is the approved aerodynamic envelope of the simulator incorporating flight test data under license from the airframe manufacturer.
3. A V-n diagram shows the normal load factor and airspeed limits of a specific aircraft type.

pull," he said. "But if you practice it a few times, then you'll release it. … Release, put the nose down, and you'll recover."

Lou Németh, chief safety officer and a captain, CAE, cited a potential source of confusion. "You're sitting in the cockpit of a stick pusher–equipped airplane, and the preflight procedures require you to hang on to the stick pusher and fight through the stick pressure," he said. "So every preflight, you're sitting there holding onto this thing, and you're doing absolutely the opposite of what you should do if the stick pusher fires in flight. … We want to demonstrate the stick pusher, and we want to see the pilot demonstrate proficiency in respecting the stick pusher when it fires in flight." Németh was chairman of the Stick Pusher and Adverse Weather Aviation Rulemaking Committee and Loss of Control Avoidance and Recovery Training, a committee of global civil aviation authorities; and co-chairman of the International Committee for Aviation Training in Extended Envelopes Training Committee.

Watershed Event

In February 2009, the Colgan Air Flight 3407 crash in the United States (*ASW*, 3/10, p. 20, and 5/12, p. 33) began to raise LOC–I to the highest tier of the safety agenda of the Air Line Pilots Association, International (ALPA), eclipsing airline pilot selection, licensing and mentoring, recalled Frank Cheeseman, human factors and training group chairman for ALPA and an Airbus A320 captain for United Airlines.

"We need to give pilots the tools to survive: low-altitude, medium-altitude and, in most of our operations, high-altitude [UPRT]," he said. "It's a pass-fail exercise. It's a train-to-proficiency exercise. It's a survival exercise."

The airline industry absolutely must "avoid negative training, but at the same time, we shouldn't be afraid to use our simulators because they're not exactly perfect," Cheeseman said. ALPA recently has joined follow-on activities, including a search for ways to enhance the "difficult skill of pilot monitoring" and redouble its effectiveness.

ALPA urges the U.S. airline industry not to attempt to circumvent full UPRT — specifically, the training requirements included in U.S. law[1] — by *not* exposing pilots to full aerodynamic stalls and recoveries in approved flight simulation training devices (FSTDs). "We don't understand why this is a big discussion in the United States," he said.

Airbus and Boeing representatives at the conference reiterated their positions that the stall avoidance and recovery aspect of UPRT is valid and important for all airline pilots, regardless of the protective automation of fly-by-wire airplanes. Such training is necessary in part to prepare flight crews for a lower level of protection — for example, changing from normal law to alternate law[2] on Airbus aircraft.

"We do the stall exercises up to the point where it is valuable," said Jacques Drappier, a captain and senior adviser training, Airbus. "We're not at the point that we go into a post-stall situation, which was the case of the Air France [Flight 447 LOC–I, *ASW*, 8/12, p. 14]. There you are in a totally different regime. And I don't think anybody is ready to go into that regime at this point in time. … I think the limitation is 'What are the capabilities of training?' not 'What are the airplane capabilities?'"

ALPA's Cheeseman said, however, "There are some airlines that are engaging [in simulator] training in a flight-protected airplane in a full-stall situation. The initial critiques from [ALPA-represented] pilots that have gone through that training have been extremely positive … a tremendous confidence-builder. I happen to be one of them."

Other Pilot Reports

As part of its advanced qualification program for pilots, UPS Air Cargo has designed programs to teach low-altitude, low-speed stalls and high-altitude, low-speed stalls in FSTDs, said attendee Jeff Ryan, a UPS captain, Boeing 767 check airman and simulator instructor.

"Having gone through it, I will tell you that it was extremely eye-opening," he said. "First, [practicing recovery from] a low-altitude, low-speed stall, initially dropping the nose, the airplane regaining flying speed, and then doing a high-altitude, low-speed stall with the autopilot engaged, [reinforced] how much time it actually took once you dropped the nose. … The airplane would break the stall, but your tendency to recover way too early and get a secondary stall was extremely impressive [in] that it took patience to get the airplane … roughly back to about 200 kt. Anything between the 130-kt to 140-kt stall — and even [at] 170 kt — you get back to a secondary stall. So the training was fantastic."

Notes

1. The Airline Safety and FAA Extension Act of 2010 affected many aspects of airline pilot licensing and training in the United States in the wake of the Colgan Air Flight 3407 crash near Buffalo, New York.
2. The Airbus system logic called *normal law* provides a number of automatic protections against exceeding flight envelope parameters. Manual selection or unexpected system reversion to *alternate law* logic requires different flight procedures.

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Pressure Points

BY LINDA WERFELMAN

A pilot's decision to continue a charter flight into IMC led to a fatal crash on a cloud-covered plateau.

The pilot of a Eurocopter AS350 BA probably felt pressured by his employer, his client and his passengers when he flew an overweight helicopter into an area of deteriorating visibility in eastern Quebec, Canada, in August 2010, the Transportation Safety Board of Canada (TSB) said.

The 235-hour pilot of the charter flight lost visual contact with the ground and then lost control of the helicopter, which crashed 22 nm (41 km) north of Sept-Îles. The pilot and his three passengers were killed in the crash, and the helicopter was destroyed.

"When inexperienced pilots face operational pressures alone, without support from the company, they can be influenced to make decisions that place them and their passengers at risk," the TSB said in its final report on the accident.

On Aug. 13, 2010 — four days before the flight — Hydro-Québec, a generator and distributor of electricity, contacted Héli-Excel to arrange for an AS350 B2 for the Aug. 17 charter flight from Sept-Îles to Poste Montagnais, 100 nm (185 km) north. Plans called for the helicopter to remain in the Poste Montagnais area for three days for inspections and maintenance of Hydro-Québec installations and to be flown back to Sept-Îles on Aug. 20.

Héli-Excel agreed to the charter request, although the specified load would have resulted in an overweight takeoff and the pilot had less experience than required by Hydro-Québec's criteria.

Because an AS350 B2 was not available, an AS350 BA — with a maximum takeoff weight 330 lb (150 kg) less than the AS350 B2 — was selected instead, and plans were made to transport some of the anticipated 300 lb (136 kg) of baggage by airplane.

Nevertheless, the morning of the flight, the passengers, who presumably were unaware of the weight limit or the agreement to divert some of the baggage to the airplane, presented more than twice the expected amount of baggage — 761 lb (345 kg) — mostly consisting of work tools.

The flight was delayed more than 90 minutes because of instrument meteorological conditions (IMC), and departed from Sept-Îles at

There were no indications of problems with the engine or flight controls of a Eurocopter AS350 BA, similar to this one, that crashed in low visibility in eastern Quebec.

©Jean-Philippe Drouin/Airliners.net

1111 local time Aug. 17, 2010, carrying three Hydro-Québec employees, 561 lb (254 kg) of baggage and 600 lb (272 kg) of fuel — enough for two hours of flying, including the required 20-minute reserve.

The pilot had reduced the fuel load because of his concern about the weight the helicopter was carrying, the report said, adding that it was "reasonable to conclude that the pilot was facing pressure from the passengers, who wanted to keep their tools."

At 1115, the pilot told Hydro-Québec that he might return to Sept-Îles because of the weather, but at 1121, as he flew north over the Moisie River at 150 ft above ground level (AGL), he said he expected to arrive at Poste Montagnais at 1215.

Although he had planned to follow the train tracks north to Poste Montagnais, he instead continued to follow the river at about 200 ft AGL, then changed directions several times — presumably because of poor visibility, the report said — before striking the ground on a plateau in a mountainous area.

A Hydro-Québec flight follower noticed at 1205 that the helicopter's location on the satellite flight-following system had been unchanged for six minutes. Air traffic controllers had received no distress signal from the helicopter's electronic locator transmitter, but the operations manager took off from the Sept-Îles base at 1328 and located the wreckage 14 minutes later.

First Season

The accident pilot had obtained his commercial pilot license in November 2007 and was hired by Héli-Excel in March 2008 as a "gopher" — who ran errands and sometimes flew helicopters on non-revenue flights. He began his first season as a commercial pilot in early 2010, receiving the required ground and flight training. He completed a pilot proficiency check and aircraft type rating in June 2010.

He lacked the minimum experience required under Canadian Aviation Regulations (CARs) for flight in reduced visibility and therefore was permitted to fly only if visibility was at least 1.0 mi (1.6 km).

The TSB report noted that he had not been provided with training in several areas — including "the dangers of VFR [visual flight rules] flight in … IMC, flying in reduced visibility, the dangers of loss of visual references, controlled flight into terrain, instrument training and recovery from an unusual attitude without visual references" — and that such training was not required under the CARs.

The pilot had flown to Poste Montagnais several times, and the route was not considered difficult.

The accident report said investigators found no indication that the pilot was tired the day of the accident flight.

There also were no indications of problems with the helicopter's engine or flight controls that would have prevented normal operations.

Low Clouds

Weather conditions at Sept-Îles on the morning of the accident flight included low clouds at 300 ft and visibility of 1.0 mi, with improvement forecast after 1000. The forecast for the area to the north, along the planned route of flight, included broken clouds at 3,000 ft AGL and visibility of 6.0 mi (9.7 km), with a slight chance of reduced visibility of 5.0 mi (8.0 km) and ceilings of 800 ft AGL. At the Sept-Îles Airport, 7 nm (13 km) southeast of the Héli-Excel base, the ceiling at 1100 was 300 ft and visibility was 8 mi (13 km).

Although the forecast for Poste Montagnais had called for a 900 ft AGL ceiling and visibility of 20 mi (32 km), helicopter pilots reported that ceilings in the Moisie and Nipissis river valleys were below the mountain peaks, with "adequate" VFR visibility.

The accident flight was conducted in uncontrolled airspace below 1,000 ft AGL and therefore subject to CARs requirements calling for visibility of at least 1 mi and for the aircraft to remain clear of clouds.

Fleet of 20

When the accident occurred, Héli-Excel had a fleet of 20 helicopters, including Bell 206s, 206Ls and 214B-1s, in addition to AS350s and AS355s.

The company is authorized under the CARs for day VFR flight in uncontrolled airspace with visibility of less than 1 mi, provided its flights meet several conditions, including that the pilot must have at least 500 flight hours as a helicopter pilot-in-command.

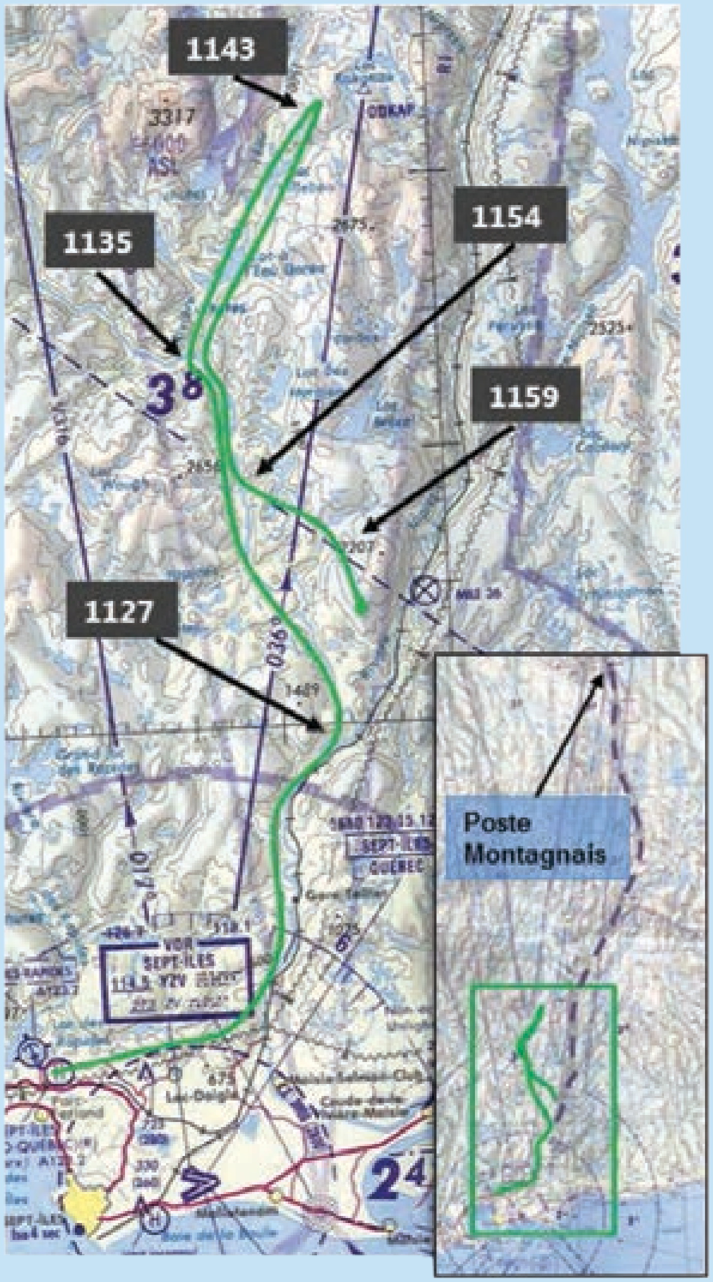
Transport Canada (TC) found "no non-compliance with any operational control aspect" during its February 2010 program validation inspection of Héli-Excel, the report said, noting that the inspections have become one of TC's "primary surveillance tools" for operators.[1]

Héli-Excel has implemented a safety management system (SMS), but because smaller operators are not yet required to have the systems, TC has not evaluated its effectiveness. The TSB said it has urged all air carriers to implement SMS and added in the report that it is "calling for TC to effectively monitor the integration of SMS practices into day-to-day operations."

Hydro-Québec's Air Transport Unit is the helicopter services industry's biggest customer in Quebec, averaging

15,000 hours of flight time a year. In 1992, in the aftermath of several accidents, the company established a qualification and technical audit program to evaluate the operators it uses and the way their aircraft are maintained. In 2005, the company developed a technical assessment program, which calls for an audit about every 18 months, followed by an assessment of the operator's performance and its compliance with contract requirements. Héli-Excel was audited under the program in February 2010 and received an R2 rating, placing it at the second-highest level.

Flight Path



Note: Blocked numbers indicate local time when the helicopter reached that point.

Source: Transportation Safety Board of Canada

Figure 1

Hydro-Québec requires pilots to have at least 800 flight hours, including 100 hours on type; 250 hours total time is acceptable, however, "if the pilot has completed the training program offered by the Association Québécoise du Transport Aérien," the report said, noting that the accident pilot had not completed the training.

VFR Flight in IMC

The report cited several earlier safety studies that found that about 80 percent of accidents associated with VFR flight into IMC involved fatalities. In Canada, those VFR-into-IMC accidents account for 15 percent of total accidents.[2,3]

An earlier TSB safety recommendation called for requiring commercial helicopter pilots to demonstrate their proficiency in basic instrument flying skills during annual check flights — a recommendation that would require helicopters to be equipped with an attitude indicator and a directional gyro. The accident helicopter lacked those instruments, and the CARs do not require them.

"The risks associated with VFR flights in adverse weather conditions are still significant, and TC has not indicated that it plans to take steps to ensure commercial helicopter pilots who are not qualified in instrument flying … maintain their proficiency in this regard," the report said.

'Another Option'

At one point in the flight, 43 minutes after takeoff, as the helicopter flew south over the Moisie River and then veered east, the helicopter had 77 minutes of fuel remaining (Figure 1). If the pilot had continued toward the junction of the Nipissis River and then on to Poste Montagnais, the helicopter's low-fuel light would have illuminated at least seven minutes before arrival.

Company policy is to land immediately if the light illuminates, and await a delivery of fuel by another helicopter.

"Because the aircraft was approximately 24 nm [44 km] from the departure point, it was still possible to return to the Sept-Îles base to refuel and depart again," the report said. "However, the weather conditions had been marginal at takeoff, and the pilot had been unsure that he would make it to Poste Montagnais. …

"A helicopter pilot always has another option — namely, to set down in a safe place and wait for the weather to improve. However, none of these three options would sit well with passengers, and the pilot would have had to admit to the passengers, his employer and Hydro-Québec that he was unable to complete the flight assigned to him. As the flight was also monitored by Hydro-Québec, a delay would have raised questions about the history of the flight, increasing the likelihood that Hydro-Québec would realize that the pilot did not have the experience for the flight required under the contract. Consequently, the pilot probably chose to take a shortcut to the east in the hopes of reaching the Nipissis River valley and reducing the flight time to Poste Montagnais."

Minutes later, he probably continued the VFR flight into IMC because he considered it "the best option," the report said, adding that according to the theory of cognitive dissonance, "his subsequent decision to continue on in marginal conditions may have distorted how he weighed the choice between continuing the flight and initiating a diversion. The more consideration a pilot gives to his decision to continue flying, the more likely it is to reinforce his choice, further distorting the situation he is in and increasing the odds that he will make risky decisions."

Immediately before the crash, the pilot lost visual reference and, because he was not qualified for instrument flight and the helicopter did not have the required instruments, he was unable to maintain aircraft control, the report said.

The circumstances of the accident indicate that the pilot "experienced operational pressures that caused him to make compromises that left him with less leeway than he had planned," the report added.

"Resources exist to reduce these operational pressures in the form of direct supervision with the use of risk assessment and decision-making tools before takeoff. … With little support from the company, it seems that the safety of the flight rested on the pilot's own ability to resist the operational pressures with which he was confronted. …

"From an organizational perspective, it does not make sense to expend so much effort to satisfy the CARs' numerous operational requirements, Hydro-Québec's audits and contractual stipulations, and then rely on a young, inexperienced pilot to ensure flight safety."

In the aftermath of the accident, Héli-Excel has taken a number of steps toward remedial action, the report said, including installing more reliable digital flight instruments, adding managers to increase pilot supervision, creating a safety system manager's position and upgrading pilot training.

In addition, Hydro-Québec introduced an air safety awareness program for its employees, increased surveillance of operators that provide its helicopter services and strengthened requirements for completion of weight and balance forms.

This article is based on TSB Aviation Investigation Report A10Q0132, "Loss of Visual Reference With the Ground, Loss of Control, Collision With Terrain; Héli-Excel Inc., Eurocopter AS350-BA (Helicopter) C-GIYR; Sept-Îles, Quebec, 22 nm N; 17 August 2010.

'It seems that the safety of the flight rested on the pilot's own ability to resist the operational pressures with which he was confronted.'

Notes

1. A program validation inspection is defined in the report as "a process comprised of a documentation review and an on-site review of one or more components of an SMS or other regulated areas of a certificate holder."
2. ATSB. Aviation Research and Analysis Report B2007/0063, *An Overview of Spatial Disorientation as a Factor in Aviation Accidents and Incidents*. 2007.
3. TSB. Aviation Investigation Reports. A08P0383, A09Q0111. A10A0056.

BY FRANK JACKMAN

European Safety

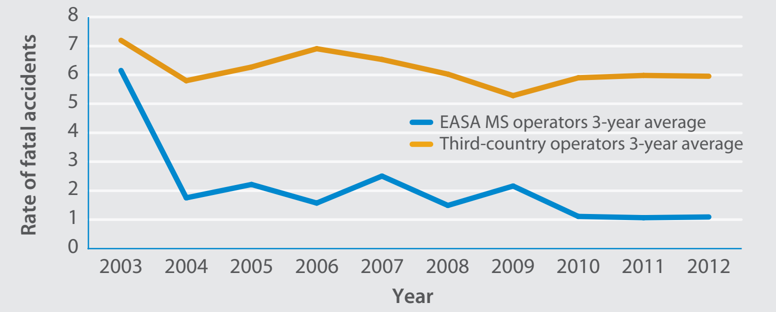
EASA states see a decline in fatal commercial air transport and general aviation accidents.

After suffering an average of 3.4 commercial air transport fatal accidents per year from 2001 through 2010, member states of the European Aviation Safety Agency (EASA) saw just one fatal accident in each of the past two years involving European-operated airplanes of more than 2,250 kg (4,960 lb) maximum takeoff mass (MTOM), according to the recently released *EASA Annual Safety Review 2012* (Table 1). The total number of commercial air transport (CAT) airplane accidents per year, however, increased from an average of 25.2 annually during the 2001–2010 period, to 30 accidents in 2011 and 34 in 2012, according to the report, which defines EASA member states (EASA MS) as the 27 European Union member states plus Lichtenstein, Norway and Switzerland.

Onboard fatalities declined from an average of 77.8 per year in 2001–2010 to six in 2011 and none last year as 2012's lone fatality occurred when a ground operator got trapped between an aircraft baggage door and a baggage loader during the boarding of an Airbus A320 at Rome Fiumicino Airport, EASA said. There were no ground fatalities involving CAT airplanes in 2011. The annual average for the 2001–2010 period was 0.8, according to the report.

Looking back over the past decade, 2003–2012, the most common type of accident among

Fatal Accident Rate, EASA Member States vs. Third-Country Operators, 2003–2012



EASA = European Aviation Safety Agency; MS = member state

Note: The fatal accident rate is created by comparing the number of fatal accidents in scheduled passenger operations with the number of flights carried out.

Source: European Aviation Safety Agency

Figure 1

Overview of Commercial Air Transport Accidents for EASA MS Aircraft Above 2,250 kg MTOM

Airplanes					Helicopters				
Period	Number of Accidents	Fatal Accidents	Fatalities on Board	Ground Fatalities	Period	Number of Accidents	Fatal Accidents	Fatalities on Board	Ground Fatalities
2001–2010 (average per year)	25.2	3.4	77.8	0.8	2001–2010 (average per year)	13.2	3.3	17.6	0.1
2011 (total)	30	1	6	0	2011 (total)	9	3	19	0
2012 (total)	34	1	0	1	2012 (total)	11	2	8	0

EASA = European Aviation Safety Agency; MS = member state; MTOM = maximum takeoff mass; 2,250 kg = 4,960 lb

Source: European Aviation Safety Agency

Table 1

CAT airplanes was what EASA called “abnormal runway contact,” which includes long, fast or hard landings and scraping of wing or tail during takeoff or landing.

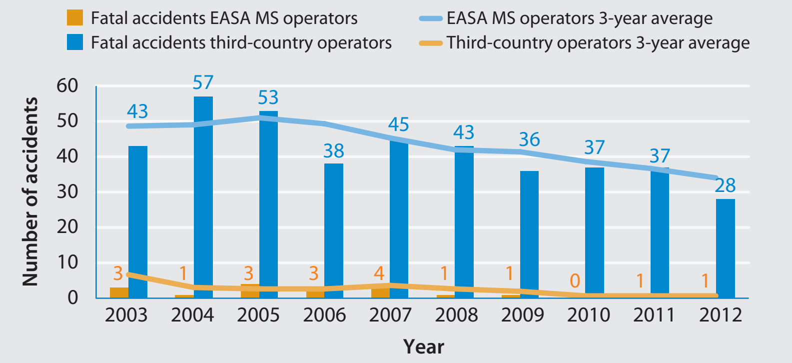
The fatal accident rate for EASA MS operators has remained at the same level for the past three years, and is below the rate for non-EASA operators (Figure 1). The number of fatal accidents among EASA MS operators also has held steady at a low rate (Figure 2).

The most common type of fatal accident for EASA MS operators during the 2003–2012 period was loss of control–in flight (LOC–I), “which involves the momentary or total loss of control of the aircraft by the flight crew. This might be the result of reduced aircraft performance or because the aircraft was flown outside its capabilities for control,” according to the EASA report. There were seven fatal LOC–I accidents involving EASA MS operators during the 2003–2012 period. During the same period, there were three fatal accidents in each of the following categories: system/component failure–non-powerplant (SCF–NP), system/component failure–powerplant (SCF–PP), unknown, fire/smoke–post impact (F-POST) and controlled flight into terrain (CFIT).

Accident categories are assigned based on the definitions of the Commercial Aviation Safety Team/International Civil Aviation Organization Common Taxonomy Team, and an accident may have more than one category, “depending on the circumstances contributing to the accident,” EASA said.

EASA also categorizes accidents based on the MTOM of the aircraft. Most CAT turbine-powered airplanes fall into the 27,001 kg to 272,200 kg MTOM range, EASA said, while smaller jets and most turboprops are found in the 5,701 kg to 27,000 kg range, and light turboprops generally are found in the 2,251 kg to 5,700 kg range. CAT airplanes in the 5,701 kg to 27,000 kg range accounted for 42 percent of the 19 fatal accidents suffered by EASA MS operators during the 2003–2012 period. The MTOM category for the largest airplanes accounted for 37 percent of the fatal accidents during the period, and the smallest MTOM airplanes accounted for 21 percent.

Fatal Accidents, EASA Member States and Third-Country Operators, 2003–2012



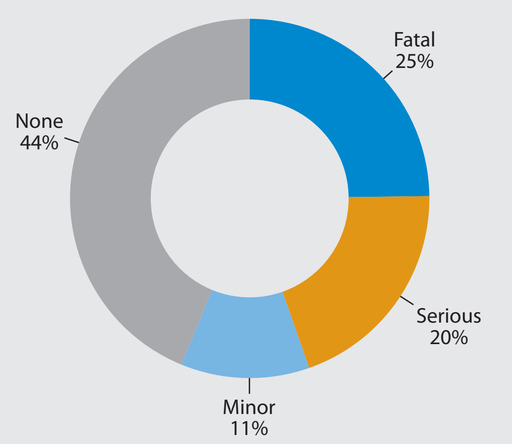
EASA = European Aviation Safety Agency; MS = member state

Source: European Aviation Safety Agency

Figure 2

Among EASA MS–operated CAT helicopters, there were two fatal accidents in 2012, down from three in 2011, and an average of 3.3 per year in the 2001–2010 period (Table 1). The number of CAT helicopter accidents last year increased to 11 from nine the previous year. The 10-year average was 13.2 per year, according to the report. Onboard fatalities in 2012 declined more than 50 percent to eight, down from 19 in 2011 and from an annual average of 17.6 in 2001–2010.

Proportion of Injury Levels for Accidents in EASA MS–Operated CAT Helicopters, 2003–2012



EASA = European Aviation Safety Agency; MS = member state; CAT = commercial air transport

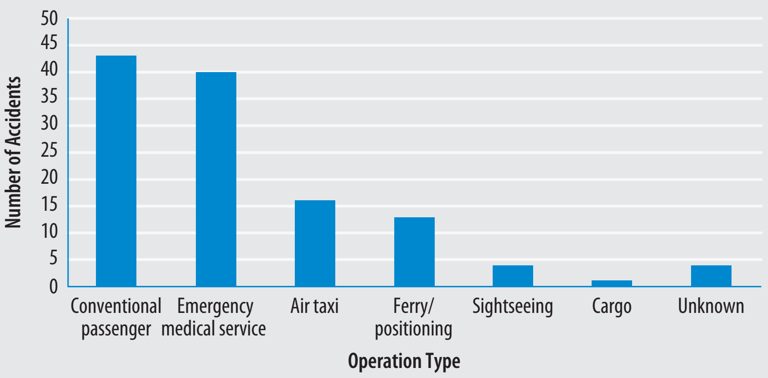
Note: Data are for all maximum takeoff mass categories.

Source: European Aviation Safety Agency

Figure 3

During the 2003–2012 period, there were 20 fatal accidents involving EASA MS–operated helicopters with an MTOM of more than 2,250 kg. The worst year during the

EASA MS–Operated CAT Helicopters By Operation Type, 2013



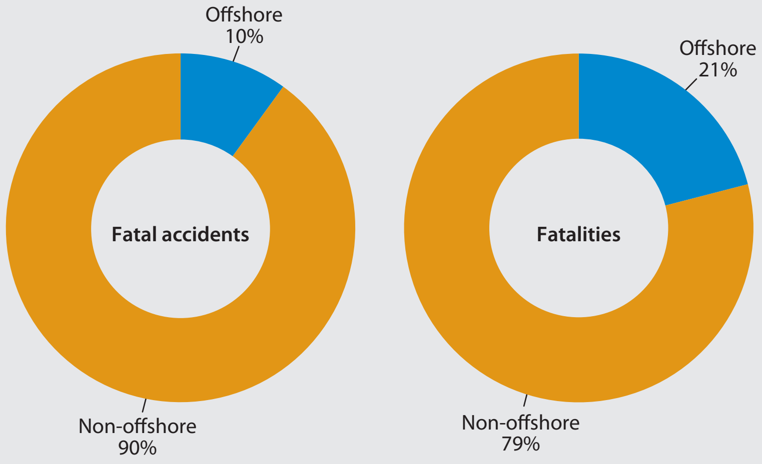
EASA = European Aviation Safety Agency; MS = member state; CAT = commercial air transport

Note: Data are for all maximum takeoff mass categories.

Source: European Aviation Safety Agency

Figure 4

Proportion of Fatal Accidents and Fatalities in EASA MS Offshore and Non-Offshore Operations, 2003–2012



EASA = European Aviation Safety Agency; MS = member state

Source: European Aviation Safety Agency

Figure 5

period was 2006, when there were five fatal accidents. Last year and in 2010, there were none. Looking at all the MTOM categories, there were no injuries in 44 percent of the EASA MS–operated CAT helicopter accidents during the period (Figure 3, p. 45). Minor or serious injuries occurred in 31 percent of the accidents, and there was at least one fatality in 25 percent of the accidents, EASA said.

The most common type of CAT helicopter accident during 2003–2012 was LOC–I, followed by SCF–NP, SCF–PP, and collision with obstacles during takeoff and landing, which includes all accidents during takeoff and landing in which the main or tail rotor collided with objects on the ground. The highest number of fatal accidents was attributed to LOC–I and CFIT, followed by low-altitude operations.

When looking at type of operation for EASA MS–operated CAT helicopters in all mass categories for the 2003–2012 period, conventional passenger operations had the most accidents, followed closely by helicopter emergency medical services. Other types of operations analyzed by EASA included air taxi, ferry/positioning, sightseeing, cargo and unknown (Figure 4).

Helicopters often are flown in offshore operations. According to EASA figures, 10 percent of fatal accidents in 2003–2012 in all MTOM categories occurred in offshore operations, but 21 percent of all fatalities occurred in those accidents (Figure 5). "In general, offshore operations are carried out with large helicopters, which, when an accident occurs, could give a larger number of casualties," EASA said. The agency calculated that the ratio of fatalities to fatal accidents is higher for offshore operations (8.67 fatalities per fatal accident) than for non-offshore operations (3.63 fatalities per fatal accident).

There were 918 accidents involving EASA MS–operated general aviation light aircraft, those below 2,250 kg MTOM, in 2012, which represents a decline of slightly more than 11 percent from the average total of 1,035.6 per year for the previous five-year period (2007–2011). The number of fatal accidents last year declined 7.5 percent to 133 from an average of 143.8 per year during the previous five years. The number of fatalities on board declined to 226 in 2012 from an average of 239 per year in 2011.

Included in the general aviation category of aircraft are balloons, dirigibles, airplanes, gliders, gyroplanes, helicopters, microlights, motorgliders and other.

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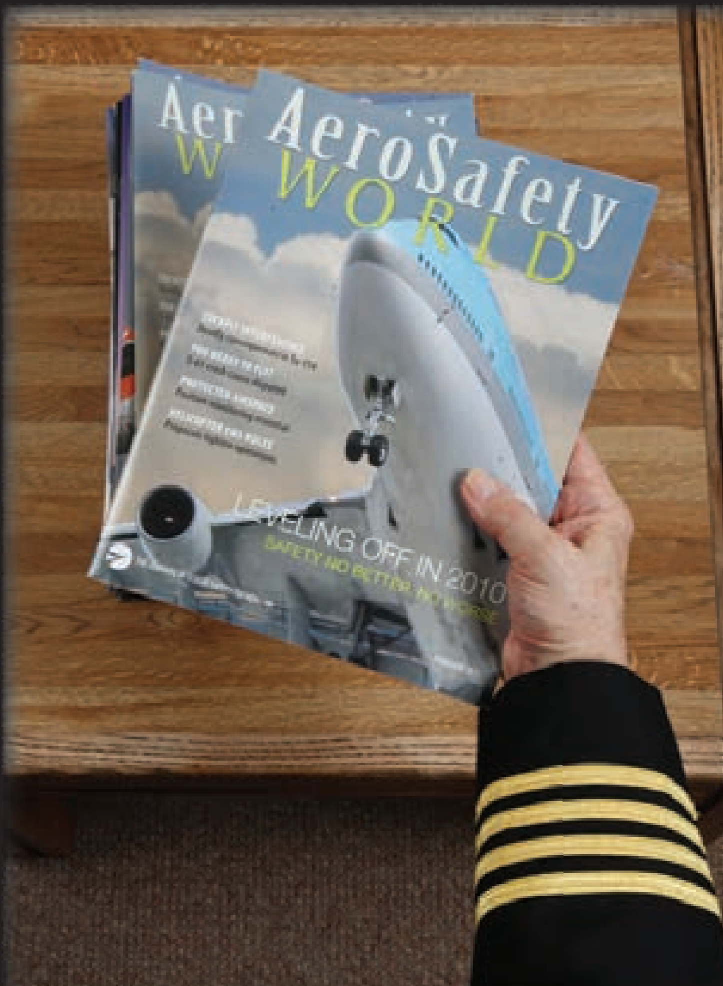


A Year in Review

The TSB's annual report laments inaction on key safety recommendations.

BY LINDA WERFELMAN

REPORTS

Annual Report to Parliament, 2012–13

Transportation Safety Board of Canada (TSB). June 2013. 46 pp. Appendixes, figures, tables. Available from TSB at <tsb.gc.ca/eng/publications/ann/2013/2012-2013.pdf>.

This report, submitted to the Canadian Parliament, details the TSB's progress in investigating accidents in aviation and other forms of transportation and its efforts to advance transportation safety.

"Overall, the TSB has been very successful in identifying safety issues and reducing risks in the transportation system," the report says of the 52 safety investigations completed by the agency in 2012–2013. "Each investigation led to a comprehensive report, identifying critical safety issues and contributing factors, communicating lessons learned and, when necessary, making recommendations aimed at reducing risks. … Our systematic approach ensured TSB resources were invested in areas with the greatest safety payoffs."

Separate sections on aviation, rail and marine transportation, and pipeline operations discuss the agency's work in those transportation modes from April 2012 through March 2013.

The report includes annual safety data in each mode for 2012, noting that 1,594 accidents and 1,287 incidents were reported to the TSB. Of that number, 239 accidents involved Canadian-registered aircraft; this represented a 4 percent increase from the 230 accidents reported in 2011 but a 5 percent decrease from the 252-accident average for 2007 through 2011.

Thirty-three of the 239 accidents were fatal crashes in which a total of 54 people were killed. In comparison, 30 fatal crashes in 2011 killed 62 people; the 2007–2011 average was 30 fatal crashes and 58 fatalities. Of the 33 fatal accidents, 11 involved commercial aircraft (six airplanes and five helicopters).

Foreign-registered aircraft were involved in 16 accidents in 2012, including one fatal accident; in 2011, there were 10 such accidents including two with fatalities.

The 2012 data included 636 reported incidents, a 6 percent decrease from the 677 recorded in 2011 and 21 percent fewer than the 2007–2011 average of 808.

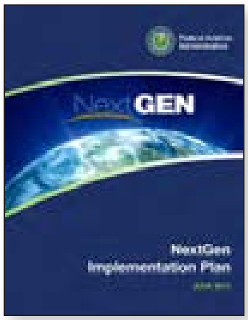
During the 2012–2013 period covered by the report, the TSB completed 26 investigations of aviation safety occurrences and began 27. On average, each investigation took 549 days.

In its review of responses to the TSB's past safety recommendations, the report says 60 percent of its aviation recommendations have received what the agency considers a "fully satisfactory" response.

"Canada has seen a number of aircraft accidents over the past few years that have involved factors relating to these outstanding recommendations," the report said. "For instance, the TSB has revived three dormant recommendations relating to post-impact fires as a result of ongoing accident investigations."

The report also said that not enough has been done to address a recommendation that calls on Transport Canada to require airports with runways that are at least 1,800 m (5,906 ft) long to have 300-m (984-ft) runway end safety areas "or a means of stopping aircraft that provides an equivalent level of safety" ("Working Safely on an Operative Runway," p. 12).

Only one of eight aviation safety items on the TSB's "watchlist" of critical recommendations — calling for installation of ground-proximity warning systems in some classes of aircraft — has received a "fully satisfactory" response, the report said, describing the response to other items as "troubling."


Federal Aviation Administration

NextGEN

NextGen Implementation Plan

JUNE 2013

NextGen Implementation Plan

U.S. Federal Aviation Administration (FAA) Office of NextGen. June 2013. 98 pp. Appendixes, figures, tables. Available from the FAA at <www.faa.gov/nextgen>.

In this report, the FAA outlines its ongoing transition to the Next Generation Air Transportation System (NextGen), which modernizes the U.S. National Airspace System (NAS) with new technologies and procedures intended to enhance safety and efficiency.

Automatic dependent surveillance–broadcast (ADS–B), the satellite-based successor to radar tracking, is among the NextGen programs that already have been widely implemented.

"By February 2013, we had deployed more than 500 of about 700 ADS–B ground stations," the report said. "This year, the FAA is continuing to work with industry to develop the best approach for aircraft operators to equip for NextGen. Our ADS–B work is driven by the fact that aircraft flying in designated airspace must be equipped to broadcast their position to the ADS–B network by Jan. 1, 2020."

The FAA has continued to expand the number of satellite-based precision arrival and departure procedures and high- and low-altitude routes in an effort to "save fuel, reduce emissions, increase flexibility in the [NAS] and facilitate more dynamic management of air traffic," the report said.

The report also described progress with metroplex-level work — an effort to implement satellite-based procedures and airspace improvements to reduce fuel consumption and emissions in defined urban areas with several airports.

"As of January, we had eight active metroplex areas in various phases of development," the report said, noting that North Texas and Houston were to be added soon.

The report said the FAA envisions significant improvements in all phases of flight within the next decade.

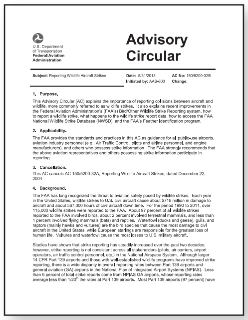
"Technologies such as ADS–B and data communications, combined with performance-based navigation (PBN), will increase safety and capacity and save time and fuel, decrease aircraft emissions and improve our ability to address noise," the report said. "With NextGen, we continue to advance safety as we look to increase air traffic and introduce new types of aircraft, such as unmanned aircraft systems and commercial space vehicles. The aviation community continues to rely on safety management systems (SMS) to continue to minimize risk as we bring together a wave of new NextGen capabilities."

Weather detection and forecasting capabilities also will be improved through NextGen programs, resulting in improved air traffic planning and more efficient weather-related rerouting, the report said.

Individual sections of the report add more details about surveillance and navigation improvements being achieved through NextGen, the system's benefits for general aviation and how the NAS will change in the future.

"Step by step, we are approaching a tipping point at which 20th-century systems and technology will give way to those of the 21st," the report said.

REGULATORY MATERIALS


U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Reporting Wildlife Aircraft Strikes

Date: 5/31/2013
Initiated by: AAS-300

AC No: 150/5200-32B
Change:

1. Purpose.

This Advisory Circular (AC) explains the importance of reporting collisions between aircraft and wildlife, more commonly referred to as wildlife strikes. It also explains recent improvements in the Federal Aviation Administration's (FAA's) Bird/Other Wildlife Strike Reporting system, how to report a wildlife strike, what happens to the wildlife strike report data, how to access the FAA National Wildlife Strike Database (NWSD), and the FAA's Feather Identification program.

2. Applicability.

The FAA provides the standards and practices in this AC as guidance for all public-use airports, aviation industry personnel (e.g., Air Traffic Control, pilots and airline personnel, and engine manufacturers), and others who possess strike information. The FAA strongly recommends that the above aviation representatives and others possessing strike information participate in reporting.

3. Cancellation.

This AC cancels AC 150/5200-32A, Reporting Wildlife Aircraft Strikes, dated December 22, 2004.

4. Background.

The FAA has long recognized the threat to aviation safety posed by wildlife strikes. Each year in the United States, wildlife strikes to U.S. civil aircraft cause about $718 million in damage to aircraft and about 567,000 hours of civil aircraft down time. For the period 1990 to 2011, over 115,000 wildlife strikes were reported to the FAA. About 97 percent of all wildlife strikes reported to the FAA involved birds, about 2 percent involved terrestrial mammals, and less than 1 percent involved flying mammals (bats) and reptiles. Waterfowl (ducks and geese), gulls, and raptors (mainly hawks and vultures) are the bird species that cause the most damage to civil aircraft in the United States, while European starlings are responsible for the greatest loss of human life. Vultures and waterfowl cause the most losses to U.S. military aircraft.

Studies have shown that strike reporting has steadily increased over the past two decades; however, strike reporting is not consistent across all stakeholders (pilots, air carriers, airport operators, air traffic control personnel, etc.) in the National Airspace System. Although larger 14 CFR Part 139 airports and those with well-established wildlife programs have improved strike reporting, there is a wide disparity in overall reporting rates between Part 139 airports and general aviation (GA) airports in the National Plan of Integrated Airport Systems (NPIAS). Less than 6 percent of total strike reports come from NPIAS GA airports, whose reporting rates average less than 1/20th the rates at Part 139 airports. Most Part 139 airports (97 percent) have

Reporting Wildlife Aircraft Strikes

U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5200-32B. May 31, 2013. 11 pp. Tables.

Wildlife strikes are to blame for about $718 million in aircraft damage and 567,000 hours of civil aircraft down time each year in the United States, the FAA says in this AC, which explains recent improvements in the FAA's Bird/Other Wildlife Strike Reporting System.

From 1990 through 2011, more than 115,000 wildlife strikes were reported to the

FAA. Of these, 97 percent involved birds. Most of the strikes associated with a loss of human life involved European starlings, but ducks, geese, gulls and raptors (primarily hawks and vultures) were responsible for the most damage to civil aircraft. Vultures, ducks and geese are blamed for the most losses to U.S. military aircraft, the AC says.

The document says that although reporting of wildlife strikes has increased over the past two decades, reporting rates are still low for some segments of the aviation community. For example, the AC says some general aviation airports file wildlife strike reports at a rate that averages less than one-twentieth of the rate at U.S. Federal Aviation Regulations Part 139 airports (those that handle larger commercial traffic). The largest Part 139 airports, especially those with wildlife-hazard management programs, file reports at about four times the rate of other airports operating under Part 139, the AC says.

A similar reporting pattern is found among airlines of varying sizes, the AC says.

The AC says the FAA "strongly encourages pilots, airport operations, aircraft maintenance personnel, air traffic control personnel, engine manufacturers or anyone else who has knowledge of a strike" to report it to the FAA National Wildlife Strike Database. Reporting forms are available online at <faa.gov/go/wildlife> and, for mobile devices, at <faa.gov/mobile>. Reporting forms also are available from airports district offices, flight standards district offices and flight service stations, and from the *Airman's Information Manual*.

If airport personnel or local biologists cannot identify the type of bird involved in a bird strike, the remains may be submitted to the Smithsonian Institution's Feather Identification Lab for identification. The AC includes detailed instructions on how to prepare remains for mailing.

This AC cancels its predecessor, AC 150/5200-32A, issued Dec. 22, 2004.

DIGITAL MEDIA

International Civil Aviation Organization (ICAO) Safety Management Website

<icao.int/safetymanagement>

ICAO has introduced a new section of its website designed to help state regulators in implementing the Standards and Recommended Practices of the new Annex 19, *Safety Management*, which will take effect in November — the first new annex in more than 30 years.

"Annex 19 consolidates safety management provisions contained in six other ICAO annexes and will now serve as a practical one-stop resource for states and industry," ICAO said.

The organization said the new section of the website is intended to support improvements in aviation safety as the aviation industry enters what is expected to be a period of considerable growth.

"Aviation safety is today as good as it has ever been, with 2012 recognized as the safest year in the history of commercial aviation," said ICAO Secretary General Raymond Benjamin. "But with the projected doubling of air traffic by 2030, it became imperative that ICAO adopt a comprehensive safety management framework to maintain and improve upon our sector's remarkable safety performance."

Various sections of the website discuss not only the specifics of Annex 19 but also the Global Aviation Safety Plan, which establishes specific safety objectives while ensuring "the efficient and effective coordination of complementary safety activities between all stakeholders," and safety management training material, including material for state safety programs and safety management systems.

Another section, for registered representatives of ICAO member states, is set aside for the integrated Safety Trend Analysis and Reporting System (iSTARS), which connects a number of sets of safety data and a related web application that are used in risk analysis.

Bird Scare Leads to Overrun

Fearing an imminent collision, the pilot rejected the takeoff after the aircraft had accelerated through V_1.

BY MARK LACAGNINA

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

JETS

Mired in Mud

Dassault Falcon 20E. Substantial damage. No injuries.

The flight crew was assigned to conduct an electronic-warfare training mission with Royal Air Force pilots over the North Sea the morning of Aug. 9, 2012. The weather at the departure point, Durham (England) Tees Valley Airport, was good, with light winds.

The crew's preflight calculations included 141 kt as V_1, which is defined by British aviation authorities as the maximum speed at which the crew must *decide* to either reject or continue a takeoff following an engine failure, according to the report by the U.K. Air Accidents Investigation Branch (AAIB). Other European and U.S. civil aviation authorities, among others, define V_1 as the speed at which *action* must be taken to reject or continue a takeoff, with the decision already made.

The Falcon was specially equipped to support military training missions and was close to its approved gross weight of 30,000 lb (13,608 kg) when the crew initiated the takeoff near the approach threshold of the 2,291-m (7,516-ft), dry runway.

"Takeoff was continued with the standard calls being made between the two pilots," the report said. "These included calls on passing 80 kt and 100 kt, with the commander expecting the next call to be on passing the calculated V_1 of 141 kt."

During this time, the commander saw a large bird take flight from the runway and then fly toward the aircraft over the runway centerline. "The commander believed the bird represented a significant threat to the aircraft," the report said. He later recalled that he announced "bird, aborting" at the same time the copilot called out "V_1."

However, investigators determined from limited recorded flight data (the operator had received an exemption from the requirements to equip the aircraft with a flight data recorder and a cockpit voice recorder) that the rejected takeoff (RTO) was begun 9 kt above V_1.

The commander reduced thrust to idle, applied full manual braking and deployed the airbrakes; the Falcon was not equipped with thrust reversers or a drag chute. As the aircraft neared the end of the runway, the commander told the copilot to assist him on the brakes. "The copilot did so, but with no discernible effect on the aircraft's deceleration," the report said.

Deceleration was reduced when the Falcon overran the runway at 75 kt and entered the 119-m (390-ft) stopway and 60-m (197-ft) strip, which were covered by scattered loose gravel. The aircraft then came to a stop quickly when the landing gear sank into soft ground on contact with the runway end safety area. The pilots and the electronic warfare officer were not hurt, but the Falcon's engines had ingested mud and stones, and the landing gear and wheel brakes had minor damage.

"The remains of a single carrion crow, weighing approximately 1.0 lb [0.5 kg], were recovered from the runway at a point approximately 1,400 m (4,600 ft) from the start of the aircraft's takeoff roll," the report said. Investigators believe that the bird had collided with the Falcon's landing gear.

The report said that performance calculations showed that if the RTO had been initiated at 141 kt, the aircraft likely could have been stopped with 97 m (318 ft) of runway remaining.

Controller Overlooked Conflict

Embraer 135, 145. No damage. No injuries.

A controller's "lack of monitoring and lack of awareness" led to a near midair collision between two Embraer regional jets at Chicago (Illinois) O'Hare International Airport the morning of Aug. 8, 2011, said the U.S. National Transportation Safety Board (NTSB).

The incident occurred in visual meteorological conditions and involved an ERJ-135, with 39 people aboard, that was on a visual approach to Runway 09R and an ERJ-145, with 45 people aboard and operated by a different airline, that was departing from Runway 32L.

The approach threshold of Runway 09R is east of Runway 32L; thus, the ERJ-135 would pass over Runway 32L on its way to land on Runway 09R.

The controller handling the ERJ-145 told investigators that he was "distracted by coordination requirements affecting two other airplanes" and had "overlooked the arriving airplane [the ERJ-135] during his scan" when he cleared the crew of the ERJ-145 for takeoff.

Shortly after the ERJ-145 reached rotation speed, the captain, the pilot monitoring, saw the ERJ-135 and told the first officer to delay the rotation. At about the same time, the controller said, "Traffic alert, left to right … stay as low as you can." The captain responded, "Yeah, we're doing that."

Meanwhile, the controller handling the ERJ-135 had told the crew to go around. The NTSB said that the airplane crossed Runway 32L about 125 ft (38 m) above and 350 ft (107 m) in front of the ERJ-145.

Damaged Seal Causes Fuel Leak

Boeing 757-200. Minor damage. No injuries.

The 757 had undergone a C-check and two post-maintenance test flights, and was scheduled for an "airtest" prior to its release to service the afternoon of Aug. 7, 2012. The flight crew and a maintenance engineer conducted the airtest over the North Sea.

"Approximately three hours of the airtest had elapsed when, during a routine fuel check, the crew noticed a lateral fuel discrepancy of approximately 600 kg [1,323 lb], with the right wing fuel tank quantity indicating less than the left wing fuel tank," the AAIB report said. Shortly thereafter, the imbalance reached 800 kg [1,764 lb], causing the engine indicating and crew alerting system to generate a "fuel configuration" warning.

While helping the pilots perform the applicable quick reference handbook checks, the engineer saw fuel leaking from the right engine. The leak was confirmed by the first officer. The commander then declared an urgency and requested and received clearance from air traffic control (ATC) to divert the flight to Newcastle (Scotland) Airport, about 85 nm (161 km) southwest.

"The flight crew then completed the 'Engine Fuel Leak' checklist by shutting down the right engine, following which they carried out an uneventful single-engine diversion and landing at Newcastle Airport," the report said.

Examination of the Rolls-Royce RB211-535E4 engine showed that fuel was leaking from a flange on a fuel tube that runs from the high-pressure fuel pump to the fuel-flow governor. The fuel tube had been replaced during the C-check in compliance with a service bulletin.

Investigators found that one of the two bolts attaching the fuel tube flange to the high-pressure pump had damaged threads and was loose, and that the internal O-ring seal was damaged, with a section missing.

"Examination of the damaged thread forms showed that the bolt had not been cross-threaded, rather that the start thread of the wire-thread insert had 'picked up' during insertion of the bolt, causing a progressive rounding-over of the bolt's thread as the bolt was tightened," the report said, noting that the O-ring had been displaced and damaged during this process.

The fuel tube had been replaced while the engine was mounted in a transport cradle during the C-check. "The lower parts of the engine, including the area where the fuel tubes were to be replaced, were close to the ground and partially obstructed by the cradle's steel framework," the report said. "These restrictions made access significantly more difficult than if the engine had been mounted on its pylon or in an engine overhaul fixture."

Smoke Traced to House Fire

Bombardier CRJ700. No damage. One serious injury.

The airplane had been dispatched for a scheduled flight from Denver to Chicago the night of July 18, 2012, with only one of the two air-conditioning packs of the environmental control system operative, according to provisions of the minimum equipment list. Due to adverse weather at Chicago O'Hare International Airport, the flight crew diverted to Peoria (Illinois, U.S.) International Airport.

The crew detected smoke during the approach to Peoria and ordered an emergency evacuation after landing. The two overwing exits and the main cabin door were used for the evacuation. One passenger suffered a broken ankle during the evacuation; the other 56 people aboard the airplane escaped injury.

An examination of the CRJ revealed no obvious source of the smoke. Investigators found, however, that the pack had failed on approach, allowing ambient air to enter the cockpit and cabin. The smoke likely was from a large house fire that the airplane had flown over on approach, the report said.

TURBOPROPS

Improper Response to RA

Saab 340B, Beech King Air B200. No damage. No injuries.

The King Air was at 14,000 ft and inbound on an emergency medical services (EMS) flight to Broken Hill, New South Wales, Australia, the morning of Aug. 26, 2011, when the flight crew was advised by ATC that a Saab 340B had departed from the Broken Hill airport and was climbing on an opposite-direction heading to 17,000 ft.

The King Air was about 50 nm (93 km) east of the airport, in uncontrolled airspace, when the crew contacted the flight crew of the Saab on the common traffic advisory frequency (CTAF) and requested their current altitude. The Saab crew replied that they were climbing through 12,000 ft and were 27 nm (50 km) east of the airport.

"They further advised that [the King Air] was observed on their aircraft's traffic-alert and collision avoidance system (TCAS) about 20 nm [37 km], in their 1 o'clock position," said the report by the Australian Transport Safety Bureau. "The pilot of [the King Air] acknowledged the information and advised that he also had [the Saab] on his TCAS and that both aircraft were 'well clear at the moment.'"

The Saab crew then changed their no. 2 radio from the CTAF frequency to the guard (emergency) frequency, leaving the no. 1 radio on the ATC frequency. "The pilot of [the King Air], however, expected the crew of [the Saab] to remain on the CTAF and maintain [13,000 ft], delaying their climb until after passing [the King Air]," the report said.

The King Air pilot attempted several times to tell the Saab crew that he would maintain 14,000 ft until passing the Saab, but there was no response on the CTAF frequency. He then received a TCAS traffic advisory and initiated a left climbing turn.

About the same time, the Saab was climbing through 13,200 ft when its TCAS issued a resolution advisory (RA) to "adjust vertical speed, adjust," which requires reduction of vertical speed to the indicated value of 2,000, 1,000, 500 or 0 fpm. The first officer, the pilot flying, believing erroneously that they were above the King Air, disengaged the autopilot and initiated a climb while the captain advised ATC that they had received and were responding to a TCAS RA.

Lateral separation was 2.2 nm (4.1 km) when the aircraft passed each other at 14,200 ft. "About the same time, the captain of [the Saab] noted that the first officer's actions were contrary to the RA and that he had initiated a climb instead of a descent," the report said. "The captain immediately advised the first officer, who then commenced a quicker-than-expected descent. The captain then assumed control of the aircraft and reduced the descent. Separation between the aircraft began to increase, with [the Saab] descending through [14,000 ft] and [the King Air] climbing through [14,300 ft]."

There was no damage to either aircraft and no injuries to the 33 people aboard the Saab or the four people aboard the King Air. Both aircraft completed their flights without further incident.

"This incident emphasises the benefit of TCAS in assisting pilots with their awareness of other traffic," the report said. "It is critical that pilots respond appropriately to a TCAS RA command."

Inadvertent Fuel Shutoff

De Havilland Turbo Beaver. Substantial damage. No injuries.

The pilot was conducting an on-demand sightseeing flight near Cantwell, Alaska, U.S., the evening of July 7, 2012, when the engine abruptly lost power. "He attempted to restart the engine but was unable to, and elected to make a forced landing in a bog," said the NTSB report.

The airplane's left wing and right elevator struck trees during the landing, but the seven passengers and the pilot were not hurt.

"After the forced landing, the pilot noticed that the emergency fuel shutoff lever on the right side of the center console had been moved toward the shutoff position," the report said. "The passenger who was seated in the right seat of the cockpit stated that he was unaware of the fuel shutoff lever and was not briefed on specific areas to be aware of in the cockpit. He had been adjusting himself in the seat just prior to the engine shutting down."

Ditch Foils Off-Runway Landing

Cessna 208B Caravan. Substantial damage. No injuries.

The pilot said that he regularly landed the Caravan on the grassy area adjacent to the paved runway at the airport in Raeford, North Carolina, U.S., to minimize wear on the main landing gear tires. However, before Aug. 18, 2012, all the landings had been conducted in the same direction.

Returning from a skydiving flight that day, the pilot decided to land in the opposite direction. The airplane struck a ditch about 200 ft (61 m) from the touchdown point on the grassy area, became airborne again and landed hard, collapsing the nose landing gear and causing substantial damage to the fuselage. The pilot and his passenger escaped injury.

PISTON AIRPLANES

Control Lost After Power Loss

Cessna 310Q. Substantial damage. One fatality.

The airplane had just undergone an annual maintenance inspection, during which the fuel hose on the left engine had been removed and reinstalled to facilitate replacement of a cylinder. "A postmaintenance engine ground run was performed, and no discrepancies were noted," the NTSB report said.

The owner picked up the airplane at Tupelo, Mississippi, U.S., the morning of Aug. 17, 2011. Witnesses heard sounds similar to a loss of power on takeoff and saw the 310 enter a descending left turn at about 500 ft. The landing gear separated when the airplane touched down on a road; the 310 then struck a vehicle and several trees before coming to a stop in front of a house. The owner/pilot was killed, but no one on the ground was hurt.

Investigators determined that the left engine had lost power on takeoff. "The B-nut connecting the fuel supply hose to the manifold valve on top of the left engine had backed off about a quarter turn," the report said. During tests, the engine operated satisfactorily with the B-nut fully tightened but immediately lost power when the nut was loosened a quarter turn.

NTSB concluded that the probable cause of the accident was "the pilot's delayed reaction in performing the engine failure procedures and his failure to maintain adequate airspeed, which resulted in loss of control" and that a contributing factor was "maintenance personnel's improper torquing of the B-nut between the fuel supply hose and the manifold valve."

Hard Impact Avoiding Geese

Piper Navajo. Substantial damage. No injuries.

The pilots were taking off from Washington County (Pennsylvania, U.S.) Airport with two passengers for an air taxi flight the morning of Sept. 9, 2012, when they saw a flock of geese approaching from the right. "The pilot-in-command believed that the birds would impact the cockpit windows, so he pushed forward on the control yoke to descend," the NTSB report said.

The Navajo touched down hard on the runway and bounced. The pilots continued the takeoff and returned to the airport for an uneventful landing. "Postaccident examination revealed structural damage to the airframe," the report said. "Also, bird remains were found on the fuselage."

Rudder Trim Bolt Removed

Piper Aerostar 601P. Substantial damage. No injuries.

Shortly after taking off from Alpine, Texas, U.S., the afternoon of Aug. 22, 2011, the pilot felt a vibration in the Aerostar's flight controls and decided to return to the airport for a precautionary landing.

The Aerostar struck a fence on short final approach and touched down hard on the runway. "During the landing, the main landing gear was pushed up through the wing and the nose gear collapsed," the NTSB report said. "The airplane subsequently exited the runway before coming to rest in an upright position." The pilot and his two passengers escaped injury.

Examination of the airplane revealed that the bolt attaching the rudder trim tab to the actuator connecting rod was missing. "The absence of this bolt would have allowed the trim tab to swing freely on its hinge," the report said.

The pilot told investigators that during his preflight inspection of the airplane, he found that the rudder trim system was inoperative. "Unable to center the rudder trim tab, the pilot elected to remove the bolt before takeoff," the report said. "The pilot further reported that he was planning to have the trim system repaired when he returned to his home base."

HELICOPTERS

Unlatched Cowling Opens

Eurocopter MBB-BK 117-C2. Substantial damage. No injuries.

The pilot was landing the EMS helicopter on a rooftop helipad at a downtown Houston hospital on July 24, 2012, when he felt a brief shudder, similar to flying through another helicopter's rotor wash. "The pilot was unaware that any damage had occurred and landed uneventfully," said the NTSB report.

A third medical crewmember boarded, and the helicopter was flown to a suburban hospital. After landing there, the crew found that the cowling on the left side of the engine had opened during the previous landing and had struck all four main rotor blades.

"The pilot stated that he failed to complete a thorough preflight inspection before the accident flight because the crew was assigned a medical mission just after their shift started," the report said. "The pilot who flew the helicopter the evening before the accident stated that he had opened the cowling to check the oil level and became distracted. He could not remember if he had secured the cowling latches."

Rotor Drag Damper Fails

Schweizer 269C. Destroyed. Two fatalities.

The pilot was repositioning the helicopter from Saint-Aignan to Breuil in France the morning of July 25, 2010, in preparation for initiation flights at an air show. About 10 minutes after takeoff, a main rotor blade drag damper failed. The pilot lost control of the helicopter, which collided with treetops and descended to the ground.

"The helicopter was being operated in the context of an aerial work company without an AOC [aircraft operating certificate]," said the report by the French Bureau d'Enquêtes et d'Analyses.

The pilot, also a certified maintenance technician, recently had performed a required 300-hour inspection of all three drag dampers and had signed them off as meeting specifications. However, he had failed to notice "degradation of the elastomer on the drag dampers," the report said. "This maintenance operation on a critical part performed by a lone mechanic and without approval by another person or an organisation independent of the operator could have contributed to the accident."

Preliminary Reports, June 2013

<table>
<tr><th>Date</th><th>Location</th><th>Aircraft Type</th><th>Aircraft Damage</th><th>Injuries</th></tr>
<tr><td>June 1</td><td>Simikot, Nepal</td><td>Dornier 228-202K</td><td>substantial</td><td>7 none</td></tr>
<tr><td colspan="5">After a go-around in fog, the Dornier landed hard, short of the runway. The left main landing gear separated, and the left wing broke in two.</td></tr>
<tr><td>June 2</td><td>Davao City, Philippines</td><td>Airbus A320-214</td><td>substantial</td><td>165 none</td></tr>
<tr><td colspan="5">The nose landing gear collapsed when the A320 veered off the runway on landing.</td></tr>
<tr><td>June 4</td><td>Petersburg, Alaska, U.S.</td><td>de Havilland Beaver</td><td>substantial</td><td>1 fatal, 2 serious, 4 minor</td></tr>
<tr><td colspan="5">One passenger was killed when the single-engine floatplane crashed in a mountain pass during a commercial sightseeing flight.</td></tr>
<tr><td>June 6</td><td>Manchester, Kentucky, U.S.</td><td>Bell 206L-1</td><td>destroyed</td><td>3 fatal</td></tr>
<tr><td colspan="5">The pilot and two medical crewmembers were killed when the LongRanger crashed in a school parking lot during approach to its home helipad in night visual meteorological conditions (VMC).</td></tr>
<tr><td>June 7</td><td>Shanghai, China</td><td>Embraer 145L1</td><td>substantial</td><td>44 none</td></tr>
<tr><td colspan="5">Instrument meteorological conditions prevailed when the nose landing gear collapsed during a hard landing.</td></tr>
<tr><td>June 7</td><td>Baton Rouge, Louisiana, U.S.</td><td>Beech King Air B200GT</td><td>destroyed</td><td>1 fatal</td></tr>
<tr><td colspan="5">No one on the ground was hurt when the King Air crashed in a residential area shortly after takeoff in VMC.</td></tr>
<tr><td>June 10</td><td>N'Gaoundéré, Cameroon</td><td>Cessna 208</td><td>destroyed</td><td>1 fatal, 1 serious, 3 minor</td></tr>
<tr><td colspan="5">The Caravan was en route to Douala when the flight crew reported an engine problem and that they were diverting to N'Gaoundéré. The captain was killed when the airplane stalled and crashed on approach.</td></tr>
<tr><td>June 10</td><td>Saint-Mathieu-de-Beloeil, Quebec, Canada</td><td>Beech King Air A100</td><td>destroyed</td><td>4 NA</td></tr>
<tr><td colspan="5">No fatalities were reported when the King Air crashed in an open field on approach.</td></tr>
<tr><td>June 10</td><td>Kupang, Indonesia</td><td>Xian MA60</td><td>destroyed</td><td>50 NA</td></tr>
<tr><td colspan="5">No fatalities were reported when the MA60 crashed short of the runway on landing.</td></tr>
<tr><td>June 10</td><td>Kawthaung, Myanmar</td><td>Xian MA60</td><td>substantial</td><td>64 none</td></tr>
<tr><td colspan="5">The aircraft veered off the runway on landing and came to a stop in bushes.</td></tr>
<tr><td>June 11</td><td>Talihina, Oklahoma, U.S.</td><td>Eurocopter AS350-B2</td><td>substantial</td><td>1 fatal, 1 serious, 2 minor</td></tr>
<tr><td colspan="5">The pilot said that he lost control of the helicopter when the rotor blades struck a light pole during takeoff from a road for an emergency medical services (EMS) flight. The passenger was killed, the flight nurse was seriously injured, and the flight paramedic and the pilot sustained minor injuries when the AStar struck terrain.</td></tr>
<tr><td>June 13</td><td>Marsh Harbour, Bahamas</td><td>Saab 340B</td><td>destroyed</td><td>21 none</td></tr>
<tr><td colspan="5">Storms were reported in the area when the Saab bounced three times on landing and veered off the runway.</td></tr>
<tr><td>June 13</td><td>Chino, California, U.S.</td><td>Canadair Challenger 601</td><td>substantial</td><td>none</td></tr>
<tr><td colspan="5">Maintenance technicians were performing an engine test when the Challenger jumped its chocks and struck a hangar.</td></tr>
<tr><td>June 18</td><td>Cincinnati, Ohio, U.S.</td><td>Israel Aircraft Industries 1124</td><td>substantial</td><td>3 none</td></tr>
<tr><td colspan="5">The Westwind was on an instructional flight when the left main landing gear collapsed during a touch-and-go landing.</td></tr>
<tr><td>June 19</td><td>Jonesboro, Arkansas, U.S.</td><td>Bell 206L-4</td><td>substantial</td><td>3 none</td></tr>
<tr><td colspan="5">The pilot conducted a forced landing after a partial loss of engine power occurred on final approach to a helipad during an EMS repositioning flight.</td></tr>
<tr><td>June 20</td><td>McClellanville, South Carolina, U.S.</td><td>Rockwell 690B</td><td>destroyed</td><td>2 fatal</td></tr>
<tr><td colspan="5">The private pilot and flight instructor were killed when the Turbo Commander crashed out of control during a flight review.</td></tr>
<tr><td>June 25</td><td>Casa Grande, Arizona, U.S.</td><td>MD Helicopters 500E</td><td>substantial</td><td>3 minor</td></tr>
<tr><td colspan="5">The helicopter touched down hard and rolled over during an autorotative landing following a loss of power during a postmaintenance test flight.</td></tr>
<tr><td>June 25</td><td>Chicago, Illinois, U.S.</td><td>Beech King Air 200</td><td>substantial</td><td>1 minor</td></tr>
<tr><td colspan="5">The King Air's right wing struck a tree during a forced landing on a road in a residential area short of the runway at Chicago Executive Airport.</td></tr>
</table>

NA = not available

This information, gathered from various government and media sources, is subject to change as the investigations of the accidents and incidents are completed.

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