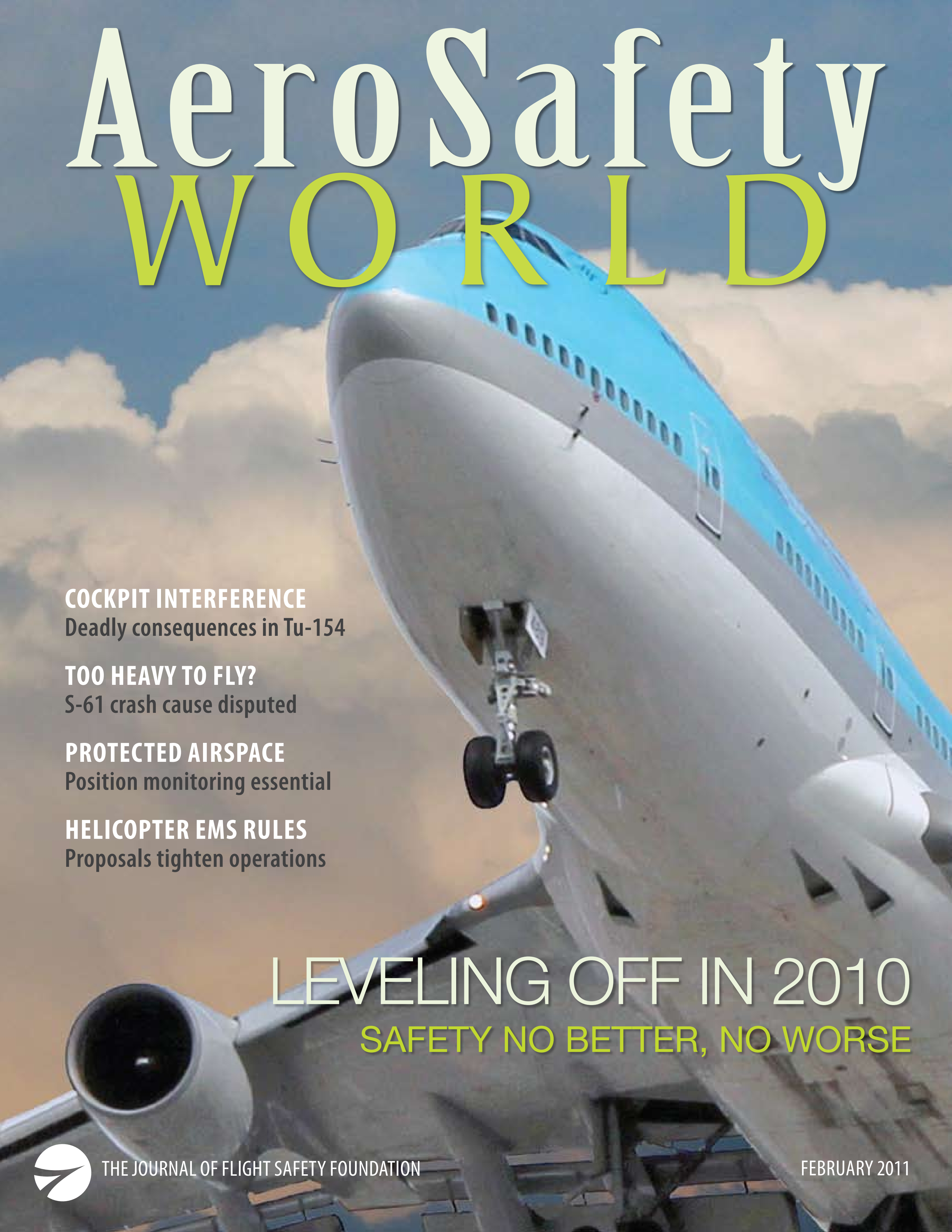

AeroSafety WORLD

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LEVELING OFF IN 2010
SAFETY NO BETTER, NO WORSE

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

FEBRUARY 2011

The System Works

During a recent trip to Africa and the Middle East, I found myself in some situations that reminded me how important it is for each airline, and this industry, to really hold itself accountable for its safety performance. Sometimes stuff happens that distracts governments from oversight and enforcement, yet that show must still go on.

I was in Beirut visiting the Arab Air Carrier Organization and talking with Lebanon's director general of civil aviation, an old friend. My timing wasn't great. When I arrived, it was clear that the volatile state of domestic politics was taking a toll on civil aviation oversight; by the time I left the next morning, the government had collapsed.

Like everybody, I felt a little nervous as I headed to the airport that morning, but it wasn't because I was afraid to get on the airplane. The airline personnel were sticking to their safety routine, and the airport operators were doing their jobs. And they were doing their jobs not because somebody was looking, because they weren't, but because being safe is built into their jobs and into their psyche. These people also know that when the world gets crazy, aviation matters. They learned that the hard way when their airport was blown up, most recently in 2006. They kept it safe then, and I knew they would keep it safe now.

My next stop was Cairo, Egypt, and on the day I arrived, neighboring Sudan was taking an important vote. It was a vote that will lead to the birth of a new nation. As I talked to my Egyptian colleagues about this remarkable event, it became clear that this new nation, essentially the southern half of Sudan, will be dependent on aviation from the moment it is born. It will be a largely landlocked state with almost no surface transportation infrastructure and a future that depends on the export of oil and minerals. The government will not be able to wait for a regulatory agency to be staffed up and audited before the geologists and miners start flying around. Those big resource companies will have to ensure that their people can travel safely from the very first day. That means they will have to publish and enforce the standards on those operators just like a regulator would, if there was one. That is just another extreme example of companies and industries owning their own safety performance without a state agency forcing compliance.

A couple days after I got home from Cairo, I followed closely the historic events in Tahrir Square. The top aviation safety guy became the acting prime minister, and clearly he was instantly busy with non-aviation priorities. But I knew the system would carry on, at least for a while. EgyptAir and others were not waiting for the regulator to turn its back so they could do stuff wrong. They had to maintain International Air Transport Association audit standards for their code-share partners, and they were committed to in-house safety programs for each other and for their customers.

So the next time you try to justify something to your CFO, and the answer is "no" because it is not a regulatory requirement, remind that person that isn't the way this industry really works. If we all waited for a regulator to force us to act, the world would be a very different place.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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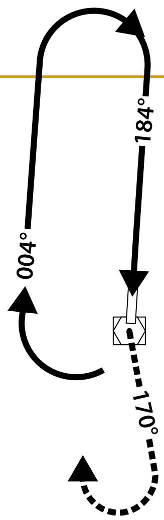

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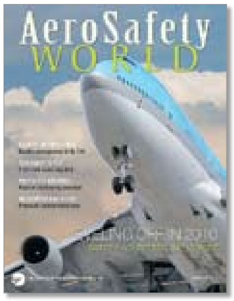

About the Cover
The global commercial jet accident rate has only budged in five years.
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If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about aviation safety, we will be glad to consider it. Send it to Director of Publications J.A. Donoghue, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA or donoghue@flightsafety.org.

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A GRAIN OF Salt

Who doesn't like and welcome praise for a job well done? Exactly, nobody. So when a mass news media magazine, *U.S. News and World Report*, came out with its own safety ranking of eight major U.S. airlines, it would have been mighty tempting for carriers at the top of the list — the "safest" — to take a bow. To do that, I believe, would be a mistake.

Despite the fact that the author opened the piece by saying "commercial air travel in the United States today is about as safe as it gets," accepting praise from a general media analysis based on assumptions and judgments of the author's choosing is misguided in that it implies acceptance of the validity of those judgments, opening the door for future subjective judgments.

Certainly, the general media will continue to do this sort of thing, using whatever criteria they think appropriate, regardless of what the aviation community says about the effort.

It is easy to criticize "list journalism," but the fact of the matter is that the only reason it is so common and pushed on journalists by their editors is that people love to read this sort of stuff. In fact, the author behind this safety ranking list seems to specialize in lists, recently offering "World's Hottest New Year's Eve Parties," "America's Most Infested Places" and "America's Meanest Airlines." You catch the drift.

The author's basic premise of scoring based on incidents per number of operations is not, in itself, a bad idea, and is similar to what we use in the industry to pinpoint areas of greatest risk. When accidents are so rare and random that they become statistically irrelevant, which is where we've been for quite a while, a larger dataset must be used. This was a breakthrough of the Commercial Aviation Safety Team and others a number of years ago that focused industry attention on controlled flight into terrain accidents and approach and landing accidents, the biggest killers at the time.

Recently, a presenter at Flight Safety Foundation's International Air Safety Seminar in Milan, Italy, introduced an idea to enlarge on that dataset, adding power by incorporating the mistakes and anomalies experienced during simulator training. This proposal is very interesting, since the scenarios commonly used in training sessions are seldom seen in real life, and learning the most common mistakes made in response to these scenarios may yield very useful training information.

But this most recent general media effort was not well informed. It did discount some of the events over which airlines have scant control, such as bird strikes, but it also discounted injuries in the cabin caused by turbulence, a decision that sort of flies in the face of a major cabin safety concern. The success with which airlines keep their passengers and crews strapped in, especially with turbulence ahead, is, I think, a measure of a safe operation.

Nonetheless, this exclusion didn't stop the author from talking about one airline's turbulence events. Also discussed was an air traffic control error that caused another carrier's loss of separation, which also was not counted in the rankings. This story was ill focused, a grab bag of minor-league airline horror stories.

So, my opening point remains: When lame stuff like this comes out in the general media, stick to the narrative you know to be true. Be satisfied with, and defend, an exemplary safety record that is not improved by any subjective ranking attempts.

J.A. Donoghue

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

CALL FOR PAPERS ➤ International Winter Operation Conference: "Safety Is No Secret." Air Canada Pilots Association. Oct. 5–6, 2011, Montreal. Capt. Barry Wiszniowski, <bwiszniowski@acpa.ca>, +1 905.678.9008; 800.634.0944, ext. 225.

MARCH 1–3 ➤ 23rd annual European Aviation Safety Seminar. Flight Safety Foundation, European Regions Airline Association and Eurocontrol. Istanbul, Turkey. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/aviation-safety-seminars/european-aviation-safety-seminar>, +1 703.739.6700, ext. 101.

MARCH 1–4 ➤ Flight Data Monitoring and Flight Operational Quality Assurance in Commercial Aviation. Cranfield University and U.K. Civil Aviation Authority. Bedfordshire, England. <shortcourse@cranfield.ac.uk>, <www.cranfield.ac.uk/soe/shortcourses/atm/page3796.html>, +44 (0)1234 754 192.

MARCH 7–10 ➤ Safety Management Course. ScandiAvia. Stockholm. Morten Kjellesvig, <morten@scandiavia.net>, <scandiavia.net/index.php/web/artikkel_kurs/management_sto_2011_01>, +47 91 18 41 82.

MARCH 10–11 ➤ Global ATM Operations Conference. Civil Air Navigation Services Organisation. Amsterdam. Anouk Achterhuis, <events@canso.org>, <www.canso.org/operationsconference2011>, +31 (0)23 568 5390.

MARCH 14–18 ➤ Legal Skills for Accident Investigators Course. Cranfield University. Bedfordshire, England. Lesley Roff, <shortcourse@cranfield.ac.uk>, <www.cranfield.ac.uk/soe/shortcourses/accident-investigation/page52032.html>, +44 (0)1234 754 192.

MARCH 15–16 ➤ Human Factors in Aviation Course — Threat and Error Management (TEM) Model. ScandiAvia. Stockholm. Morten Kjellesvig, <morten@scandiavia.net>, <scandiavia.net/index.php/web/artikkel_kurs/tem_sto_2011_01>, +47 91 18 41 82.

MARCH 15–17 ➤ Safety Management Systems Implementation and Operation Course. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Page McCanless, <mpthomps@mitre.org>, <www.mitremai.org/MITREMAI/sms_course/sms2.cfm>, +1 703.983.6799.

MARCH 17–18 ➤ Overview of Aviation Safety Management Systems Workshop. ATC Vantage. Tampa, Florida, U.S. <info@atcvantage.com>, <atcvantage.com/sms-workshop-March.html>, +1 727.410.4757.

MARCH 18 ➤ Aviation SMS Audit Course. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Page McCanless, <mpthomps@mitre.org>, <www.mitremai.org/MITREMAI/sms_course/smsaudit.cfm>, +1 703.983.6799.

MARCH 20–22 ➤ Implementing SMS at Your Airport Workshop. American Association of Airport Executives and Airports Council International–North America. San Antonio, Texas, U.S. <AAAEMeetings@aaae.org>, <www.aaae.org/meetings/meetings_calendar/mtgdetails.cfm?Meeting_ID=110306>, +1 703.824.0500.

MARCH 21–APRIL 1 ➤ Flight Operations Inspector Theory Training. CAA International. Gatwick Airport, England. Sandra Rigby, <training@caainternational.com>, <www.caainternational.com/site/cms/contentviewarticle.asp?article=505>, +44 (0)1293 573389.

MARCH 22–24 ➤ Human Factors Analysis and Classification System (HFACS) Workshop. HFACS Inc. Atlanta. Dan McCune, <mccune@hfacs.com>, <www.hfacs.com>, 800.320.0833.

MARCH 23–25 ➤ Airport Wildlife Mitigation Training. Embry-Riddle Aeronautical University and Portland International Airport. Portland, Oregon, U.S. Paul Eschenfelder, <eschenfelder@compuserve.com>, <worldwide.erau.edu/professional/seminars-workshops/wildlife-hazard-management/index.html>.

MARCH 23–24 ➤ Quality Systems Auditor Course. SureSafe Management Solutions. Vancouver, British Columbia, Canada. <info@suresafe.org>, <www.suresafe.org>, +1 403.200.3886.

MARCH 28–30 ➤ CHC Safety and Quality Summit. CHC Helicopter. Vancouver, British Columbia, Canada. <summit@chc.ca>, <www.chcsafetyqualitysummit.com>, +1 604.232.7424.

MARCH 29–30 ➤ Aviation Human Factors and SMS Seminar III: Real-World Flight Operations and Research Progress. Signal Charlie and U.S. Federal Aviation Administration Safety Team. Dallas. Kent B. Lewis, <lewis.kent@gmail.com>, <www.signalcharlie.net/Seminar+2011>, +1 817.692.1971.

MARCH 31–APRIL 2 ➤ Human Factors Analysis and Classification System (HFACS) Workshop. HFACS Inc. Vancouver, British Columbia, Canada. Dan McCune, <mccune@hfacs.com>, <www.hfacs.com>, 800.320.0833.

APRIL 5–7 ➤ 26th Annual Maintenance Management Conference. National Business Aviation Association. San Diego. <info@nbaa.org>, <www.nbaa.org/events/mmc/2011>, +1 202.783.9000.

APRIL 6–7 ➤ European Regions Airline Association (ERA) Regional Airline Conference. ERA. Malta. <www.eraa.org/events/regional-airline-conference/370-rac11-introduction>.

APRIL 7–8 ➤ ESASI Regional Air Safety Seminar. European Society of Air Safety Investigators and NetJets. Lisbon. Anne Evans, <anne_e_evans@hotmail.com>, <www.esasi.eu/esasi2011.html>, +44 (0)7860 516763.

APRIL 19–21 ➤ 56th annual Corporate Aviation Safety Seminar. Flight Safety Foundation and National Business Aviation Association. San Diego. Sandy Wirtz, <swirtz@nbaa.org>; Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/aviation-safety-seminars/corporate-aviation-safety-seminar>, +1 703.739.6700, ext. 101.

APRIL 20 ➤ Pilot Training Best Practices Workshop. International Association of Flight Training Professionals and SKYbrary. Orlando, Florida, U.S. Robert B. Barnes, Rbarnes@IAFTP.org, +1 480.585.5703.

APRIL 21 ➤ Free Half-Day Safety Management System Overview Course. The Aviation Consulting Group. Miami-Fort Lauderdale, Florida, U.S. Robert Baron, <www.tacgworldwide.com>, +1 954.803.5807.

MAY 2–5 ➤ 16th International Symposium on Aviation Psychology. Wright State University and Air Force Research Laboratory Human Effectiveness Directorate. Dayton, Ohio, U.S. Pamela Tsang, <isap2011@psych.wright.edu>, <www.wright.edu/isap>, +1 937.775.2469.

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If you have a safety-related conference, seminar or meeting, we'll list it. Get the information to us early. Send listings to Rick Darby at Flight Safety Foundation, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA, or <darby@flightsafety.org>.

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

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Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 1,075 individuals and member organizations in 130 countries.

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I ♥
AVIATION

Safety News

Errors in Calculation

Simple mistakes in calculating aircraft performance data and in data entry have led to a number of takeoff accidents worldwide, according to a report by the Australian Transport Safety Bureau (ATSB).

An ATSB report documented 31 such accidents and incidents between January 1989 and June 2009.

"These types of errors have many different origins: with crew actions involving the wrong figure being used, data entered incorrectly, data not being updated and data being excluded," said the report, *Takeoff Performance Calculation and Entry Errors: A Global Perspective*.


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"Furthermore, a range of systems and devices have been involved in these errors, including performance documentation, laptop computers, the flight management computer and the aircraft communications addressing and reporting systems. The consequences of these errors also ranged from a noticeable reduction in the aircraft's performance during the takeoff to the aircraft being destroyed and loss of life."

Most of the errors — 39 percent — were attributed to "crew actions, including monitoring and checking, assessing and planning, and the use of aircraft equipment," the report said. The document also noted that 31 percent of errors were associated with "absent or inadequate risk controls, mostly centered on poor procedures, non-optimally designed aircraft automation systems, inappropriately designed or unavailable reference materials, and inadequate crew management practices and training."

Because individual airlines use different methods for calculating and entering takeoff performance data, there is no single proposal for reducing errors, the report said. Nevertheless, the document suggested that operators and manufacturers consider development of "appropriate crew procedures" such as enhanced cross-checking and modified software design for entering and checking data. In addition, pilots "need to ensure procedures are followed, even when faced with time pressures or distractions," the report said.

Fatigue Analysis

The airport air traffic controller on duty during the fatal crash of a Comair Bombardier CRJ100ER at Blue Grass Airport in Lexington, Kentucky, U.S., was "substantially fatigued when he failed to detect that the plane was on the wrong runway and cleared it for takeoff," a team of sleep researchers say.

Researchers at Washington State University (WSU) in Spokane, writing in the journal *Accident Analysis and Prevention*, said their analysis of the case suggests that mathematical fatigue-prediction models could be used to create work schedules that take into account sleep schedules and circadian rhythms to reduce the risk of fatigue-related accidents.

The CRJ crashed Aug. 27, 2006, killing the captain, flight attendant and 47 passengers; the first officer received serious injuries. The U.S. National Transportation Safety Board (NTSB) said the probable causes were "the flight crewmembers' failure to use available cues and aids to identify the airplane's location on the airport surface during taxi and their failure to cross-check and verify that the airplane was on the correct runway before takeoff."

The NTSB report noted that the controller was on duty alone when the accident occurred just after 0600 local time, that he had been at work since about 2330 the previous night and that he likely was fatigued.

Gregory Belenky, director of the WSU Sleep and Performance Research Center and a coauthor of the paper, said that the controller was tired and "was working a schedule that was not circadian-friendly."

Belenky and research assistant Lora Wu, coauthor of the paper, said that their work was not intended to place blame

David Mueller/Wikimedia

on anyone involved in the accident but to identify the times of day that are "relatively more dangerous than other times of day."

The researchers employed a mathematical model in analyzing the controller's pre-accident work history — two evening shifts, two day shifts and the overnight shift during which the crash occurred.

"While the controller had 10 hours off before his last shift, … his circadian cycle let him get only two or three hours of sleep," they said, estimating that at the time of the accident, he was "performing at 71 percent of his effectiveness."

Air Taxi Training in CRM

© Denkou Images/Fotolia

Pilots and flight attendants working for U.S. Federal Aviation Regulations Part 135 non-scheduled charter airlines and air taxis must now be trained in crew resource management (CRM), according to new rules established by the U.S. Federal Aviation Administration.

Air carriers affected by the rule have two years to establish initial and recurrent CRM training, which provides instruction in communication and teamwork; managing workload, time, fatigue and stress; and decision making, the FAA said.

Similar training has been required since 1995 for crewmembers in larger airplanes operating under Part 121.

"I know the value of making crew resource management part of the safety culture from my days as an airline pilot," FAA Administrator Randy Babbitt said. "A crew that works as a team is a better crew, regardless of the size of the plane or the size of the airline."

Issuance of the final rule comes in response to a 2003 recommendation from the U.S. National Transportation Safety Board (NTSB). The item has been included since 2006 on the NTSB list of "Most Wanted Transportation Safety Improvements."

Laser Strikes

The number of reported incidents involving lasers pointed at aircraft in the United States increased 86 percent between 2009 and 2010 to a record 2,836 incidents, the U.S. Federal Aviation Administration (FAA) says.

That number compared with nearly 300 in 2005, the first year that the FAA had a formal reporting system in place to collect information from pilots on laser strikes.

"The FAA is actively warning people not to point high-powered lasers at aircraft because they can damage a pilot's eyes or cause temporary blindness," said FAA Administrator Randy Babbitt. "We continue to ask pilots to immediately report laser events to air traffic controllers so we can contact local law enforcement officials."

More laser events — 102 — were reported at Los Angeles International Airport in 2010 than at any other airport.

Air France Embraces Safety Plans

Air France plans to quickly implement most of the 35 recommendations submitted by an independent safety review team that was established in the aftermath of the June 1, 2009, crash of an Airbus A330 into the Atlantic Ocean.

The airline said that it already has implemented preliminary recommendations, including creating a flight safety committee within the Air France Board of Directors and becoming the first major European airline to institute the line operations safety audit (LOSA) — a program in which trained observers ride in the cockpit on regularly scheduled flights to collect safety-related data.

Air France said the safety review team's findings "primarily concern the company's organization, its corporate culture and the individual behavior of its staff managers and unions."

Pierre-Henri Gourgeon, CEO of Air France–KLM, said, "Air France is the only airline to have [submitted], on its sole initiative, to the opinion of a team of external experts. … By implementing their recommendations, which combine the best practices observed individually in other airlines worldwide, Air France will place its flight safety performance at the highest level possible."

The 2009 crash, which occurred during a flight from Rio de Janeiro, Brazil, to Paris, killed all 228 people in the airplane. Despite several extensive searches, the airplane's flight recorders have not been found, and investigators have not determined the cause of the crash.

© Air France

Coping With Winter

European airports have been told to develop contingency plans as soon as possible to describe how to prevent the disruptions in air traffic that accompanied heavy snows in December 2010.

© Swisshippo/Dreamstime.com

Siim Kallas, European Commission (EC) vice president in charge of transport, told officials of major European airports that action is needed to "ensure the proper functioning of the airline hubs."

The aviation industry is primarily responsible for planning, although the EC can strengthen regulations, if necessary, Kallas said.

He noted that many of Europe's largest and busiest airports were partially shut down at the start of the Christmas holidays, many flights were canceled and thousands of passengers were stranded. Concerns about a shortage of deicing products also affected airport operations, he said.

"We know that winter arrives every year, and we should be ready for it," Kallas said. "In particular, we need to introduce minimum service and quality requirements at European airports for our passengers."

In Other News …

In a reciprocal membership agreement, Flight Safety Foundation has become an industry partner of the **Arab Air Carriers Organization** (AACO), which represents about two dozen carriers from Arabic-speaking nations. The AACO also has become a member of the Foundation. … The U.S. National Oceanic and Atmospheric Administration (NOAA) says its satellites aided in the rescues of 43 people involved in aviation incidents in 2010. The 43 were among 295 people saved in 2010 after NOAA satellites picked up distress signals from their **emergency beacons**. … Jeppesen has introduced a **fatigue risk management** application for the Apple iPhone. The CrewAlert application, intended for use by schedulers, crewmembers and others to predict alertness levels, allows data to be fed into an airline's fatigue risk management system.

Sarah Lederer

Sarah Bojarsky Lederer, widow of Flight Safety Foundation founder Jerome F. Lederer, died in Aliso Viejo, California, U.S., on Feb. 6 — seven years to the day after her husband's death. She was 99.

She had been a social worker in New York City, vice president of the New Rochelle, New York, Board of Education and a member of the board of the New Rochelle Municipal Housing Authority. She also was a regulation writer for the District of Columbia Redevelopment Land Agency.

Survivors include a daughter, Nancy Cain; a brother, Eli Boyer; and two granddaughters. Another daughter, Susan Lederer, died in 2008.

Out of ASAP

The union representing pilots at USA 3000 Airlines says they will withdraw from participation in the airline's voluntary aviation safety action program (ASAP) because of company actions that "destroyed the trust required for a successful program."

The company said that it "believes strongly in the value of the ASAP program," that it regrets the pilots' action and that it hopes the union will reconsider.

The Airline Professionals Association Teamsters Local 1224 complained that unauthorized individuals had access to confidential ASAP information. The union also said that letters had been inappropriately placed in the personnel files of several of USA 3000's 60 pilots, "even though the events and the circumstances surrounding them were admitted into ASAP by the event review committee" at the airline. The union said that the letters were inaccurate and that pilots feared that they might eventually be released under laws that make pilot records available to potential employers.

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Compiled and edited by Linda Werfelman.

Susan Reed

A new control law in flight guidance computers will reduce non-safety-critical TCAS RAs, Airbus says.

Softening Level-Offs

BY WAYNE ROSENKRANS | FROM MILAN

An altitude-capture software enhancement has been developed to eliminate the predominant cause of resolution advisories (RAs) from traffic-alerting and collision avoidance systems (TCAS II). It works by automatically adjusting the trajectory of at least one airplane converging with another during specific climb/descent scenarios.

Airbus TCAS Alert Prevention (TCAP) adds this functionality to the existing spectrum of defenses against midair collisions, said Christophe Cail, test pilot for the company. No changes to TCAS, human-machine interface or training are required.

Performance assessment with Eurocontrol's Interactive Collision Avoidance Simulator ($InCAS^3$) tool and Airbus simulation tools has enabled the company to estimate introduction of TCAP on new airframes and as retrofits beginning in 2011–2013, assuming that regulatory certification proceeds as expected, Cail said in November 2010 at Flight Safety Foundation's International Air Safety Seminar in Milan, Italy. Increasing traffic volume and wider use of reduced vertical separation minimums have been among factors drawing worldwide attention to the so-called side effect of the TCAS RAs generated in non-safety-critical scenarios. He called these "nuisance RAs during 1,000-ft level-off maneuvers."

Addressing this issue has been challenging because TCAS algorithms do not take into account pilot intentions, such as the intent to change an apparent collision trajectory by leveling off. The Airbus solution responds to safety recommendations from the French Bureau d'Enquêtes et d'Analyses (BEA) and Eurocontrol. In 2003, after investigating an incident involving an RA, the BEA recommended that the TCAS RA-triggering threshold be taken into account in the altitude-capture law of Airbus automation, he said. The same year, Eurocontrol proposed that Airbus modify its autopilot altitude-capture law by "an earlier reduction of vertical rate." Several airlines also requested a solution.

The specific types of RAs for which TCAP was designed are operationally undesired alerts in either of two simple encounter geometries. "More than 50 percent of all RAs [in Europe are] from these two geometries," Cail said. "The first is when one aircraft is climbing toward a flight level [FL] such as FL 100 [approximately 10,000 ft] and another aircraft [in cruise] is just at the adjacent flight level, 1,000 feet above, at FL 110." What typically has occurred is that, depending on the vertical speeds and the geometry, the climbing crew received first a traffic advisory (TA), then an RA directing them to "adjust vertical speed" while the TCAS aboard the aircraft in level flight directed that crew first to climb and then to descend back to the assigned flight level (Figure 1).

The other encounter geometry involves one airplane climbing toward a selected flight level, say FL 100, and the other aircraft descending to capture FL 110. "The relative vertical speed is higher, and the flight crews could get an RA," he said.

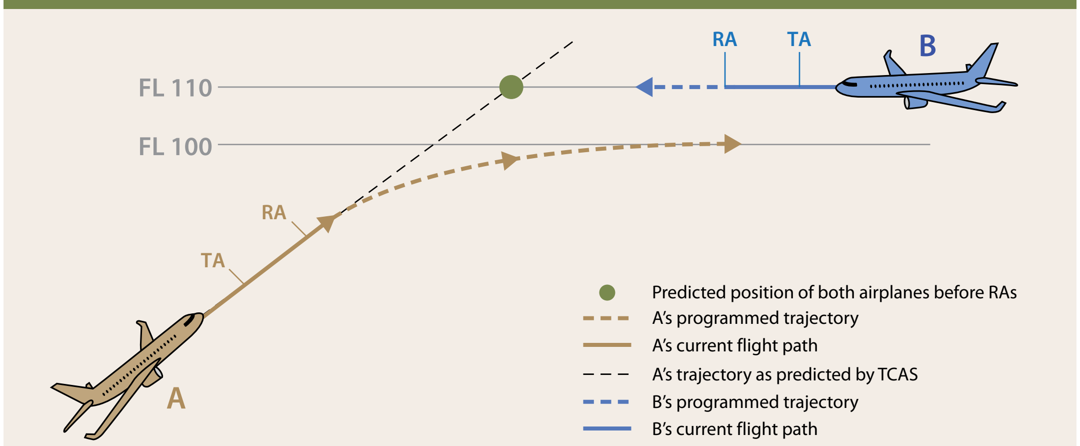
In 2010, Airbus assessed TCAP performance. "We avoided 100 percent of those operationally undesired RAs [in simulated cases]," Cail said. "We are very confident that in actual airspace, TCAP will be very efficient. [This research] has to be consolidated later on during a study in the framework of the Single European Sky Air Traffic Management Research project."

When trajectories of one TCAP-equipped airplane and one non-equipped airplane converged on altitudes separated by 1,000 ft per air traffic control (ATC) instructions, one TA and two RAs occurred on each flight deck. Only one TA occurred on each aircraft, however, when one was TCAP-equipped in the same simulated scenario. "So the benefit is also for non-equipped aircraft," he said.

The logic of TCAS explains why non-safety-critical RAs occur even with Version 7.1 software released in 2009 (*ASW*, 4/09, p. 34). "TCAS [logic] doesn't 'care' about the intention of the crew or what is in the flight management system of the aircraft," Cail said. For example, in aircraft between FL 100 and FL 200, if the computed time to collision is less than 30 seconds, the flight crews will receive an RA, he added.

"Usually, [the recommended intervention (*ASW*, 4/09, p. 19)] when an aircraft is close to its targeted flight level is … to manually select a new vertical speed instead of leaving the aircraft to follow its existing path," he said. "What happens

Operationally Undesired TCAS RA: Single Level-Off Maneuver



TCAS = traffic-alerting and collision avoidance system; TA = traffic advisory; RA = resolution advisory; FL = flight level

Source: Airbus

Figure 1

in reality is that [this intervention] is not always applied."

Because TCAS generates TAs — indicating the presence of another aircraft — before RAs, Airbus flight guidance computer system engineers developed a method of "softening" the trajectory, reducing the vertical speed of the TCAP-equipped airplane to avoid the need for an RA in these scenarios. "The principle was to introduce a new altitude-capture law that will 'soften' the capture in the presence of other traffic," Cail said. "We wanted to impact only the flight guidance computer, with no human-machine interface impact and no additional training."

Along with the prerequisite TA, three other conditions must be satisfied for TCAP to activate. "The autopilot and/or the flight director has to be engaged," he said. "The aircraft has to be converging toward its selected altitude [and the situation must meet] the 'TCAP availability threshold,' [designed to limit] activations only to TAs corresponding to the 1,000-ft level-off encounters."

The TCAP availability threshold is a vertical distance calculated using the equipped airplane's vertical speed, its distance to capture of the selected altitude and the altitude where the TA occurred. This distance is applied by the altitude-capture control law within the flight guidance computer, which factors in an intruder aircraft capturing the same altitude with conventional altitude-capture control law as one aircraft climbs and the other descends.

For instance, if while descending to capture FL 300, a TCAP-equipped airplane crosses FL 340 with a vertical speed of 6,000 fpm and convergence with an intruder aircraft triggers a TA, TCAP will activate given that the equipped airplane's position is lower than FL 365. But in the same scenario with a vertical speed of 2,000 fpm, TCAP activation will be inhibited given that the equipped airplane's position is not lower than FL 335.

"If, before the TA triggering, the [autopilot] is in open climb/descent mode or level change mode in descent, there will be an immediate reversion to altitude capture mode [ALT* on the Airbus flight mode annunciator (FMA)] with the new TCAP altitude control law active," Cail said. If the aircraft is already in ALT* mode with conventional altitude capture control law active when a TA occurs, ALT* will be maintained but with an automatic change from that law to TCAP control law, he said.

To retain the existing human-machine interface, the ALT* mode remains displayed on the FMA. There is no change to the autopilot/flight director/autothrottle engagement stages or other impact on the lateral trajectory or mode, he added.

"When the TA occurs, the ALT* with TCAP law remains until the end of the capture [even if the TA ceases, to avoid causing further TAs]," Cail said. "[In ALT* TCAP] control law, one or several vertical speed targets [are computed,] and the airplane will go from one [speed target] to another with a load factor of 0.15 g [i.e., 15 percent of standard gravitational acceleration]. As a pilot, you feel it [as sensory feedback by design]. At the end of the capture, [this mode] reverts to the normal ALT* parabola [trajectory profile] at 0.5 g." Airbus optimized this function during 100,000 simulated encounters, including other algorithms for "early TAs" that occur farther than 2,000 ft from the selected level-off altitude.

Cail used a typical operational scenario with and without TCAP to illustrate the benefits for non-equipped airplanes. One flight crew with TCAP receives the TA while in descent and 2,000 ft above the targeted flight level. "As soon as the airplane gets the TA, TCAP will take the first new vertical speed target," Cail said. "As soon as the aircraft crosses 2,000 ft above the targeted flight level, there will be a reduction of the vertical speed to 1,500 fpm."

In this scenario without TCAP, the flight guidance computer of the descending airplane is in ALT* mode and less than 2,000 ft from the crew's targeted flight level. "The crew gets the TA, and instead of continuing the capture that [would lead] to an RA, the pilot will [have to select a] vertical speed that is lower, a value between 1,200 fpm and 1,500 fpm," Cail said. "This function will increase the time to capture the altitude. This is one of the reasons [Airbus] wanted to activate [TCAP] only when relevant. The average increase in time is something like 40 seconds."

Airbus envisions TCAP reducing non-safety-critical RAs worldwide. Meanwhile, the RAs targeted by TCAP continue to occur despite appropriate maneuvers by pilots and appropriate instructions by ATC controllers, he said. Fewer RAs mean "less stress for the crew and less perturbation for the traffic because no avoidance maneuver will be done; it is unnecessary," he said.

With TCAP, flight crews will monitor the autopilot modes, airplane trajectory and altitude capture without the obligation to remember to manually intervene to adjust the vertical speed during the last 1,500 ft before capture, Cail added.

Airbus expects to obtain regulatory certification between 2011 and mid-2013, with timing dependent on the aircraft type. The company expects to fly TCAP-equipped test airplanes in early 2011, he said.

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Commercial jet accident rates were good in 2010, just not better.

Leveling Off

BY JAMES M. BURIN

The trend of an impressive but non-improving safety record continued in 2010.

The accident rate for commercial jets in 2010 was 0.54 major accidents per million departures. That was almost identical to the average rate of 0.55 for the previous five years and slightly better than the 0.57 rate for the previous decade. Five of the 19 major commercial jet accidents — two controlled flight into terrain (CFIT) accidents, two loss of control (LOC) accidents and one runway excursion accident — accounted for 96 percent of the fatalities.

The business jet fleet, which normally averages about 10 major accidents a year, had a good year, with only eight major accidents. The commercial turboprop fleet had its best year ever in terms of number of major accidents, but CFIT accidents continue to dominate the turboprop accident and fatality numbers.

Approximately 6 percent of the turbojet fleet is Eastern-built, while 20 percent of the turboprop fleet is Eastern-built. The commercial turbojet numbers increased approximately 2 percent from 2009, and the commercial turboprop numbers grew almost 2 percent, the first time in several years they have shown an increase. As usual, the business jet numbers increased the most, approximately 4 percent. These numbers reflect the total fleets. The active fleets, the aircraft actually in service, are somewhat smaller. Approximately 9 percent of the turbojet fleet is inactive, and that number is growing.

Approximately 14 percent of the turboprop fleet is inactive. Four percent of the business jets were inactive, the second year in a row that there were more than just a few inactive business jets.

There were 19 major accidents involving commercial jet operations in 2010 (Table 1), which includes all scheduled and unscheduled passenger and cargo operations for Western- and Eastern-built commercial jet aircraft. Fifteen of these involved Western-built aircraft. Fifteen of the 19 major accidents were approach and landing accidents (ALAs). There were two CFIT accidents and two LOC accidents. Five of the 19 commercial jet major accidents were runway excursions.

The major accident rate for Western-built commercial jets has virtually leveled off, as has the five-year running average (Figure 1). These accident rates are only for Western-built aircraft because even though we know the number of major accidents for Eastern-built aircraft, we do not have reliable worldwide exposure data to calculate rates for them.

There were only eight major accidents involving corporate jets in 2010 (Table 2, p. 18). A comparison with the yearly number of corporate jet major accidents since 2001 highlights the fact that corporate jets had an excellent year safety-wise (Figure 2, p. 18). Although worldwide exposure data are not available for

Major Accidents, Worldwide Commercial Jets
January 1, 2010–December 31, 2010

Date	Operator	Aircraft	Location	Phase	Fatalities
Jan. 2, 2010	CAA	727	Kinshasa, DRC	Landing	0
Jan. 24, 2010	Taban Air	TU-154	Mashhad, Iran	Landing	0
Jan. 24, 2010	Ethiopian Airlines	737	Beirut, Lebanon	Climb	90
March 22, 2010	Avistar-TU	TU-204	Moscow	Approach	0
April 13, 2010	Merpati Airlines	737	Manokwari, Indonesia	Landing	0
April 13, 2010	AeroUnión	A300	Monterrey, Mexico	Approach	5
May 5, 2010	Satena	EMB-145	Mitú, Colombia	Landing	0
May 12, 2010	Afriqiyah Airways	A330	Tripoli, Libya	Approach	103
May 22, 2010	Air India Express	737	Mangalore, India	Landing	158
July 27, 2010	Lufthansa	MD-11F	Riyadh, Saudi Arabia	Landing	0
July 28, 2010	Airblue	A321	Islamabad, Pakistan	Approach	152
July 28, 2010	Mauritania Airways	737	Conakry, Guinea	Landing	0
Aug. 16, 2010	Aires	737	San Andrés, Colombia	Landing	2
Aug. 24, 2010	Henan Airlines	EMB-190	Yichan, China	Approach	42
Aug. 25, 2010	Passaredo Linhas Aéreas	EMB-145	Vitória da Conquista, Brazil	Approach	0
Sept. 3, 2010	UPS	747	Dubai, UAE	Approach	2
Sept. 24, 2010	Windjet	A319	Palermo, Italy	Landing	0
Nov. 28, 2010	Sun Way	IL-76	Karachi, Pakistan	Climb	8
Dec. 4, 2010	Dagestan Airlines	TU-154	Moscow	Climb	2

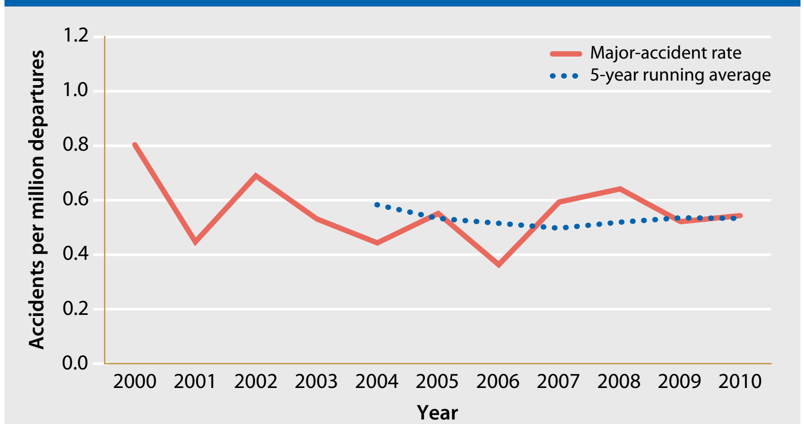
Loss of control accident   Controlled flight into terrain (CFIT) accident   Runway excursion

DRC = Democratic Republic of Congo; UAE = United Arab Emirates

Source: Ascend

Table 1

Western-Built Commercial Jet Major Accident Rates, 2000–2010



Note: Total departure data are not available for Eastern-built aircraft.

Source: Ascend

Figure 1

Major Accidents, Worldwide Corporate Jets
January 1, 2010–December 31, 2010

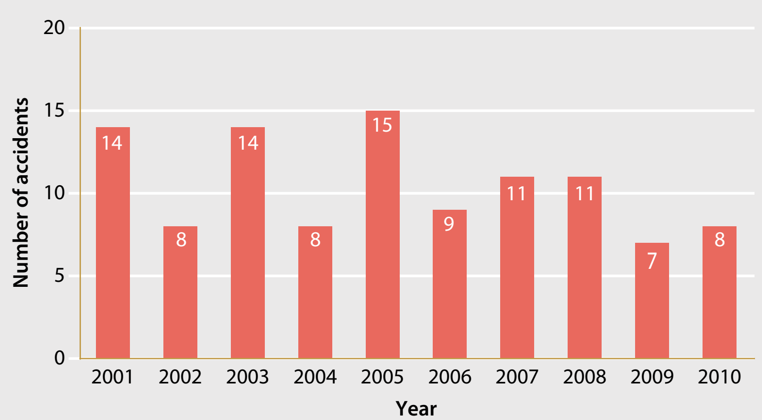
Date	Operator	Aircraft	Location	Phase	Fatalities
Jan. 5, 2010	Royal Air Freight	Lear 35	Chicago	Approach	2
Feb. 14, 2010	Time Air	Citation Bravo	Schöna, Germany	En route	2
July 15, 2010	Prince Aviation	Citation Bravo	Bol, Croatia	Landing	0
Aug. 12, 2010	Ocean Air Taxi	Lear 55	Rio de Janeiro, Brazil	Landing	0
Aug. 31, 2010	Trans Air	Citation II	Misima, PNG	Landing	4
Oct. 6, 2010	Aviones Taxi	Citation I	Veracruz, Mexico	En route	8
Nov. 19, 2010	Frandley Aviation Ptn	Citation I	Birmingham, U.K.	Landing	0
Dec. 19, 2010	Windrose Air	Hawker Premier	St. Moritz, Switzerland	Approach	2

PNG = Papua New Guinea

Source: Ascend

Table 2

Major Accidents, Corporate Jets, 2001–2010



Source: Ascend

Figure 2

corporate jets, the number of aircraft and the number of departures have been increasing steadily throughout the decade, so their accident rate is estimated to be decreasing.

There were 20 major accidents involving Western- and Eastern-built commercial turboprop aircraft with more than 14 seats in 2010 (Table 3). This is the lowest-ever number of major accidents for turboprops. The most significant safety challenge for commercial turboprops continues to be CFIT accidents. In 2008, seven of the 29 turboprop major accidents were CFIT accidents. In 2009, seven of the 21 turboprop major accidents were CFIT accidents. For 2010, four of the 20 turboprop major accidents were CFITs.

CFIT has not been eliminated among commercial jets, but we are making progress in reducing it. The story is not so positive for turboprops.

As in the past 20 years, CFIT, ALA, and LOC accidents continue to account for the majority of accidents and cause the majority of fatalities. Normally, ALAs account for 50 to 60 percent of the major accidents each year for any type of aircraft (commercial jets, business jets, turboprops or general aviation). In 2010, there was an unusually high percentage of ALAs involving commercial jets and business jets. The recently released updated *Approach and Landing Accident Reduction (ALAR) Tool Kit* <flightsafety.org/current-safety-initiatives/approach-and-landing-accident-reduction-alar/alar-tool-kit-cd> will, it is hoped, help reduce the risk of this type of accident. In 2010, ALAR training using the updated tool kit was conducted in Singapore; Manila, Philippines; Bangkok, Thailand; and Tripoli, Libya.

The number of CFIT accidents involving commercial jet aircraft since 1998 shows the slow but positive progress we are making in reducing the risk. In the past two years, we have suffered the first CFIT accidents involving aircraft with functioning terrain awareness and warning systems (TAWS). In those cases, the TAWS functioned normally and gave the flight crews sufficient warning of the impending CFIT accident. Those warnings, however, were not acted upon with enough urgency to prevent the disasters.

In 2006, LOC accidents took over from CFIT as the leading killer in commercial aviation. Unfortunately, that class of accidents is lengthening its lead. Unlike with CFIT, we have never had a year with zero LOC accidents.

The term "loss of control" actually does not accurately describe many of the accidents. About half of recent "loss of control" accidents have been what is more accurately described as "lack of control" (LAC) accidents because the crews had full control of the aircraft at all times.[1] Since LOC accidents are normally not survivable, even a low number of LOC accidents usually results in a high number of fatalities. The two LOC accidents in 2010 accounted for over one-third of the total commercial jet fatalities for the year.

Some common elements are emerging in many of the loss or lack of control accidents. First, the autopilot is normally involved. Either the crew thinks it is on and it is not, or they try to turn it on and it will not engage. Second, there are no visual references — for example, in instrument meteorological conditions or at night with few or no outside visual references. Finally, many times the pilot monitoring is aware of the deteriorating situation, but waits too long or is unable to relay this information to the pilot flying.

The Foundation's goal is "to make aviation safer by reducing the risk of an accident." We have achieved great success toward that goal, but as can be seen from the recent safety record, there are still challenges to be addressed. The commercial jet accident rate is low and very impressive, but it has stopped improving. CFIT continues to be a challenge for commercial turboprops, and loss of control accidents continue to dominate the fatality numbers for commercial jets. In an industry where risk will never be zero, we face the public's expectation of perfection as the minimum acceptable standard. However, the aviation industry continues to successfully address that challenge and is constantly working to make aviation safer by reducing the risk of an accident.

Major Accidents, Worldwide Commercial Turboprops
January 1, 2010–December 31, 2010

Date	Operator	Aircraft	Location	Phase	Fatalities	
Jan. 22, 2010	Alaska Central Express	B-1900	Sand Point, AK, U.S.	Takeoff	2	
Jan. 25, 2010	Piquiatuba Táxi Aéreo	EMB-110	Senador José Porfirio, Brazil	Approach	2	●
March 18, 2010	EXIN	AN-26	Tallinn, Estonia	Go around	0	
March 22, 2010	Airnorth	EMB-120	Darwin, Australia	Takeoff	2	
April 21, 2010	Interisland Airlines	AN-12	Pampanga, Philippines	Approach	3	
May 15, 2010	Blue Wings Airlines	AN-28	Poeketi, Suriname	En route	8	
May 17, 2010	Pamir Airways	AN-24	Salang Pass, Afghanistan	En route	44	●
June 19, 2010	Aero Service	CASA-212	Yangadou, Congo	En route	11	
July 18, 2010	Cebu Air	ATR-72	Manila, Philippines	Landing	0	
Aug. 3, 2010	Katekavia	AN-24	Igarka, Russia	Approach	12	●
Aug. 24, 2010	Agni Air	DO-228	Bastipur, Nepal	Enroute	14	
Aug. 25, 2010	Filair	LET -410	Bandundu, DRC	Approach	20	
Sept. 13, 2010	Conviasa	ATR-42	Puerto Ordaz, Venezuela	Approach	17	
Oct. 12, 2010	Transafrik	C-130	Kabul, Afghanistan	Enroute	8	
Oct. 21, 2010	TRACEP	Let 410	Bugulumisa, DRC	Climb	2	
Nov. 4, 2010	Aerocaribbean	ATR-72	Guasimal, Cuba	En route	68	
Nov. 5, 2010	JS Air	Beech 1900	Karachi, Pakistan	Climb	21	
Nov. 11, 2010	Tarco Airlines	AN-24	Zalingei, Sudan	Landing	6	
Dec. 3, 2010	Kaya Airlines	Beech 1900	Maputo, Mozambique	Approach	0	
Dec. 15, 2010	Tara Air	DHC-6	Lamidanda, Nepal	En route	22	●

● Controlled flight into terrain (CFIT) accident

DRC = Democratic Republic of Congo

Source: Ascend

Table 3

Note

1. The Foundation uses this definition of an LOC accident: "An accident in which an aircraft is unintentionally flown into a position from which the crew is unable to recover due to aircrew, aircraft, environmental or a combination of these factors." This is the definition of an LAC accident: "An accident in which a fully controllable aircraft is unintentionally flown into a position from which the crew is unable to recover. A 'fully controllable aircraft' responds to control inputs in an appropriate manner."

'CLASH *of* MOTIVES'

The Tu-154 pilot knew that the approach was unsafe but was strongly motivated to land.

© Jan Ostrowski/Airliners.net

BY MARK LACAGNINA

The flight crew's failure to proceed to an alternate airport after being told repeatedly that the weather conditions at Smolensk (Russia) Severny Airdrome were significantly lower than the nonprecision approach minimums was the "immediate cause" of the controlled flight into terrain accident that killed all 96 people aboard a Tupolev 154M the morning of April 10, 2010, according to the final report by the Russian Interstate Aviation Committee (IAC).

The IAC also faulted the crew's continued descent below the decision height without visual contact with ground references and their failure to respond to numerous terrain awareness and warning system (TAWS) warnings.

The aircraft, operated by the Polish Ministry of Defense, was transporting Polish President Lech Kaczynski and other government officials, as well as parliament members, clergy and others to attend an event marking the 70th anniversary of the massacre of Polish intellectuals, politicians and military officers in Katyn, according to media reports.

The IAC report said that the presence on the flight deck of the commander-in-chief of the Polish air force during the approach exerted "psychological pressure on the PIC's [pilot-in-command's] decision to continue descent in the conditions of unjustified risk with a dominating aim of landing at any means."

The four flight crewmembers were Polish air force pilots assigned to a special regiment conducting VIP flights. The PIC, 36, had more than 3,400 flight hours, including 530 hours as a Tu-154 PIC and 1,663 hours as a copilot in type. The report noted that he was authorized to conduct nondirectional beacon (NDB) approaches with visibility no lower than 1,200 m (3/4 mi) and with ceilings no lower than 100 m (328 ft).

The copilot, 36, had more than 1,700 flight hours, including 198 hours as a Tu-154 copilot and 277 hours as a navigator in type. The navigator, 32, had more than 1,060 flight hours, including 59 hours as a Tu-154 navigator and 389 hours as a Yakovlev 40 copilot. The flight engineer, 37, had more than 320 flight hours.

"It is impossible to assess the professional level of the PIC and the other crewmembers completely, as the Polish representatives [to the investigation] did not provide relative documentation to confirm their

Tupolev Tu-154M

© Michal Kral/Airliners.net

The Tu-154 medium-range airliner initially was designed to replace the first-generation turboprop and jet transports in the Aeroflot fleet. The three-engine airplane entered passenger service in 1972. Refinements that included upgrades of the rear-fuselage-mounted Kuznetsov NK-8-2 turbofan engines marked the successive introductions of the A, B and B-2 models. The next model, the Tu-154M, debuted in 1984 with a redesigned empennage and more modern Soloviev D-30KU engines, each rated at 104 kN (23,386 lb) thrust.

The airplane accommodates three flight crewmembers and up to 180 passengers, and was designed to operate on unpaved and relatively short runways. Maximum weights for the Tu-154M are 100,000 kg (220,460 lb) for takeoff and 80,000 kg (176,368 lb) for landing. Maximum payload is 18,000 kg (39,683 lb). Maximum cruise speed is 513 kt, and maximum cruise height is 11,900 m (39,000 ft). Ranges are 2,100 nm (3,889 km) with maximum payload and 3,563 nm (6,599 km) with maximum fuel and 5,450 kg (12,015 lb) payload. The avionics equipment meets International Civil Aviation Organization standards for Category II landings.

The accident airplane, shown above, was built in 1990. Nearly 900 Tu-154s were built before the airplane was replaced in 1995 by the Tu-204, which has two engines mounted under the wings.

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

qualification," the report said. However, it noted that "the PIC had comparatively insignificant experience of unsupervised flight in his position (a little over 500 hours), and he was appointed along with a crew who had even less experience of unsupervised flights on type."

The report said that the formation of the crew for the flight to Smolensk "was done without considering the actual professional level of each person and the nature of the task." Of the four crewmembers, only the PIC had previously flown to Smolensk, serving as a copilot on three flights to the airport.

The report also said that the Tu-154 crew "did not have complete air navigation and other data on Smolensk Severny Airdrome when preparing for the flight," and that a notice to airmen about inoperative navigation aids at the airport was not provided to the crew. The crew also was not aware that one of the alternate airports on their flight plan — Vibebsk, Belarus — was not open. (The other filed alternate was Minsk, also in Belarus.)

Fog and Low Clouds

The aircraft was 27 minutes behind schedule when it departed from Warsaw at 0927 Smolensk time (0727 Warsaw time). The estimated flight time was 1 hour and 15 minutes.

About 40 minutes after departure, Minsk Control cleared the crew to descend from 10,000 m (32,810 ft) to 3,900 m (12,796 ft) and advised them that the visibility at the Smolensk airport was 400 m (1/4 mi) in fog. "However, the crew did not show any concern and did not request recommendations as to the alternate airdromes," the report said.

Smolensk Severny (North) Airdrome is a joint-use airport served only by NDB approaches. It has one runway, which is 2,500 m (8,203 ft) long and 49 m (161 ft) wide. The report noted that the airport is not certified for international flights.

Visibilities of 3 to 4 km (2 to 2 1/2 mi) had been forecast, but the weather conditions at Smolensk had worsened during the morning as fog and low clouds drifted in from the southeast. Visibility had decreased from 4 km to 2 km (1 1/4 mi) during the approach of a Yakovlev 40 that had landed at 0915. (The Yak-40 also was carrying Polish delegates to the Katyn commemoration.) About 25 minutes later, the crew of a Russian Ilyushin 76 diverted to Moscow after conducting two radar-assisted NDB approaches and missed approaches at Smolensk.

"The weather measurements taken at 0940 showed that the weather conditions — visibility

800 m [1/2 mi], cloud base 80 m [262 ft] — got below the airdrome minima — 100 [m ceiling] x 1,000 [m; 5/8 mi visibility] — for landing on Runway 26 using the radar and NDB landing system," the report said.

At 1023, the Tu-154 crew established radio communication with the chief air traffic controller at Smolensk, who advised that "it is foggy, visibility 400 m" and warned that the weather conditions were not appropriate for landing, the report said.

'Trial Approach'

The crew discussed this information among themselves and with passengers who had entered the cockpit. "The crew did not take the correct decision to go to an alternate airdrome," the report said. "The PIC realized that it was difficult to approach in such conditions but, considering the importance of the task and the possible negative reaction of the main passenger in case of leaving for an alternate airdrome without a trial approach, took a decision to make a trial approach."

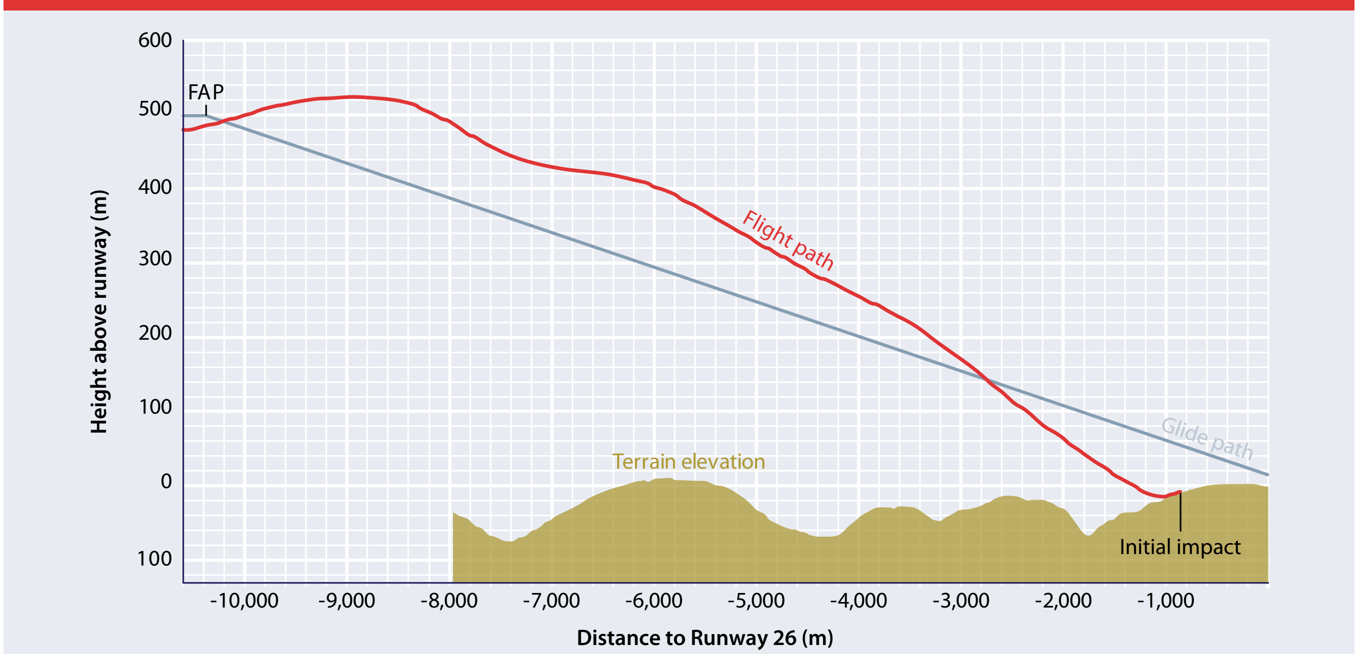
The presence of the other people in the cockpit "obviously intensified stress and distracted the crew from their duties," the report said. "It can most probably be assumed that the PIC experienced a psychological clash of motives. On the one hand, he realized that landing in these conditions was unsafe … on the other hand, he had strong motivation to land at that airdrome. … When a person experiences a clash of motives, his attention gets narrower and the probability of inadequate decisions increases."

The crew requested clearance to conduct a trial approach but did not ask for radar assistance, according to the report. The controller approved the request but later, when the aircraft was turning toward the final approach course, told the crew not to descend below 100 m and to be ready to conduct a missed approach from that altitude, the report said.

The PIC, who was communicating with the controller in Russian as well as flying the aircraft with the autopilot and autothrottle engaged, acknowledged the instruction by saying, emphatically, "Yes, sir."

The crew of the Yak-40 that had landed earlier established radio contact with the Tu-154 crew and told them several times that the weather conditions were unfavorable for a landing, the report said. "The last warning [was] given before the latter approached the final turn. The Yak-40 crew transmitted that the visibility at the airdrome was 200 m [1/8 mi]."

Tu-154 Flight Path



FAP = final approach point

Source: Russian Interstate Aviation Committee

Figure 1

'Passive Behavior'

The report said that the crew demonstrated "passive behavior" during the approach. They did not conduct a full briefing or establish reference speeds. The Tu-154 crossed the outer marker at 420 m (1,378 ft), or 120 m (394 ft) higher than the published crossing altitude, and at 300 kph (162 kt), or about 35 kph (19 kt) higher than the appropriate airspeed.

The crew increased the descent rate to 8 m/sec (26 ft/sec) in an attempt to establish the aircraft on the proper glide path. This descent rate, which resulted in a glide path of 5 degrees, was maintained almost until impact.

The report said that the PIC did not monitor the aircraft's rate of descent during the final stage of the approach: "No attempts were made to decrease the vertical speed, even when reaching the decision height of 100 m. It should be noted that, even when approaching in simple meteorological conditions (when the pilot can clearly see the runway and visually monitor the height), the vertical speed of descent should be reduced to the standard speed of 4-5 m/sec [13-16 ft/sec] before reaching a height of 40-50 m [131-164 ft] to conduct a safe landing."

The PIC became distracted, "turning his eyes and attention to the space outside the cockpit in order to search for the runway or ground references," the report said. The copilot and the other crewmembers likely were not monitoring the instruments, either.

The report said that crew resource management was absent. The copilot did not call out "steep descent," as required when the descent rate exceeded 5 m/sec, or "high airspeed" when required. He did call for a go-around when the aircraft reached the decision height but took no decisive action when the PIC did not respond to the call.

"The FDR [flight data recorder] analysis revealed that at 1040:51, when the 'go around' callout sounded, the [control column] was slightly pulled up, but not enough to disengage the autopilot [or] to go around," the report said. "Most probably, this action was instinctive of the copilot, who realized the critical nature of the situation better than the other crewmembers."

The report said that the presence of the air force commander-in-chief likely impelled the PIC to continue the approach. "There was evidence that the crew were expecting possible negative reaction in case they did not land at Smolensk Severny Airdrome. The expectation of punishment in case of proceeding to an alternate airdrome formed the dominant idea of landing by any means and drove them to take unjustified risks."

Two flight crewmembers, the PIC and the copilot, had been aboard an aircraft whose commander had refused for safety reasons to land in Tblisi, Georgia, in August 2008, despite direct orders by the Polish president and the air force deputy commander-in-chief. The report said that "strict measures" were taken against the commander after that flight, on which the Tu-154 PIC had served as copilot and the copilot had served as the navigator.

Misset Altimeter

Investigators found that the Tu-154 navigator had set the PIC's pressure altimeter incorrectly, causing it to read about 160 m (525 ft) high. "This could have misinformed the PIC if he was monitoring altitude," the report said, noting, however, that there was "a lot of other information" indicating that the aircraft was too low.

Among this information were four TAWS warnings. One of the warnings — "TERRAIN AHEAD, PULL UP, PULL UP" — was generated when the aircraft reached a radio altimeter height of 105 m (345 ft) and continued for 12 seconds. Although the crew should have responded immediately by initiating a climb, no action was taken, the report said.

The initial impact occurred near the middle marker. The aircraft was about 11 m (36 ft) above ground level and slightly left of the extended runway centerline when it struck the top of a tree about 1,100 m (3,609 ft) from — and 15 m (49 ft) below — the runway threshold.

The report said that analysis of recorded flight data and examination of the accident site indicated that the PIC attempted to initiate a go-around by pulling the control column all the way back. Angle-of-attack was near the stall value, and the aircraft was climbing when it clipped several more trees on rising terrain. The left wing then struck a large birch tree and separated from the fuselage. The aircraft rolled inverted and crashed in a swampy area.

Based on the findings of the investigation, the IAC issued several recommendations, including calls for improved training and procedures for pilots in Poland's special air regiment, and for civil aviation authorities to consider prohibiting the presence of nonessential personnel in cockpits and requiring technical checks before international flights to airports that are not certified for such operations.

This article is based on the English translation of the final report by the IAC Air Accident Investigation Commission. The final report in Russian and English, comments by the Polish government in Polish and other information about the accident are available at <www.mak.ru/english/info/tu-154m_101.html>.

SMS Swiss Style

'Walking the talk' and adapting to culture helped the civil aviation authority to convert skeptics.

BY WAYNE ROSENKRANS | FROM MILAN

Wikimedia

Attention to preferred languages, local culture and persuasive modeling has helped Switzerland move to the forefront in national implementation of safety management systems (SMSs), says Peter Müller, safety analyst technical, Safety Risk Management, Swiss Federal Office of Civil Aviation (FOCA). Müller led the core team that implemented the FOCA SMS and champions SMS in the nation's aviation industry. He explained the key steps at Flight Safety Foundation's International Air Safety Seminar in Milan, Italy, in November 2010.

In the context of four crashes within a relatively short period, the Swiss Ministry of Transport contracted with the Dutch National Aerospace Laboratory (NLR) to conduct an in-depth analysis of the nation's aviation system that resulted in a final report in mid-2003. "Just two of the 28 recommendations are still outstanding," Müller said. "NLR recommended that the Swiss government develop a national safety policy, which was done, and progress further in developing a safety-driven surveillance system — moving away from a [regulatory] compliance-oriented system to a performance-based oversight system. … We will achieve the desired [SMS] maturity level within the Swiss aviation industry by the end of 2011, which will be the end of the implementation phase."

Since 2000, the country's complex regulatory framework and relationship to ICAO, EASA and Eurocontrol standards have required acting on the best available information to proceed with SMS implementation. "The Swiss government had decided to comply with the ICAO standards [already effective] 1 January 2009, so we had to establish our own approach," he said.

One early impediment was rampant skepticism about the timing of FOCA's SMS requirements — that is, expecting implementation to begin in January 2009 — relative to pending SMS requirements of EASA and imminent changes in Swiss aerodrome regulations. "People were coming up to me and asking, 'Aren't you running ahead of what is coming out of EASA? Will we later need to change the whole thing?'" Müller recalled. "But we were able to convince the industry that we are on the correct path [and EASA] accepted, and now promotes, the [Swiss] implementation. … We [told aerodrome officials] we were asking for an integrated system because FOCA cannot have compliance-only while trying to develop an SMS. We have had to do both at the same time."

Executives of small companies, some involved in airport ground handling, often objected based on cost concerns. After only a one-day workshop, including hands-on practice with SMS tools, many skeptics came on board. "When they got home in the evening, they knew exactly what they would have to [do] and how they would do it for their company," he added.

As further evidence of industry buy-in, Müller cited a FOCA-sponsored SMS conference in September 2010 in which agency staff gave the welcome and the introduction, then all other presentations were given by expert industry representatives.

"Management needs to have figures [data] to decide about protection versus production," Müller said. "If they don't have any figures — if they have just a best guess on safety — they cannot make this decision, so usually they tend to make the decision [in favor of] production, not protection. Swiss industry has recognized that safety figures have the same value as economic figures. Management will ask now for both to make their decisions."

He attributed the gradual turnaround in attitudes to constant FOCA leadership on SMS. "First, we had to demonstrate that we walk the talk, then … be open to communicate and to cooperate with the industry," he said.

Practical hurdles were how to achieve one level of safety, setting due dates for SMS-related tasks, determining the need for guidance material, identifying existing solutions before inventing new ones, and getting ready to assess the maturity level of each SMS in the industry.

Native Languages

Capitalizing on languages spoken and written most often in everyday work greatly improved communication of SMS concepts, he said. "A safety management system is really a cultural thing, so the language barrier is not [a factor] to be overlooked," Müller said. "In Switzerland, usually we don't speak English. We speak German, French and Italian, and a small minority speaks [Rhaeto-Rumansch]; these are the four official languages.

"Our *Safety Management System Assessment Guide* was developed in the English language, and nothing happened. We translated it into German, French and Italian, and then [the content] started to move around in the industry. We recognized that using the [non-Swiss] language really had been a big barrier." Emphasis on clear communication also extends to consistent vocabulary for SMS terms within each language used.

Safety Inspector Roles

A key decision in FOCA's strategic planning for SMS was not to establish a specific dedicated team of specialists to conduct oversight of SMS in the industry. Instead, the agency primarily aimed to make SMS widely understood and managed within the capabilities of all inspectors.

"The responsibility to evaluate SMSs in the industry remains with the dedicated line inspector," Müller said. "That means FOCA had to teach inspectors how to assess multiple certificated organizations [and] coordinate internally with the maintenance inspectors and with other involved inspectors. … FOCA had to … demonstrate to the industry that we are willing to do the utmost in supporting and guiding them through this experience."

The FOCA SMS core team supports the inspectors, develops guidelines and harmonizes the SMS maturity-assessment process throughout the various domains. The team also prepared an SMS maturity-assessment tool suitable for when the inspectors conduct semi-annual checks and annual ratings of each Swiss organization's SMS. "The FOCA SMS core team also is evaluating the status of SMS implementation at all levels within the industry," he said.

In 2012 and beyond, FOCA officials look forward to resolution of central questions for themselves and their counterparts at other European civil aviation authorities. "As a small state, should we really define our own acceptable level of safety?" Müller asked. "Or should Switzerland join with other European countries to define a common acceptable level of safety?"

Another possibility is that Swiss aviation companies someday could become isolated from their regulator in unforeseen ways. "So we have to interface with them [through] our state safety plan and state safety program," he said.

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Do the Right Thing

BY ROBERT I. BARON

Professionalism and integrity are the last barriers against unapproved or unwise short cuts.

An experienced and qualified aircraft maintenance technician (AMT) with a tight deadline discovered that he needed a special jig to drill a new door torque tube on a Boeing 747. The jig was not available, so he decided to drill the holes by hand with a pillar drill — a fixed workshop drill and an unapproved procedure.

Subsequently, the door came open in flight and the flight crew had to make an emergency landing. The AMT, being a "company man" and trying to get the aircraft out on time, committed what is known as a situational violation. A situational violation occurs when an AMT, typically with good intentions, deviates from a procedure to get the job done.

The reason for a procedural deviation may stem from time pressure, working conditions or a lack of resources. This example is not only a classic maintenance human factors error, but also speaks to the issue of professionalism and integrity conflicting with efficiency.

The European Aviation Safety Agency (EASA), in its suggested syllabus for human factors training for maintenance, specifically mentions *professionalism and integrity* as a training topic. But what is "professionalism and integrity," and can it even be taught? The Merriam-Webster dictionary defines professionalism as "the conduct, aims or qualities that characterize or mark a profession or a professional person" and defines integrity as "a firm adherence to a code of moral values." The topic can be nebulous and difficult to develop into a training module, yet is unquestionably a critical part of a healthy safety culture.

Regulations offer some aviation-specific guidance on teaching professionalism and integrity. For instance, the U.K. Civil Aviation Authority has a small section in Civil Aviation Publication (CAP) 716, *Aviation Maintenance Human Factors (EASA Part 145)* about the subject. Two key points discussed are, first, that employees basically know how to behave in a professional manner but may be limited in doing so due to organizational issues such as pressure, lack of resources, poor training, etc.; and that, in a human factors training course, it is up to the trainer to determine whether problems with professionalism are on an individual or organizational level and tailor the training accordingly.

CAP 716 does not elaborate on the topic of integrity as it does with professionalism, perhaps because it is assumed that they overlap. That is partly true, but integrity still warrants a bit more elucidation.

Based on the definition of integrity as "a firm adherence to a code of moral values," this is where things can get interesting. How can an employee adhere firmly to a code of *moral* values that is largely unwritten and not available to look up in the employee handbook? A code of values is something that is learned through upbringing and life experiences. By the time a person becomes gainfully employed, he or she should have a good idea of what is morally or ethically right. Yet corporate greed and power can cause otherwise good people to cross the line, sometimes hazy, between right and wrong.

How can an employee adhere firmly to a code of moral values that is largely unwritten and not available to look up in the employee handbook?

While financial scandals on a corporate level are rare in aviation, significant events have occasionally led to deviations from integrity, typically in the normal pursuit of cost savings and efficiency. For instance, the crash of American Airlines Flight 191, a McDonnell Douglas DC-10-10, at Chicago O'Hare International Airport on May 25, 1979, was precipitated by procedures that were put in place by the company's maintenance management.

Management accepted the use of a forklift to change engines on the aircraft. The U.S. National Transportation Safety Board (NTSB) found serious omissions, however, in its final report on the accident:

"Carriers are permitted to develop their own step-by-step maintenance procedures for a specific task without obtaining the approval of either the manufacturer of the aircraft or the FAA [U.S. Federal Aviation Administration]. It is not unusual for a carrier to develop procedures which deviate from those specified by the manufacturer if its engineering and maintenance personnel believe that the task can be accomplished more efficiently by using an alternate method.

"Thus, in what they perceived to be in the interest of efficiency, safety and economy, three major carriers developed procedures to comply with the changes required in [service bulletins] by removing the engine and pylon assembly as a single unit. … Both American Airlines and Continental Airlines employed a procedure which damaged a critical structural member of the aircraft. …

"The evidence indicated that American Airlines' engineering and maintenance personnel implemented the procedure without a thorough evaluation to insure that it could be conducted without difficulty and without the risk of damaging the pylon structure. The [NTSB] believes that a close examination of the procedure might have disclosed difficulties that would have concerned the engineering staff. In order to remove the load from the forward and aft bulkhead's spherical joints simultaneously, the lifting forks had to be placed precisely to insure that the load distribution on each fork was such that the resultant forklift load was exactly beneath the center of gravity of the engine and pylon assembly. To accomplish this, the forklift operator had to control the horizontal, vertical and tilt movements with extreme precision. The failure … to emphasize the precision this operation required indicates that engineering personnel did not consider either the degree of difficulty involved or the consequences of placing the lift improperly. Forklift operators apparently did not receive instruction on the necessity for precision, and the maintenance and engineering staff apparently did not conduct an adequate evaluation of the forklift to ascertain that it was capable of providing the required precision."

Maintenance management failed to discover that using the forklift was creating an unseen crack in the accident aircraft's engine pylon. This crack continued to propagate and eventually caused the left engine to depart from the aircraft on its takeoff rotation and the aircraft to crash shortly after becoming airborne. Two hundred and fifty-eight people (including 13 crewmembers) aboard the aircraft and two people on the ground were killed.

The crash of American Flight 191 can be interpreted as an example of the integrity line being crossed in one respect. The forklift procedure was designed so that the aircraft would spend less time in maintenance and more time generating income. When management changed a procedure without adequate safety analysis, however, lower level employees were "along for the ride."

Integrity also encompasses adequate company and regulatory oversight of a maintenance procedure. This issue was involved in the crash of Continental Express Flight 2574 in 1991, in which 47 screws were not re-installed on the horizontal stabilizer during a shift turnover. The NTSB said, "The probable cause of this accident was the failure of Continental Express maintenance and inspection personnel to adhere to proper maintenance and quality assurance procedures for the airplane's horizontal stabilizer deice boots that led to the sudden in-flight loss of the partially secured left horizontal stabilizer leading edge and the immediate severe nose-down pitchover and breakup of the airplane. Contributing to the cause of the accident was the failure of the Continental Express management to ensure compliance with the approved maintenance procedures, and the failure of FAA surveillance to detect and verify compliance with approved procedures."

Such failures can be extrapolated to a fundamental question about personal integrity. Why would employees, as individual professionals, go "along for the ride" with these types of breaches in integrity if they know they are working contrary to approved procedures? Sometimes this is a matter of *norms* of the safety culture, or the "normal" way work is being conducted, whether right or wrong.

Social psychological phenomena such as cognitive dissonance and conformity also may be involved. Cognitive dissonance occurs when reasoning is consonant (in agreement) and dissonant (incongruous) at the same time. This might happen when an employee knows that an incorrect procedure is being used universally but, at the same time, does not want to speak up for fear of castigation.

Similarly, *conformity* is a strong social psychological phenomenon that occurs when an employee chooses to "go with the crowd" rather than stand out as a complainer, loner, non–team player, etc. Conformity can be further exacerbated by the tremendous peer pressure that often develops in groups. Individual employees need to realize that, although these pressures are commonplace and perhaps inevitable, they do not relieve the employee from the responsibility to speak up and challenge unsafe instructions. Otherwise, on a personal level, they are overstepping the bounds of integrity and their actions may become a contributing factor in an aircraft accident or incident.

The topic of professionalism and integrity is clearly not popular in the field of aviation human factors. It is reasonable to assume that this is due to the topic's socially awkward nature and the diversity of opinion and work experiences. Trying to "teach" the topic also can be confounding because many instructors have a hard time compiling relevant information. Overall, there is not much guidance compared with that available for other human factors topics.

So, again, can professionalism and integrity be taught? Perhaps in principle, but applying them in the workplace is largely the responsibility of the individual, since they are based on values, not a technical process that can be measured and supervised.

What should be the baseline expectation for professionalism and integrity among AMTs? From my own search for common principles, I propose these as starting points:

- Arrive at work on time and be prepared to work.
- Stay current on procedures, and strive to increase your knowledge.
- Respect your peers — even if you don't particularly care for them.
- Be part of the team effort to make safety the no. 1 priority.
- Be assertive with management whenever necessary for safety.
- Watch for opportunities to draw the line between right and wrong.
- Be alert for business expediency that drives unsafe deviations from approved procedures.
- Do not "go with the flow" when the flow is going the wrong way.
- Ask yourself if actions deemed legally or technically acceptable could be morally wrong.

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The NTSB cites misstatement of empty weight as a cause of a fatal S-61N crash; the operator disagrees.

Weighty Issues

BY LINDA WERFELMAN

The owner's "intentional understatement" of a helicopter's empty weight was partly to blame for the Aug. 5, 2008, crash of a Sikorsky S-61N that killed seven firefighters and two crewmembers during a forest fire near Weaverville, California, U.S., the U.S. National Transportation Safety Board (NTSB) says.

Three firefighters and a third crewmember were seriously injured and the helicopter was destroyed in the crash of the S-61N, which was operated by the U.S. Forest Service (USFS) as a public flight,[1] under contract with Carson Helicopters[2] of Grants Pass, Oregon.

In its final report on the accident, the NTSB said the probable causes were "the following actions by Carson Helicopters: the intentional understatement of the helicopter's empty weight, the alteration of the power-available chart to exaggerate the helicopter's lift ability and the practice of using unapproved above-minimum

U.S. National Transportation Safety Board

Accident aircraft snorkeling water for fire fighting.

specification torque in performance calculations that, collectively, resulted in the pilots relying on performance calculations that significantly overestimated the helicopter's load-carrying capacity and did not provide an adequate performance margin for a successful takeoff."

The NTSB also cited "insufficient oversight by the USFS and the Federal Aviation Administration (FAA)."

Factors contributing to the accident were the "immediate, intense fire that resulted from the spillage of fuel upon impact from the fuel tanks that were not crash resistant, the separation from the floor of the cabin seats that were not crash resistant and the use of an inappropriate release mechanism on the cabin seat restraints."

Carson Helicopters disputed the NTSB's findings, saying that it "strongly believes that the accident was caused by the loss of power to the no. 2 engine due to contamination in the fuel control" (see "Dissenting Opinion," p. 32).

Performance Charts

The morning of the accident, around 0830 local time, crewmembers attended a briefing at the Trinity Helibase,[3] 7 nm (13 km) northeast of Weaverville. Afterward, the pilot-in-command (PIC) completed performance load calculation forms required by the USFS. The copilot told investigators that all calculations were performed using Carson Helicopters' performance charts and the helicopter empty weight specified by the company.

Later in the day, the pilots participated in rappel training with the Trinity helitack crew — trained in working with helicopters in an initial attack on a large fire and in suppressing fires with bucket drops and the movement of equipment and personnel. About 1320, the pilots flew a two-hour water-dropping mission over a fire in the Shasta–Trinity National Forest. They then ate lunch and had the helicopter refueled before the PIC met with an inspector pilot for an oral examination.

About 1630, the pilots were told about a planned repositioning mission.

"Based on a forecast of lightning for the high mountainous areas that night, USFS management had decided to transport two hand crews[4] from H-44 [Helispot-44], which has an elevation of 5,980 ft, to Helispot-36 (H-36), which has an elevation of 1,531 ft," the report said. The pilots had never flown to H-44; neither had members of the Trinity helitack crew, who were being transported to both locations to aid in the repositioning.

About 1707, the helicopter left the Trinity Helibase for a series of flights to H-36 and H-44, first to prepare and then to begin transporting the firefighters. The two-pilot crew was accompanied by the inspector pilot, who conducted a flight evaluation of the PIC early in the operation and also served as the required safety crewmember.

About 1814, during departure from H-44, the helicopter "felt heavy, slow and sluggish," one of the firefighters in the aircraft said. Flight recordings indicated that the engines reached "topping" — maximum gas generator speed limit, which corresponds to maximum engine power output — and then decreased. The report noted that in an S-61N, "when the collective is raised, power is automatically increased up to the point at which the engines reach topping. At that point, any further increase in collective results in an increase in drag that cannot be compensated for, and the main rotor speed begins to decay, or droop. When the speed of the main rotor droops significantly, the main rotor loses lift and the helicopter descends."

The cockpit voice recorder (CVR) contained no discussion of reaching topping speed, the report said.

About 1843, during the next departure from H-44, the engines again reached topping speed for about 18 seconds and then decreased. Again, the pilots did not discuss the matter.

At 1905, after the helicopter landed at the helibase for refueling, two mechanics conducted a routine visual inspection. They found ash on the main rotor blades and at the engine inlets, but the compressors' first-stage stators were clean. One mechanic "began wiping the blades with a rag, which easily removed the ash, leaving the wiped area of the blades free of debris," the report said.

The mechanics told investigators that both pilots had said that the helicopter had been operating well, and one added that the PIC asked them to finish their work because the required shut-down time was approaching and he wanted to depart. In response, the mechanics stopped wiping the blades and engine inlets and prepared the helicopter for takeoff.

The helicopter landed at H-44 about 1936, picked up the departing firefighters and, at 1941, lifted off. Before takeoff, the pilots were told that the manifested weight of the firefighters and cargo was 2,355 lb (1,068 kg), below the maximum payload of 2,552 lb (1,158 kg). The copilot also noted that the temperature was 12 or 13 degrees F cooler than they had calculated.

Analysis of the CVR indicated that, 22 seconds after the crew applied power, the engines reached topping speed, and remained there until the end of the recording.

Witnesses on the ground said that as the helicopter lifted off, it appeared to be moving slowly and that its movement was "labored," the report said. The slow movement was "inconsistent with the last two departures," one witness said.

The helicopter climbed about 20 ft, then moved forward and to the right, struck trees, fell to the ground and burned. One witness said that both engines continued operating for about 30 seconds after the impact.

Qualification Cards

The PIC held an airline transport pilot certificate, a helicopter rating and type ratings for S-76s and Boeing Vertol 234s; he also had type ratings at the commercial level for BV-107s and S-61s. He had 20,286 flight hours, including 8,166 hours in S-61s, and an Interagency Helicopter Pilot Qualification card issued by the U.S. Agriculture

Dissenting Opinion

Carson Helicopters has challenged the U.S. National Transportation Safety Board's (NTSB's) finding that company actions were to blame for the Aug. 5, 2008, crash of a Sikorsky S-61N, complaining that the agency tried to "make Carson a scapegoat" while ignoring "an ongoing safety-of-flight issue."

Franklin Carson, president of Carson Helicopters, denounced as "arbitrary and one-sided" the Dec. 7, 2010, public hearing during which the NTSB approved its final report on the accident, including the probable cause.

Carson said that the company believes that the accident was caused by a loss of power to the no. 2 engine and that the power loss resulted from contamination in the fuel control. He said the NTSB ignored "indisputable evidence" that supports the company's claim.

He noted that, six years before the accident, his company told engine manufacturer General Electric (GE), Sikorsky and Columbia Helicopters, which overhauls fuel controls, about Carson Helicopters' belief that fuel control contamination caused engines to lose power.

"Two years before the accident, GE recommended that Sikorsky change the airframe filter for the fuel control from 40 microns to 10 microns to address this problem," Carson said. "One day after the accident, GE e-mailed Sikorsky asking what was being done about changing the airframe fuel filter. It wasn't until almost two years after the accident that Sikorsky issued a service bulletin changing the approved filter from 40 microns to 10 microns."

Carson said that the NTSB "ignored the experienced copilot's direct testimony that he saw signs of power loss in the no. 2 engine immediately prior to the crash, and … ignored his direct reading of the actual air temperature at the scene in favor of manufactured data that fit their preconceived narrative."

In addition, he said that the NTSB "lost care and custody of fuel control unit (FCU) parts early in this investigation and from that point forward did not pursue evidence chains leading to the fuel control units." He said that "significant contaminants ranging in size up to 28 microns" were found inside the no. 2 FCU and added, "There is a history of power loss problems due to contaminants in the FCU because of inadequate fuel filtering that was known by the manufacturer and not properly explored by the NTSB."

Carson said that the NTSB did not participate in independent flight tests that were conducted in density altitude conditions that matched those at the accident site. The tests verified U.S. Federal Aviation Administration performance charts that showed that the helicopter had more than enough power to fly out of Helispot-44, he said.

He also said that the NTSB's primary investigation team "had no relevant helicopter experience to properly investigate this accident and misplaced their emphasis on poorly contrived data instead of concentrating on the hard evidence leading to the ultimate cause of this accident and an ongoing safety-of-flight issue."

— LW

Department and U.S. Interior Department. The card — required by the USFS for pilots flying its missions — cited the pilot's qualifications and indicated that he was approved for mountain flying, external load operations, retardant/water-dropping, long-line vertical reference and snorkel. All of these operations were permitted in S-61s.

The evaluation on the afternoon and the evening of the accident flight had been conducted to add a "mission fire suppression (helitack)" endorsement to allow the PIC to transport firefighters to and from a fire line. He had been on duty for four days before the accident for as long as 14 hours each day but had flown only on the first of the four days, when he recorded four hours of flight time.

The copilot had 3,000 flight hours, including 1,100 hours in S-61s. He had a commercial pilot certificate with helicopter and instrument-helicopter ratings, an S-61 type rating and a second-class medical certificate. He also held an Interagency Helicopter Pilot Qualification Card, which specified his qualifications for the five types of missions for which the PIC qualified, in addition to fire suppression (helitack) and reconnaissance and surveillance.

His duty period began July 30, and he had flown for two hours on July 31 and four hours on Aug. 2.

The helicopter was manufactured in 1965 and was purchased in 2007 by Carson Helicopters and reconfigured, with modifications of the landing gear, seats, cargo hook and interior, and removal of overwater equipment. In June 2008, further modifications were made, including the installation of additional passenger seats required by the USFS. The helicopter arrived at the Trinity Helibase, under contract to the USFS, on July 1, 2008.

It had 35,396 flight hours when the accident occurred. It had two General Electric CT58-140 turboshaft engines. The no. 1 engine had 22,323 hours and the no. 2 engine, 32,439 hours total time; the no. 1 engine had accumulated 1,016 hours since overhaul, and the no. 2 engine, 238 hours. The helicopter was equipped with a 900-gal (3,407-L) aerial liquid-dispersing tank.

U.S. National Transportation Safety Board

The helicopter was owned by Carson Helicopters Inc. (CHI) and was one of 10 S-61Ns that the company leased to Carson Helicopter Services Inc. (CHSI). CHSI began operations in 2003, with headquarters in Grants Pass, and focused on logging operations. By 2005, the bulk of CHSI summer operations consisted of contracts with USFS, especially for water-dropping flights.

At the time of the accident, CHSI employed 200 people, including 50 pilots — whose experience averaged 12,000 flight hours — and 51 maintenance personnel.

Witnesses said the helicopter's movement was "labored" as it lifted off and climbed about 20 ft before crashing into the ground.

Weight and Balance

The NTSB's review of aircraft weight and balance records indicated that the empty weight of the helicopter at the time of the accident was

13,845 lb (6,280 kg) — 1,437 lb (652 kg) more than the empty weight used by the PIC in his load calculations. During the investigation, Carson Helicopters estimated the empty weight at 13,432 lb (6,093 kg) — 1,024 lb (464 kg) heavier than the empty weight used by the PIC, the NTSB said.

The NTSB calculated the total weight of the helicopter — including the weights of the flight crew, the inspector pilot, the load manifest and the estimated fuel load — to be 19,008 lb (8,622 kg). Using the operator's estimate of empty weight, the total was 18,595 lb (8,435 kg).

In a May 2010 submission to the NTSB, Carson Helicopters said that it was unaware until after the accident "that there were anomalies and irregularities in the weight documents maintained for [the accident helicopter] and in the performance charts in Carson's, and presumably the accident aircraft's, flight manuals."

In the submission, Carson Helicopters said it could not determine the reason for the incorrect information, although "many of the anomalies and irregularities" apparently originated in documents put together by a company official who later was fired.

"In response to these anomalies and irregularities, Carson has modified its operations and procedures, including but not limited to improving internal controls over the weighing process, to minimize chances of such anomalies and irregularities occurring in the future," the submission said.

After the accident, the USFS examined six of Carson Helicopters' aircraft working on agency contracts and concluded that records did not accurately reflect the equipment installed in the helicopters. Several weeks later, the USFS suspended work being performed in accordance with its two contracts with Carson Helicopters, citing its concerns about discrepancies in recorded statements of helicopter weights and the "Takeoff Power Available" chart.

In February 2009, the USFS terminated the contracts, citing issues involving helicopter weight and related performance specifications. The USFS said that seven of the 10 Carson Helicopters aircraft under contract to the agency weighed "more than their equipped weight as bid," that five of the helicopters did not meet a specification requiring a minimum payload of 3,000 lb (1,361 kg) for operations at 7,000 ft pressure altitude and 20 degrees C (68 degrees F), and that operations of all 10 helicopters were conducted using "an improperly modified performance chart that was propagated into Carson's internal flight manuals."

Contract Changes

The report said that both the USFS and the FAA failed to detect the use of incorrect weight and performance charts for the accident helicopter and that, if either agency had identified the problem, and the problem had been rectified, the accident might have been prevented.

After the accident, the USFS made a number of changes in its contract for heavy and medium helicopters used in fire fighting, including:

- The addition to evaluation flights of tasks designed to "determine whether the pilot exhibits the knowledge and skills to properly perform a HOGE [hover out of ground effect] power check before landing at or departing from helispots located in confined areas, pinnacles or ridgelines";
- The use of spot checks, to be observed by a USFS maintenance inspector, that include "inspections/weighing/tests as deemed necessary to determine the contractor's equipment and/or personnel currently meet specifications"; and,
- A new requirement that "after proposal evaluations and before or post award, all aircraft will be physically weighed with the weighing witnessed by agency aircraft inspectors."

The report included about one dozen recommendations each to the FAA and the USFS, including a call for the FAA to clarify its authority over public aircraft (*ASW,* 12/10-1/11, p. 10).

This article is based on NTSB Accident Report NTSB/AAR-10/06, Crash During Takeoff of Carson Helicopters Inc. Firefighting Helicopter Under Contract to the U.S. Forest Service; Sikorsky S-61N, N612AZ; Near Weaverville, California; August 5, 2008.

Notes

1. As public flights — conducted on behalf of the government — these operations are not subject to many of the Federal Aviation Regulations that govern civil flights.
2. The NTSB used the term "Carson Helicopters" to refer to two companies — Carson Helicopters Inc. and Carson Helicopter Services Inc. — which are separate legal entities although they are owned by the same people and have the same president.
3. The USFS defines a *helibase* as a "designated, permanent facility for helicopter operations." A related facility is a *helispot*, defined by USFS as "a natural or improved takeoff and landing area intended for temporary or occasional helicopter use."
4. A *hand crew* consists of about 20 people who have been organized and trained for fire fighting work, usually using hand tools.

At 2300 local time on April 22, 2009, the reported conditions at the North Myrtle Beach (South Carolina, U.S.) Airport were calm winds with 10 mi (16 km) visibility and a temperature of 52 degrees F (11 degrees C). Some 90 minutes later, the winds were gusting to 16 kt, the visibility was 2.5 mi (4 km), and the temperature was 66 degrees F (19 degrees C). The dramatic change in conditions was not due to an approaching weather system. It was due to an approaching wildfire.

During that day, a fire which started on the outskirts of Conway, a small town west of Myrtle Beach, made a 5 mi (8 km) run to the east, driven by strong westerly winds gusting to 29 kt. In the evening, the winds died down and the fire was seemingly contained by major highways to east and northeast.

But around midnight, the fire blew up. Flames shot up over 200 ft (61 m) into the air. A massive convective column developed over the fire and extended 10,000 ft into the atmosphere. The fire was responsible for the deteriorating conditions at the nearby North Myrtle Beach Airport.

Wildfires are common throughout the world. With the exception of deserts and areas with permanent snow and ice cover, wherever there is continuous vegetation cover, fires can occur. Recent headlines are full of wildfire stories. In summer 2010, historic wildfires ravaged western Russia. Then, in December, the worst wildfire ever in Israel claimed many lives. In 2009, the

Wildfires Make Their Own Weather

BY ED BROTAK

Fire-induced phenomena are rare but threatening for aviation.

© EllsworthC/Wikimedia

deadliest wildfires in the history of Australia hit the southeastern part of that country.

From the high-latitude boreal forests to the subtropical grasslands, wildfires are a threat. Whenever the vegetation dries out, there is the potential for fire. All that is needed is an ignition source. Lightning strikes cause the majority of wildfires. Dry lightning — lightning without rain — is the most dangerous. In the drier regions of the world, the rain from thunderstorms can evaporate before it reaches the ground.

Any wind direction that puts the fire upwind of you causes problems.

Other wildfires can be attributed to man. These can be accidental or sometimes even deliberately set. Overall, fires are beneficial to the environment. They help recycle vital elements back into the ground, which is the rationale behind the "slash and burn" tradition of agriculture. Fires also can benefit nature by renewing older, less productive ecosystems. Problems arise when man's possessions or activities are affected by wildfire.

The usual perception is that drought conditions precede major wildfires. It is true that the fuel for the fire, the vegetation, needs to be dry. Surface leaves and litter can dry out quickly, though. The Myrtle Beach fire had no antecedent drought. The surface fuels dried out enough to support a fire in only one week without rain.

Brush, such as the chaparral of California, dries quickly and is very flammable. In forests, the evergreen needle leaves burn readily under most conditions and surface fires can quickly become crown fires, traveling through the tops of the trees.

Drought is a natural occurrence in almost all regions. Some areas have dry seasons every year. Dry summers are common on the west side of continents in the middle latitudes. Dry winters occur in some tropical and subtropical locations. Wildfires often occur in the dry season. Periodic droughts affect just about all other regions that usually have consistent rainfall year-round.

Wildfires pose unique problems for the aviation community. There is the obvious physical danger of the fire itself to aviation facilities and aircraft on the ground. At one point, the recent fires in Russia destroyed 13 hangars and much equipment at one military facility. The most common problem is the reduction in visibility because of the smoke. For example, last August, measured visibilities at one point dropped to 1/8 mi (200 m) at several major international airports around Moscow due to smoke from the nearby wildfires, forcing many incoming flights to divert to other locations. In April 2005, all four major airports in Honduras had to close because of limited visibility caused by smoke from numerous wildfires.

Visibility effects strongly depend on wind direction. Simply put, any wind direction that puts the fire upwind of you causes problems. And visibility can decrease quickly. For example, at the Boise (Idaho, U.S.) Municipal Airport, on July 28, 2010, the visibility went from 10 mi

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(16 km) to 1 3/4 mi (2.8 km) in nine minutes when the wind shifted and started blowing in smoke from a nearby wildfire.

In worst-case scenarios, visibility can drop to near zero and close airports. In some instances, the reduced visibility is accompanied by strong winds that can easily affect aircraft operations. When the Myrtle Beach fire made its first run on April 22, at one point the tower at Myrtle Beach International Airport recorded visibility of 2 mi (3.2 km) to the northeast while reporting winds gusting to 22 kt.

Most wildfires are wind driven. The winds are usually produced by large-scale weather systems that are fairly easy to forecast. Although the wind forecast predicts which direction the fire is headed, fire control can still be difficult. If a heavy fuel supply is available to the fire, it is pushed forward by the wind, often at exceptional speed. Add any terrain factors that inhibit firefighting and the fire may be uncontrollable. Such fast-moving fires usually do not send heated air very high.

But when a fire develops a vertical component, the dangers multiply and the situation becomes much more complex and less predictable. Any glider pilot will tell you about good "thermals" over a fire. Air, heated by the fire, becomes buoyant and rises, causing a "convective column" overhead.

For small fires and most rapidly moving ones, convection doesn't pose much of a problem to aviation. Larger fires, especially ones not driven by strong winds, can develop significant convective columns that shoot upward for thousands of feet. The so-called "Station fire" just outside Los Angeles burned more than 160,000 acres in August and September 2009, the largest fire ever recorded in Los Angeles County. At its peak, it produced a convective column estimated at 23,000 ft. Some fires have produced convective columns estimated at 40,000 ft.

Convective columns of this magnitude are similar to thunderstorms. They contain both updrafts and downdrafts and can produce extreme turbulence. Aircraft en route have to detour around them. If near a terminal, they can present a serious obstacle to takeoffs and landings. The powerful updrafts in these convective columns carry dense smoke and even small, burning debris well up into the atmosphere. There, upper level winds can transport them far downwind.

At the surface, burning embers can fall out of the sky sometimes a mile (1.6 km) or more ahead of the main fire. They can cause spot fires that eventually merge with the main fire and greatly increase the forward speed of the fire. The smoke can be carried even farther downstream. Visibility may be reduced miles ahead.

With a significant convective column, a wildfire can literally start producing its own weather. A low-level inflow of air is induced to replace the air that is being taken aloft. This produces strong winds directed towards the fire. The downdrafts from wildfire-induced convection reaches the surface, producing strong winds from varying directions, again very similar to thunderstorms. This type of wind shear also poses a threat to low-flying aircraft.

The main part of a wildfire-induced updraft contains superheated, smoke-filled air, the smoke column from the fire. Under the right atmospheric conditions, a true cloud may form on top of this updraft. A "pyrocumulus" cloud is composed of water droplets and/or ice crystals at great heights. It appears white as opposed to the dark smoke column below. Such clouds have been known to produce lightning, yet another aviation threat. In some instances, they have even produced rain.

To make matters worse, the convective or "plume-driven" fire can develop under seemingly benign weather conditions. Light winds at the surface and aloft, which normally make a wildfire easy to contain, allow the heated air to rise straight up, forming the convective column. Atmospheric instability, as indicated by steep lapse rates, also allows air parcels to rise more, increasing convective column growth.

The "Station fire" was an excellent example of "fire-induced weather" and was extensively studied because two firefighters were killed battling the blaze. On August 30, a firestorm engulfed a base camp where a crew was stationed. Two of the men attempting to flee the fire were killed when their truck plunged off a cliff. Wind gusts estimated at 40 kt unexpectedly drove the fire toward the camp. The prevailing winds in the region were much lighter, and it is believed that a strong inflow into a nearby fire's convective column was responsible for the high winds and resultant rapid fire spread.

Now, transpose this scenario to an aviation situation: Imagine the effects on aircraft operations if winds suddenly change direction and increase velocity to this magnitude. Such a situation is virtually impossible to forecast. These are convectively driven winds, and convection is not a smooth, continuous process but occurs in spurts. Bursts of upward-moving air can raise the convective column to great heights. Then, just as quickly, the convective column can collapse, initiating downdrafts.

In recent years, extreme weather events have become more frequent. They include droughts and the resultant wildfires. We can expect the aviation problems caused by wildfires to also become more frequent.

Dangerous Approaches

Straying outside the protected areas can be fatal.

BY DICK MCKINNEY AND ERIK REED MOHN

While poring through rafts of reports on accidents and serious incidents in the course of our investigations as members of the Flight Safety Foundation (FSF) Approach and Landing Accident Reduction (ALAR) Task Force, the same questions occurred over and over: Why didn't the flight crew follow standard operating procedures? Why didn't they fly their instruments? Why didn't they hear and respond to the ground-proximity warning system (GPWS)?

Poor decision making in many cases was caused by stress overload that resulted in the narrowing of crew focus to the point that warnings were not heard, recognized or acted upon.

In the course of working with accidents similar to those in this article, we noted that many times the pilots seemed to lack knowledge of the design criteria for the instrument approach procedures that they were conducting.

In both the *U.S. Standard for Terminal Instrument Procedures* (TERPS) and the International Civil Aviation Organization (ICAO) equivalent, *Procedures for Air Navigation Services–Aircraft Operations* (PANS-OPS), there are strict — and different — limitations of which pilots must be aware. Without knowledge of the limitations, pilots may inadvertently stray outside the protected areas and place themselves and their aircraft in peril.

Unexpected Approach

We studied the Conviasa Boeing 737-200 accident report, attempting to identify the stressors that might have overloaded the crew to the point that they strayed from a protected area and failed to respond properly to GPWS warnings for the last 22 seconds of the flight.

The 737 was being ferried from Venezuela to its new owner in Latacunga, Ecuador, the night of Aug. 30, 2008. The crew expected, and briefed for, a published arrival procedure that leads almost straight in to the instrument landing system (ILS) approach to Runway 18. However, when they contacted Latacunga Tower, they were told to fly a different arrival procedure, which requires crossing the Latacunga VOR/DME (VHF omnidirectional radio/distance measuring equipment) station south of Runway 18 and turning to a heading of 004 degrees. This basically places the aircraft on a right downwind leg for Runway 18 (Figure 1).

The aircraft must track 004 degrees until reaching the ILS turn-in point, which is defined as 9 nm DME on the 340-degree radial of the VOR. For an aircraft with conventional navigation equipment, such as a 737-200, navigating to the turn-in point requires some dead reckoning skills. The area west of the airport is protected from obstacles only up to 4 nm from the runway centerline; beyond that lies high, rugged terrain.

Cockpit voice recorder (CVR) data indicated that as the 737 neared the VOR, the crew was "behind the aircraft" and attempting to navigate via both instrument and visual references. The arrival chart specifies a maximum speed of 200 kt, but recorded flight data indicated that the 737's calibrated airspeed was 210 kt as it crossed the VOR and began a shallow right turn to the north. Airspeed increased to 225 kt during the turn. The high speed, wind drift and 22-degree bank angle caused the aircraft to roll out on downwind 7 nm west of the runway centerline, outside the protected area. Shortly thereafter, Quito Radar lost radar contact with the aircraft.

One minute after crossing the VOR, the commander commented that the radial did not "look right" but that he could see the lights of the city. The first officer said that he did not see the lights of the city or the airport.

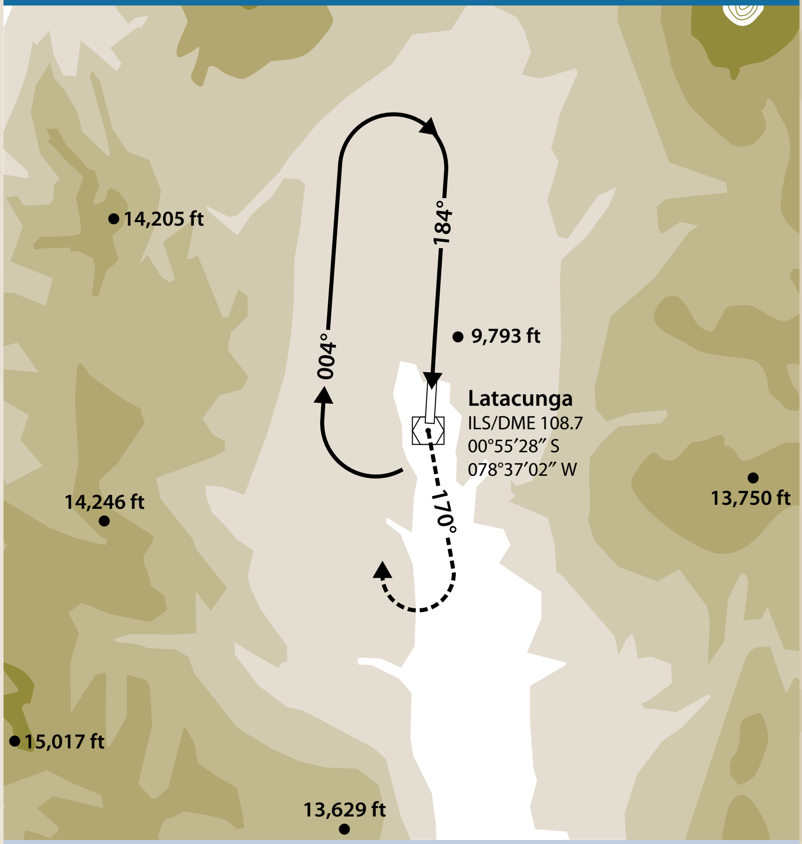
As the crew began configuring the aircraft for the approach 40 seconds later, the GPWS sounded: "Whoop, whoop, terrain." The commander voiced an expletive. The GPWS sounded again, and the first officer called for a go-around. The GPWS warnings continued for the next 22 seconds, until the aircraft struck a mountain at 13,100 ft. Both pilots and their passenger, a mechanic, were killed.

Investigators determined that the engines were operating at a high power setting and that the aircraft could have out-climbed the mountain if the commander had immediately and correctly reacted to the GPWS warning.

Risk Awareness

Among the products resulting from the Foundation's ALAR work is the *Approach and Landing Risk Awareness Tool* (Figure 2, p. 40).[1] Although it is intended to be used as a planning tool, to gain an awareness of risk before beginning an

Latacunga Arrival Procedure



Note: In 2008, a Boeing 737 crew strayed outside protected airspace after making the procedure turn onto the 004-degree heading, and the airplane struck a mountain west of the airport.

Sources: Dick McKinney, Erik Reed Mohn

Figure 1

Approach-and-Landing Risk Awareness Tool

Elements of this tool should be integrated, as appropriate, with the standard approach briefing prior to the beginning of descent to improve awareness of factors that can increase the risk of an accident during approach and landing. The number of warning symbols (⚠) that accompany each factor indicates a relative measure of risk. Generally, the greater the number of warning symbols that accompany a factor, the greater the risk presented by that factor. Flight crews should consider carefully the effects of multiple risk factors, exercise appropriate vigilance and be prepared to conduct a go-around or a missed approach.

Failure to recognize the need for a missed approach and to execute a missed approach is a major cause of approach-and-landing accidents.

Flight Crew	
Long duty period — reduced alertness	⚠⚠
Single-pilot operation	⚠⚠
Airport Services and Equipment	
No ATC approach service or airport tower service	⚠⚠⚠
No current local weather report	⚠⚠
Unfamiliar airport or unfamiliar procedures	⚠⚠
Minimal or no approach lights or runway lights	⚠
No visual landing aid (e.g., VASI/PAPI)	⚠
Foreign destination — possible communication/ language problems	⚠
Expected Approach	
Nonprecision approach — especially with step-down procedure or circling procedure	⚠⚠⚠
Visual approach in darkness	⚠⚠
Late runway change	⚠⚠
No published STAR, STAR/RNAV or STAR/FMSP	⚠

Environment	
Hilly terrain or mountainous terrain	⚠⚠
Visibility restrictions (e.g., darkness, fog, haze, IMC, low light, mist, smoke)	⚠⚠
Visual illusions (e.g., sloping terrain, wet runway, whiteout/snow)	⚠⚠
Wind conditions (e.g., crosswind, gusts, tail wind, wind shear)	⚠⚠
Runway conditions (e.g., ice, slush, snow, water)	⚠⚠
Cold-temperature effects — true altitude (actual height above mean sea level) lower than indicated altitude	⚠
Aircraft Equipment	
No GPWS/EGPWS/GCAS/TAWS with up-to-date database and current software version	⚠⚠⚠
No radio altimeter	⚠⚠⚠
No wind shear warning system	⚠
No TCAS II	⚠

Source: Flight Safety Foundation

Figure 2

approach, we'll use it to look back at the risks that the 737 crew faced during their approach to Latacunga.

The findings of the accident investigation show that the flight crew risk factor "long duty period — reduced alertness" likely was involved. The report said that about 20 minutes before the accident occurred at 2150 local time, the commander complained that he had been flying all day and was still at work.

The report also noted that the Latacunga airport is designated as a "special airport" that requires initial operating experience with a check pilot, followed by at least two approaches and landings per year to maintain currency. The 737 commander had flown only once to the airport, which is at an elevation of 9,205 ft and is flanked by mountains rising more than 5,000 ft higher. Thus, the approach conducted by the 737 crew involved the risk factor "unfamiliar airport or unfamiliar procedures."

The crew expected the straight-in arrival procedure but was assigned the more complex procedure, which is similar to the "late runway change" risk factor. In retrospect, the commander should have requested the straight-in procedure, rather than accepting the change. Apparently sharing a common trait among pilots in being mission-oriented, the crew likely was reluctant to ask for extra time or a change of plan. They might not have wanted to slow down someone behind them, or refuse a challenge.

There are three risk factors in the "environment" section that apply to this accident: the terrain was, indeed, mountainous; visibility was restricted by darkness; and the conditions were conducive to somatogyral and somatogravic illusions.

In conclusion, we found that six separate risk factors and 12 warning symbols applied to the approach at Latacunga, which indicates that this was a very dangerous approach.

A similar accident at Bardufoss Airport in northern Norway the night of Nov. 14, 1989, killed the pilots and the two passengers when their Cessna Citation 551 struck a mountain outside a protected area for a procedure turn onto the ILS approach to Runway 29. The accident investigation board concluded that the aircraft "was on the wrong track, and the speed was 100 kt too high" when the accident occurred.

The accidents at Latacunga and Bardufoss happened during the intermediate segments of approach procedures that were complex and workload-intensive. Common factors were flight outside protected areas and excess speed. It is noteworthy that on most approach charts, the underlying design speed is not printed. Pilots are supposed to know such things, but often they do not.

Circling Hazards

The last accident that we'll discuss happened in Busan, South Korea, on April 15, 2002. The crew of the Air China 767-200ER conducted the ILS/DME approach to Runway 36L down to Category C minimums and circled to land on Runway 18R. Visibility was 2 mi (3,200 m) in rain and fog, and surface winds were from 210 degrees at 17 kt.

The approach was a TERPS-based procedure that required a Category C aircraft to remain within 1.7 nm of the runway threshold. The accident report said that the crew descended too low, too soon, lost sight of the runway and hit a 670-ft hill approximately 2.5 nm (4.6 km) north of the airport.[2] The 767 was destroyed; 129 occupants were killed, and 37 survived.

This accident illustrates a serious problem with circling approaches: It is not enough to know what boundaries to stay within; it is of paramount importance to have the runway and the terrain within the prescribed circling area in sight at all times. If you lose sight of the airport and the terrain for even a fraction of a second, it's time to go around.

The U.S. Federal Aviation Administration *Aeronautical Information Manual* states the following about circling minimums:

> *Published circling minimums provide obstacle clearance when pilots remain within the appropriate area of protection. Pilots should remain at or above the circling altitude until the aircraft is continuously in a position from which a descent to a landing on the intended runway can be made at a normal rate of descent using normal maneuvers. Circling may require maneuvers at low altitude, at low airspeed and in marginal weather conditions. Pilots must use sound*

Terrain rises precipitously near the airport in Bardufoss, Norway, where an approach accident occurred in 1989.

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judgment, have an in-depth knowledge of their capabilities and fully understand the aircraft performance to determine the exact circling maneuver since weather, unique airport design and the aircraft position, altitude and airspeed must all be considered.

ICAO provides the following information in Doc 8168, *Aircraft Operations*:

A circling approach is a visual flight maneuver. … After initial visual contact, the basic assumption is that the runway environment (i.e., the runway threshold or approach lighting aids or other markings identifiable with the runway) should be kept in sight while at MDA/H [minimum descent altitude/height] for circling. If visual reference is lost while circling to land from an instrument approach, the missed approach specified for that particular procedure must be followed.

Circling approaches are the most dangerous of all approaches.

No Room for Error

Circling approaches are the most dangerous of all approaches, especially when the procedure is a TERPS design. TERPS circling approaches leave no room for error. For example, the protected area for Category C aircraft could provide only 300 ft of obstacle clearance within 1.7 nm of the thresholds of the runways suitable for use (Table 1). Thus, a tower or a mountain bluff 1,000 ft higher than field elevation can be located 1.75 nm off the end of the landing runway.

PANS-OPS provides a minimum of 394 ft of obstacle clearance within 4.2 nm of the runway thresholds.

The issue of TERPS vs. PANS-OPS is very serious for a pilot flying a TERPS approach using PANS-OPS techniques. How do you know whether a procedure is TERPS or PANS-OPS? Look on the left side of the approach chart for "PANS-OPS" or "TERPS" printed vertically. If there is no label, use every means at your disposal to determine the design basis for the approach. Ask air traffic control; the controller might not know, but he or she may be able to find out.

Do not assume that all airports in the same country use the same design criteria. Some states use PANS-OPS procedures for civil airports and TERPS for airports that are used, or have been used, by the U.S. military. It is the responsibility of the operator's operations department to convey this kind of information to pilots; unfortunately, not all departments do. Moreover, not all chart providers publish the information on their charts — a serious omission, in our opinion.

Circling Approach Obstacle Protection

	TERPS			PANS-OPS		
Aircraft Category	Airspeed[1]	Radius of Protected Area[2]	Minimum Obstruction Clearance	Maximum Airspeed[3]	Radius of Protected Area[2]	Minimum Obstruction Clearance
A	< 91 kt	1.3 nm	300 ft	100 kt	1.68 nm	295 ft
B	91–120 kt	1.5 nm	300 ft	135 kt	2.66 nm	295 ft
C	121–140 kt	1.7 nm	300 ft	180 kt	4.20 nm	394 ft
D	141–165 kt	2.3 nm	300 ft	205 kt	5.28 nm	394 ft
E	> 165 ft	4.5 nm	300 ft	NA	NA	NA

TERPS = *U.S. Standard for Terminal Instrument Procedures*; PANS-OPS = International Civil Aviation Organization *Procedures for Air Navigation Services–Aircraft Operations*; NA = not applicable

Notes

1. Based on 1.3 times the stall speed in landing configuration and at maximum landing weight.
2. Extends from the runway threshold to the arc defining the circling area.
3. Based on maneuvering speed during circling approach.

Sources: U.S. Federal Aviation Administration, International Civil Aviation Organization

Table 1

Training Gap

It is, of course, impossible to say what the pilots who ended up in these accidents knew or did not know about the design criteria governing the procedures they flew. What can be said with certainty is that they busted the design criteria and paid the ultimate price.

In principle, both TERPS and PANS-OPS obstacle-protection areas must be considered funnels that pilots must stay within. There might be rocks just outside the funnels.

There are differences between TERPS and PANS-OPS that pilots who fly in both environments need to know, and the unfortunate fact is that very few airlines teach their pilots about them. The philosophy seems to be that as long as pilots follow the approach procedures, they will be all right.

The problem is that many pilots do not have the necessary knowledge to stay safe while following an approach procedure. We believe that the airlines should consider this knowledge gap more seriously and incorporate TERPS and PANS-OPS briefings in their initial and recurrent training programs. Money is always tight, but what we are advocating is an awareness program. If pilots are aware that these problems exist, they could access the appropriate documentation when necessary. Pilots who mainly operate in one design environment — TERPS or PANS-OPS — cannot be expected to know the intricacies of unfamiliar procedures in the other design environment.

Our review of training material from Airbus for the A330 and A340, from Boeing for the 737 and MD-80, and from Canadair for the CRJ900 showed that only Boeing includes the TERPS and PANS-OPS circling area limitations. However, the Boeing material does not connect these limitations to aircraft category (i.e., A, B, C or D) or to aircraft speed. The other manufacturers provide only vague general guidelines. A common suggestion, for example, is to make an initial, 45-degree turn away from the approach track for 45 seconds. This, however, will put you outside the 1.7-nm protected area specified by TERPS in 65 seconds at 140 kt, or in 50 seconds at 180 kt.

What we, as an industry, teach our pilots is not sufficient. The manufacturers, in cooperation with the operators of their equipment, should easily be able to do a lot better. In addition, we believe that it is time for aviation regulatory authorities to tighten the requirements for training on the design criteria for circling approaches. We also would like to see new regulations mandating proper labeling of approach charts.

This 767 struck a hill in South Korea in 2002 when the crew descended too low during a circling approach

Moreover, after having looked at many different types of approach charts during our careers, a good case could be made for simplifying them.

Flying will never be risk free, but it is every pilot's duty to mitigate the risk as well as he or she can. It is every flight department manager's duty to do the same. The areas we have covered here have not received the attention they deserve. We hope this will change.

Dick McKinney is a former U.S. Air Force fighter pilot and American Airlines captain. He recently retired as an International Air Transport Association flight operations auditor. McKinney was an FSF ALAR Task Force core team member and served on several working groups.

Erik Reed Mohn, a fellow of the Royal Aeronautical Society and a former Norwegian air force pilot, is a Boeing 737 captain for SAS. He was co-chair of the FSF ALAR Operations and Training Working Group.

Notes

1. The *Approach and Landing Risk Awareness Tool* is part of the FSF *ALAR Tool Kit*, which provides on compact disc a unique set of pilot briefing notes, videos, presentations, risk-awareness checklist and other tools designed to help prevent approach and landing accidents. More information about the tool kit is available on the Foundation's Web site, <flightsafety.org>.

2. The official report is available at <www.skybrary.aero/bookshelf/books/549.pdf>.

Proposed modifications of rules governing air ambulance helicopters should help prevent accidents, supporters say.

BY LINDA WERFELMAN

Changing the Rules

Proposed changes in regulations governing helicopter emergency medical services (EMS)[1] operations — including a plan to institute stricter limits for weather minimums and flight crew rest requirements — are crucial to improving safety, the U.S. National Transportation Safety Board (NTSB) says.

"In the past year, 12 total and seven fatal HEMS [helicopter EMS] accidents have occurred, some of which might have been prevented with the implementation of these rules," said NTSB Chairman Deborah A.P. Hersman, in comments submitted in January in response to the U.S. Federal Aviation Administration's (FAA's) notice of proposed rulemaking (NPRM).[2]

The NPRM, which also contains provisions addressing commercial helicopter operations, Part 91 general helicopter operations, and load manifest requirements for Part 135 aircraft, was published in October 2010 in the U.S. *Federal*

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Register (Table 1, p. 46). A public comment period ended in January.

A key provision would require all helicopter air ambulance flights with medical personnel aboard to be conducted under U.S. Federal Aviation Regulations Part 135, which currently governs commuter and on-demand operations. Currently, many of these flights are subject to the less stringent weather minimums and flight crew duty and flight time limitations and rest requirements of Part 91, which outlines general operating and flight rules. Operations under Part 91 currently are permitted when patients are not aboard and when the medical crewmembers aboard are employed by the helicopter operator; if they work for another organization, the flight is conducted under Part 135.

The NTSB for several years has advocated placing HEMS flights under Part 135, and in her comments about the NPRM, Hersman said, "The ability to fly under Part 91 potentially provides the operator with additional operational flexibilities due to decreased visual flight rules (VFR) weather minimums and no flight crew rest requirements. The NTSB believes that these operational benefits of operating under Part 91 are greatly overshadowed by the increased risk that such operations have historically posed."

Some industry groups, while voicing support for the move to apply Part 135 safety criteria to all flights carrying medical crewmembers, also expressed concern about the details of implementing the provision.

The Association of Air Medical Services (AAMS), which represents providers of air and ground medical transport systems, said in its comments that many operators currently apply the more stringent Part 135 requirements for weather minimums and crew rest.

"While we believe that codifying these requirements via regulation would provide a stable and consistent enforcement of a widely used practice, the FAA must first address the many potential unintended consequences that exist under the proposed language," AAMS said.

For example, the association said, its members are especially concerned that the language included in the NPRM might limit opportunities for instrument flight rules (IFR) training and proficiency training — activities that sometimes are conducted during return flights when patients are not in the helicopters but medical personnel are present.

The Helicopter Association International (HAI) also warned of "potential unintended consequences" if the Part 135 provision is adopted, adding, "We suggest that the FAA work with industry stakeholders to conduct a detailed review of the legal, regulatory and practical implications of the proposed language before this provision is finalized."

The association also noted that many operators currently use global positioning system (GPS) approaches that have been approved under Part 91. "We are concerned about the potential impact of the proposed provisions on that activity," HAI said, emphasizing the need to encourage increased use of IFR flight. "In this rulemaking, the FAA must avoid creating unintended impediments to the use of IFR."

The National Air Transportation Association (NATA) said it was concerned about the "cumulative costs being imposed on helicopter operators, particularly air ambulance helicopters" by the implementation of Part 135 provisions. A longer implementation timetable or staggered implementation of some requirements might ease the financial burden, NATA said.

The Association of Critical Care Transport (ACCT), made up of air and ground critical care transport providers and others, called for "fundamental change … to protect patients and the front-line pilots and medical providers who care for them" and said that "there is broad industry consensus on the need for increased regulation."

ACCT endorsed the FAA's proposals to apply Part 135 to all legs of air ambulance flights when medical personnel are aboard and said that the accompanying proposal to implement operational control centers (OCCs) and enhanced operational control procedures should be expanded to require all air ambulances — including the small operators excluded from the FAA's proposal — to have an OCC.

Summary: Helicopter EMS Safety NPRM	
Common causal factors of accidents	Controlled flight into terrain, loss of control, inadvertent flight into instrument meteorological conditions, night flying
Proposed risk mitigations	Requirement to install helicopter terrain awareness and warning systems; establishment of operational control centers; conduct flights under FARs Part 135 when medical personnel are aboard
Estimated cost to industry	$225 million over 10-year period: $136 million for air ambulance certificate holders, $89 million for commercial helicopter operators
Estimated benefits	$83 million – $1.98 billion over 10-year period

EMS = emergency medical services; FARs = U.S. Federal Aviation Regulations; NPRM = Notice of Proposed Rulemaking

Source: FAA Notice of Proposed Rulemaking FAA-02010-0982, published Oct. 12, 2010

Table 1

Other organizations, including HAI, disagreed. HAI said that, although it supports the concept of OCCs, the NPRM provision calling for their establishment for any operation with more than 10 aircraft "creates an unnecessarily costly and unworkable monstrosity."

In the NPRM, the FAA said it was considering a requirement that a lightweight aircraft recording system (LARS) be installed in helicopter air ambulances to record flight performance and operational data, and provide critical information in case of an accident. Flight data recording equipment has not been widely used in commercial helicopter air ambulances, the FAA said, indicating that about 89 percent of helicopter air ambulance certificate holders have not installed flight data recorders or other similar devices.

In its comments on the NPRM, HAI said that although LARS has safety-enhancing potential, "we do not believe that the technology is sufficiently mature … to serve as the basis for a regulatory equipment mandate." An FAA-industry work group should conduct a study to help provide long-term guidance on the issue, HAI said.

Night Vision Goggles

The National EMS Pilots Association (NEMSPA) challenged a provision of the NPRM that would require operators of helicopters used in air ambulance flights to equip the aircraft with helicopter terrain awareness and warning systems (HTAWS).

"The FAA should not mandate HTAWS in lieu of other proven technologies, including night vision goggles (NVGs) and other night vision imaging systems," NEMSPA said.

"While NEMSPA recognizes HTAWS as a great technology, it has only been truly tested and proven in the high-altitude IFR environment by fixed-wing aircraft," the organization added. "Minimal data currently exist for its use in the low-altitude helicopter community. … NEMSPA would request that the FAA reconsider HTAWS as described in its current form within the NPRM. In addition, NEMSPA would request that the FAA consider additional night vision solutions, such as NVGs, as being of equal value to HTAWS."

AAMS agreed, calling for use of NVGs along with HTAWS.

"We do not view NVGs and HTAWS as an either/or proposition," AAMS said. "Both have safety benefits that can complement one another."

LifeFlight of Maine, which operates twin-engine aircraft fully equipped for IFR flight with NVGs for all crewmembers, urged the FAA to go further than the NPRM. "Instrument flight coupled with NVGs and HTAWS should be a minimum equipage standard for HEMS night operations," the organization said. "Both are important safety tools used to assist the pilot and should be on board and available at night. HEMS pilots/medical crew should be trained to use their discretion regarding the environmental conditions/appropriateness of NVG use."

Wider Application

The Air Medical Operators Association (AMOA) called for wider application of the proposed rules, suggesting that any new requirements should be applied not only to privately owned air ambulance operations but also to government entities that operate aircraft used to transport patients.

"All helicopter operators carrying patients should operate to a single safety standard," AMOA said. "These rules, therefore, should apply to every operation, regardless of affiliation or revenue status."

PHI Inc., whose Air Medical Group operates from 70 bases across the United States, also urged the FAA to apply safety requirements to all air ambulance operators. "Thousands of passengers are transported every year on air ambulance flights by government operators," PHI said. "PHI Inc. believes the safety enhancements in the proposed rule should also apply to protect these passengers."

Previous interpretations of FAA guidance have indicated that "routine medevac of persons due to traffic accidents or other similar incidents and hospital-to-hospital patient transfers are not governmental functions and should be considered civil aircraft, subject to FAA safety oversight," PHI said.

Effective Oversight

AMOA also said that it was concerned about "the FAA's ability to effectively inspect and oversee these proposed new requirements in a manner consistent with uniform application of the rules in a timely manner." The organization noted that in the past, it has experienced "uneven application of the current rules due to a wide range of interpretations and misunderstandings among FAA inspectors, flight standards district offices (FSDOs) and headquarters."

Instrument Ratings

Another provision of the NPRM calls for all helicopter air ambulance operators to ensure that their pilots-in-command hold an instrument rating. ACCT, which was among the organizations endorsing the provision, said that it "acknowledges the potential for helicopter air ambulance pilots to enter into inadvertent IMC [instrument meteorological conditions] and agrees with the FAA proposition. … The additional training and familiarity with instrument procedures during IMC … will ensure pilots are aware of the hazards and risks and may reduce the incidents of [inadvertent] IMC encounters."

Other provisions that the FAA said were intended to enhance safety of helicopter air ambulance operations would "increase VFR weather minima, allow IFR operations at locations without weather reporting, specify procedures for VFR/visual transitions from instrument approaches and require additional flight planning." The FAA said these proposals were intended to reduce accidents involving controlled flight into terrain (CFIT), collisions with obstacles, nighttime accidents and accidents resulting from inadvertent flight into IMC.

Some of these measures already exist in FAA Operations Specification A021, issued to certificate holders that conduct helicopter air ambulance operations.

HAI said that it "strongly supports efforts to promote the use of IFR whenever possible as a means of enhancing safety and reducing CFIT accidents." However, the organization and others criticized the FAA's explanation of how some of the provisions would be implemented.

For example, HAI complained of a "fatal flaw" in the proposed rule to allow IFR operations at airports and heliports without weather reporting, noting that the NPRM does not specify that possessing area forecast weather information is an acceptable alternative to having an approved weather reporting facility within 15 nm (28 km) of an intended landing area.

"As a result, this proposal would actually undermine the progress that has been made under A021, allowing many operators to develop IFR systems using area forecast weather," HAI said. "If the proposed rule is enacted as written, in many cases this proposal would require an operator to add an approved automated weather station at a location within 15 nm or operate VFR. This significantly undermines the ability of operators to add IFR operations as a safety improvement/risk mitigation strategy."

Other sections of the NPRM would require all commercial helicopter operators to "revise IFR alternate airport weather minimums, demonstrate competency in recovery from inadvertent [flight into IMC], equip their helicopters with radio altimeters, and change the definition of 'extended overwater operation' and require additional equipment for these operations."

Operators of all Part 135 aircraft — both airplanes and helicopters — would be required under terms of the NPRM to prepare a load manifest before flight and transmit a copy to their base of operations.

Another provision would require Part 91 operators of general aviation helicopters to revise their VFR weather minimums.

Notes

1. The NTSB refers to EMS operations, while the FAA uses the term "air ambulance."
2. FAA. *Federal Register* Volume 75 (Oct. 12, 2010): 62,639–62,674.

Wikimedia

BY WAYNE ROSENKRANS | FROM MILAN

By All Means

Italian authorities embrace information-sharing to help mitigate runway incursions.

Airport and air traffic control (ATC) specialists in Italy expect to manage runway incursion risk as a high priority for the foreseeable future as projections call for increased European air traffic with few runway additions, says Massimo Garbini, director general of Ente Nazionale di Assistenza al Volo (ENAV), the Italian company for air navigation services. Nevertheless, recent ENAV data show that preventing and mitigating errors by pilots (Figure 1) stands to have the greatest impact in Italy's campaign against runway incursions, which are a worldwide problem.

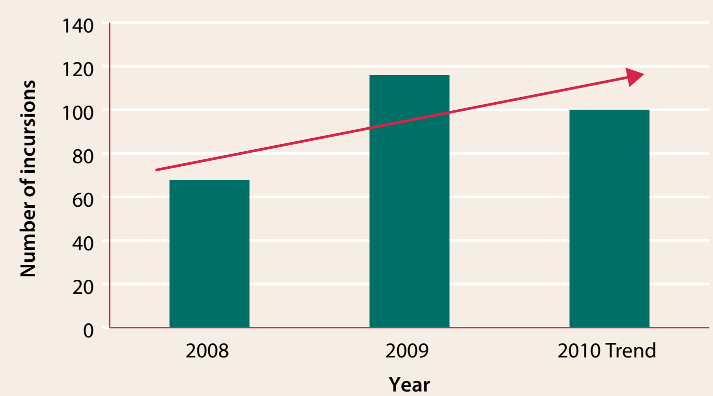
Surface surveillance technology; improved adherence to standard phraseology and procedures; local runway safety teams; markings, signs, runway guard lights and stop bars; hot spot maps; and government-industry collaboration have been among significant advances since a fatal accident occurred at Milano Linate Airport in October 2001 (*ASW,* 11/10, p. 44).

"It is very important that our people not forget [safety, given that] it has been nine years with no [airline] accident occurring in Italy," Garbini said in November 2010 during Flight Safety Foundation's International Air Safety Seminar in Milan.

The scope of changes in the intervening years has included embracing just-culture principles despite some unresolved legal impediments.

"At least internally, we decided not to blame someone for [an error] in operations," he said. "In today's environment, [all stakeholders] can

Non-ATM Runway Incursions in Italy, 2008–2010



ATM = air traffic management

Notes: Other ENAV data showed significant reduction of runway incursions caused by ATM errors over these years but these data showed increases in the incursions caused by pilots, airfield drivers and other factors. The 2010 numbers were reported with data available in November.

Source: Ente Nazionale di Assistenza al Volo (ENAV)

Figure 1

speak completely openly, transparently and directly. … The number of runway incursions is still increasing, so we cannot consider them only a problem for the air navigation service provider or the pilot, or a problem of the airport authority. … If one controller could make an error while operating, maybe the problem is my problem [in that] I have not provided the controller with enough training. … The [airfield] driver's problem is my problem. The controller's problems must be the [shared responsibility] of the airlines and the pilots, and so on."

About 70 percent of the ENAV infrastructure investment plan targets activities intended to increase the level of safety "instead of capacity or punctuality," he added. "For example, ENAV decided to provide free … training of [airfield] drivers at airports and to issue [airfield] driver licenses."

ENAV's solutions have relied principally on analyzing accident/incident data. "The main ATC error identified has [involved prospective memory, the controller] forgetting a clearance issued for takeoff or landing," Garbini said. Strict adherence to procedures mitigates this threat, he said.

Controllers' susceptibility to failing to recognize a readback error has been the second leading error type. "We need to stress the standardization of phraseology, to use the right phraseology," Garbini said. "We need to be strict in the training of controllers on this." ENAV also has been cooperating with Eurocontrol and airlines to resolve confusion of aircraft with similar call signs.

Constructive memory errors — when a controller became so convinced that a pilot would comply with an ATC instruction that a discrepancy was not noticed — also were identified, he said. One airline pilot responded to a takeoff clearance then remained on the runway without explanation, an unexpected and disruptive action from controllers' standpoint. "If I have cleared someone to take off, and the takeoff happens two or three minutes later, there can be taxi errors leading to runway incursions," Garbini said.

Italian airfield drivers have been prone to errors of noncompliance with ATC instructions "exactly like pilots," he said, and in the past, drivers typically had relatively inferior training. "Pilots and controllers attend professional training courses," Garbini said. "For drivers, it was very difficult to attend [such training,] especially in Italy."

Wayne Rosenkrans

Garbini

In one example from the ENAV presentation, an airliner flight crew acknowledged a "hold short" instruction from ATC but instead followed another aircraft across a runway, although the flight crew of a third airplane had been cleared for takeoff on that runway. "There was a good reaction from the controller [who radioed] 'Stop immediately the takeoff,'" Garbini recalled. In this case, the crew taking off also was able to see the crossing airplane and safely reject the takeoff.

In another example, a tower controller during nighttime operations suddenly observed a car on the landing runway, by sight and radar display, while an airliner was on 2.0 nm (3.7 km) final. The controller instructed the landing aircraft crew in English, "Conduct a standard missed approach; there is a car on the runway" but received no response to her first or second transmission. Further attempts also alerted the landing crew that ATC could not communicate with the car driver. A pilot then responded, and the crew safely conducted the missed approach.

"Instead of saying at least six or seven times, 'Please perform a standard missed approach,' which could mean that there was no danger at all but just a procedural problem … she needed to say 'pull up' … or use some phraseology that the pilots immediately would listen to [and know] to interrupt their landing, to overshoot absolutely," Garbini said. "[The lesson] from the pilots' point of view is to take care of the communications while on final and during the landing."

In another situation, an airliner crew, attempting to hold short of the landing runway, inadvertently slid onto the active runway because of an icy taxiway. Garbini said, "The controller said to himself, 'To be sure, let me again call [the taxiing crew] because their speed is so high.' He radioed, 'Landing in progress, maintain on the taxiway,' but the taxiing airplane pilot [replied], 'It's very slick out here, we are sliding, we can't hold short.' So the controller told the airplane on 1 nm final to go around." The conflict was resolved safely.

In other actions across Italy, rethinking airport layouts to optimize the level of safety during taxi has been pursued. Other airport risk analyses of normal operations have uncovered opportunities to upgrade runway signs and markings to be in the optimal position for all users, he said.

BY RICK DARBY

Re-Examining the Rudder

Rudder-use training is increasing, but gaps in understanding persist.

Transport airplane pilots have used, or expected to use, the rudder "in ways not always trained and in ways not recommended by the manufacturer," according to a survey conducted for the U.S. Federal Aviation Administration (FAA).[1] The survey also found that "erroneous and accidental [rudder] inputs occur" and that some pilots had to compensate for overcontrolled or wrong-direction rudder commands.

Rudder inputs became a prominent issue following the fatal accident involving American Airlines Flight 587, an Airbus A300, shortly after takeoff on Nov. 12, 2001. The flight data recorder indicated that moments before the accident there had been several rudder pedal inputs, to nearly full deflection, in opposite directions. The airplane's vertical stabilizer separated in flight, control was lost and the airplane crashed into a residential area near John F. Kennedy International Airport, New York.

"This accident focused international attention on how pilots apply rudder controls and industrywide pilot training of rudder usage in transport airplanes," the survey report says.

On Feb. 15, 2002, the FAA issued Notice N8400.28, *Transport-category Airplanes – Rudder and Vertical Stabilizer Awareness*, which directed principal operations inspectors to be certain that air carriers were aware of the danger of sequential, opposite full rudder inputs, or "rudder reversals."

The survey was developed after publication of Notice 8400.28 to ascertain pilot experience with rudder movements, as well as in-flight upsets. The survey, transmitted by the Internet to pilots of airlines belonging to the International Air Transport Association, included 52 questions about their use of rudder controls in response to upsets or unusual attitudes.[2] Among the questions were some about rudder training and unusual attitude training before and after the February 2002 notice. From the 2,179 total survey responses, 914 were selected as meeting the criteria assigned for statistical analysis.

A total of 283 pilots reported the number of upsets they had experienced in their careers. Most common was excessive bank, with a mean of 39 degrees, followed by altitude loss, with a mean of 461 ft. Pitch-up and pitch-down, with mean values of 8.4 degrees and 4.2 degrees respectively, were next in frequency among reported upsets.

Some pilots reported experiences in which rudder inputs did not produce the intended result. "Of the 118 pilots reporting an unexpected rudder characteristic, 37 percent reported an unexpected force, 31 percent reported an unexpected motion, 43 percent reported a lack of response and 40 percent reported an unexpected input sensitivity," the report says.

In response to questions concerning issues connected with rudder control inputs, pilots reported the following:

- **"Sequential opposite pilot inputs to rudder.** Thirty-seven pilots reported a total of 38 events in which they made sequential opposite-rudder pedal inputs;
- **"Pilot overcontrol or wrong-direction inputs.** One hundred forty-eight pilots reported 150 events in which they overcontrolled or made inputs in the wrong direction that had to be neutralized or reversed. Seventy-five percent of these events involved overcontrol; 25 percent were wrong-direction. Fifty-three percent of wrong-direction inputs involved yaw, 50 percent involved roll and 10 percent involved pitch;
- **"Unintentional crossed controls.** A total of 41 pilots reported they had unintentionally commanded uncoordinated rudder-pedal and control-wheel or sidestick commands; [and,]
- **"Inadvertent rudder inputs.** A total of 174 pilots reported making inadvertent, or accidental, inputs."

The inadvertent rudder inputs rarely resulted in pitch upsets, the report says. However, pilots reported 75 instances in which bank angles occurred, ranging up to 20 degrees, with 29 percent of pilots describing bank angles of more than 15 degrees. Sixty-eight pilots experienced yaw, up to 20 degrees, as a result of rudder inputs.

"One hundred eighty-eight pilots reported observing another pilot making inappropriate overcontrolling or wrong-direction inputs that had to be neutralized or reversed," the report says. Seventy-one percent of those errors involved overcontrol and 29 percent were in the wrong direction. Sixty percent of reported events involved erroneous yaw input, 58 percent involved erroneous roll input and 6 percent involved pitch.

Pilots described the phases of flight and situations when they would consider using the rudder pedals (Table 1).

"Intentions were varied for upset recovery, with 57 percent considering rudder use on takeoff, about a third in climb, cruise and descent, and 58 percent on landing," the report says. "Rudder use for engine failure was considered by at least two-thirds in all phases, almost all on takeoff, and over 80 percent for climb and landing. Intentions to use rudder to counter light turbulence were reported by many fewer respondents, with about 10 percent on takeoff and landing and less than 5 percent in other phases. Rudder use in crosswind was considered by few respondents in climb and cruise, but by 84 percent on takeoff, 18 percent during descent and 82 percent during landing."

The survey included questions about how the pilots had been instructed to use the rudder, both on the aircraft they were currently flying (Table 2) and for any aircraft they had previously flown. "Respondent perceptions of training recommendations for rudder use on their current aircraft were fairly consistent with their intentions [as shown in Table 1]," the report says.

Percentage of Pilots Who Would Use Rudder Input, by Flight Situation and Phase of Flight

	Phase of Flight				
Flight Situation	Takeoff	Climb	Cruise	Descent	Landing
Upset recovery	57%	40%	32%	34%	58%
Engine failure	96%	80%	69%	66%	86%
Counter light turbulence	10%	4%	3%	4%	11%
Counter in excess of moderate turbulence	21%	2%	10%	11%	4%
During crosswind conditions	84%	5%	3%	18%	82%
Passenger comfort	5%	4%	4%	13%	20%
Turn coordination	20%	17%	11%	14%	20%
Yaw damper hard-over/malfunction	56%	52%	49%	50%	57%
Dutch roll after yaw damper failure	30%	30%	36%	33%	30%

Source: U.S. Federal Aviation Administration

Table 1

Percentage of Pilots Reporting Training-Recommended Rudder Use on Aircraft Currently Flown, by Flight Situation and Phase of Flight

	Phase of Flight				
Flight Situation	Takeoff	Climb	Cruise	Descent	Landing
Upset recovery	36%	30%	29%	25%	35%
Engine failure	97%	79%	66%	66%	88%
Counter light turbulence	6%	3%	3%	2%	6%
Counter in excess of moderate turbulence	11%	5%	6%	11%	11%
During crosswind conditions	83%	7%	3%	5%	90%
Passenger comfort	5%	3%	3%	3%	5%
Turn coordination	15%	14%	12%	12%	15%
Yaw damper hard-over/malfunction	36%	33%	33%	32%	38%
Dutch roll after yaw damper failure	21%	21%	24%	21%	21%

Source: U.S. Federal Aviation Administration

Table 2

Pilot Rudder-Use Training, by Time Frame and Type

Time Frame	Type of Training: Recurrent Simulator	Recurrent Classroom	Safety Bulletin	Operations Bulletin	Aircraft Checkout	Discussion with Other Pilots	Personal Flying Experience
Pre-2002 rudder training	28%	18%	12%	12%	11%	11%	9%
Post-2002 rudder training	40%	31%	28%	28%	22%	16%	5%

Source: U.S. Federal Aviation Administration

Table 3

"For upset recovery, a quarter to a third of respondents perceived [that training recommended] rudder use; this was slightly lower than their intentions reported … . Rudder use for engine failure was perceived as recommended by at least two-thirds in all phases; almost all on takeoff and roughly 80 percent for climb and landing."

Pilots' perceptions of training recommendations for rudder use on previous aircraft flown were generally in line with intentions. "However, respondent perceptions for upset recovery recommendations were higher than their current aircraft by about 10 percent but still lower than intentions reported," the report says. "Additionally, use for turn coordination was higher, suggesting that many had flown aircraft at some point in their career in which rudder input was required to maintain coordinated flight in turns."

The report says that, in response to questions about their training on rudder use, 34 percent said that they had received additional training before February 2002, the publication date of Notice N8400.28, and 52 percent had received more training after that date. Post-2002 rudder training increased in almost every training category (Table 3).

"The number of sequential opposite-direction rudder inputs and reversed over-application of rudder reported by the respondents is important," the report says. "It implies that the [American Airlines Flight 587] Airbus accident differs in magnitude but not in fundamental misinterpretation or application error from events reported by respondents. Pilots reported a number of situations, mostly erroneous inputs requiring neutralization or reversal, which had the potential to exceed certification criteria but probably did not reach ultimate load."

Several questions were put to pilots about their monitoring of the control inputs by the pilot flying. "While the majority of respondents reported efforts to monitor the controls when acting as non-flying or monitoring pilot in a variety of phases of flight, monitoring sidestick pitch and roll was reported by many fewer respondents," the report says. No pilot expressed a preference or dislike about any particular control system design.

In their own judgment, pilots found simulators to be the most effective mode for rudder characteristics training. About half of all respondents also had received aerobatic training at least once.

"Importantly, however, the data reveal continuing inconsistency between respondent intentions, perceptions of training recommendations and published guidance," the report says. "Specific areas requiring further emphasis based upon survey responses include:

- "Avoidance of over-controlling or opposite-direction inputs, particularly involving the rudder;
- "Explanation and understanding of rudder characteristics, including forces, motions, responses and sensitivity; [and,]
- "Efforts to bring intentions to use rudder into close alignment with guidance provided in the *Upset Recovery Training Aid*."[3]

The report recommends "continued emphasis" by civil aviation authorities, manufacturers and operators on appropriate rudder use, "given the frequency of reported events in which rudder reversal was a real possibility." In addition, "future rudder designs should consider tolerance of common mistakes or inappropriate control inputs made by pilots."

Notes

1. FAA Civil Aerospace Medical Institute. *An International Survey of Transport Airplane Pilots' Experiences and Perspectives of Lateral/Directional Control Events and Rudder Issues in Transport Airplanes (Rudder Survey).* DOT/FAA/AM-10/14. October 2010.
2. Upset was defined as "unintentional conditions describing an airplane motion that a pilot believed required immediate corrective action."
3. FAA. *Airplane Upset Recovery Training Aid*, revision 2. 2008. The training aid's definition of "upset" differs from that used in the survey, and consists of a pitch attitude greater than 25 degrees nose-up, greater than 10 degrees nose-down or bank angle greater than 45 degrees.

When Worlds Collide

Technical accident investigation and criminal proceedings can work at cross-purposes.

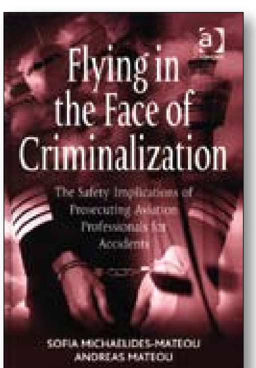
BY RICK DARBY

BOOKS

Civil Versus Criminal Liability

Flying in the Face of Criminalization: The Safety Implications of Prosecuting Aviation Professionals for Accidents

Michaelides-Mateou, Sofia; Mateou , Andreas. Farnham, Surrey, England, and Burlington, Vermont, U.S.: Ashgate, 2010. 232 pp. Figures, references, index.



"Aviation professionals who have been criminally prosecuted subsequent to an aviation accident were charged with a variety of criminal offenses," the authors say. "Despite the differences in the legal systems and the penal codes for each country, the common elements of the charges are based on breach of duty, negligence and manslaughter."

Specific charges against pilots and air traffic controllers have included "causing death through a reckless, careless and dangerous act"; "criminal negligence causing bodily harm and dangerous operation of an aircraft"; "manslaughter and negligent flying causing death"; and "negligent homicide and negligently disturbing public transport." Being killed may or may not put an individual beyond the reach of the law, depending on how you look at it — the pilots of an ATR 42 taking off in icy conditions at Milan, Italy, in October 1987, who died along with 34 passengers, were posthumously charged with murder and convicted.

The International Civil Aviation Organization (ICAO) Standards and Recommended Practices, Annex 13, *Aircraft Accident and Incident Investigation*, tells state accident investigation bodies: "The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents. It is not the purpose of this activity to apportion blame or liability." Further, Annex 13 says that the investigators shall not make the information gained available to police and judicial investigators "unless the appropriate authority for the administration of justice determines that their disclosure outweighs the adverse domestic and international impact such action may have on future investigations."

ICAO, however, has no authority over any state's legal apparatus. The authors note that Annex 13 "does not ensure that, in practice, the evidence and results of the investigations are not used in subsequent legal consequences and litigation. Concurrent to the accident investigation carried out in terms of Annex 13, police and judicial investigation will also be carried out in order to determine what offenses were

A well-established means exists for the scales to be reasonably balanced through civil litigation entirely outside the criminal justice system.

committed, the exact nature of the offenses and the parties who have allegedly committed any such offenses."

Increasingly, serious aviation accidents result in two investigations — one by the national accident investigation authority and another, sometimes following and sometimes in parallel, by criminal investigators.

"The comprehensive collection of cases that we have included shows that there were 27 cases of aviation accidents which were criminally investigated from 1956–1999 and 28 cases from 2000–2009," the authors say. "There were 27 cases spanning 43 years and over 28 cases in the last decade. Our research into cases where aviation professionals have faced criminal charges subsequent to an aviation accident has led us to believe that there will be a significant increase in cases where aviation accidents will be followed by criminal prosecutions." Such prosecutions, they say, are "based on the public's expectation that criminal prosecution will ensure aviation safety, and perhaps judicial authorities believe that prosecution will be the only way to increase safety and protect the public."

Two worlds are colliding. The first is traditional, technical accident investigation, which is best served by full disclosure of all relevant facts by everyone involved, in addition to physical evidence. The goal is to determine causal factors and offer recommendations for reducing the likelihood of accidents with similar causal factors. The second is law enforcement, with its own codes and traditions, and based on administering justice against individuals, including corporate "persons," who commit acts that cause harm.

A large portion of accidents — 80 percent is a commonly cited figure — involve human error. Legal systems have long recognized the concept of responsibility for human error and created a system of civil liability for error involving negligence, whereby injured parties or relatives of those killed can sue for financial compensation. The authors discuss in detail the meaning of civil liability, particularly as it pertains to aircraft accidents. "Liability in tort (negligence) may be imposed as the legal consequence of a person's act or omission to act in accordance with a legal duty imposed on him," they say.

That legal duty must be a "duty of care" of the defendant toward the claimant. In simplified layman's terms, a person or entity must take reasonable care to avoid acts or omissions which can reasonably be foreseen as likely to injure someone in relation or proximity to the defendant, or under the defendant's control.

Thus, while there is no absolute justice in the world, a well-established means exists for the scales to be reasonably balanced through civil litigation entirely outside the criminal justice system. Then what is the justification for law enforcement to step in?

The Convention on International Civil Aviation, ICAO's "constitution," says in Article 12 that "each contracting state undertakes to adopt measures to ensure that every aircraft flying over or maneuvering within its territory and that every aircraft carrying its nationality mark, wherever such aircraft may be, shall comply with the rules and regulations relating to the flight and maneuver of aircraft there in force."

"It is therefore clearly stated that the provisions establishing criminal liability are set out in the domestic legislation of each contracting party, which differs from state to state," the authors say. "Modern aircraft are capable of crossing half the globe, flying non-stop from Singapore to New York and from London to Sydney. During the flight, the aircraft will traverse countries with different legal systems and aviation legislation."

Sentencing can be drastic. "In the Korean Airlines DC-10 accident in Tripoli [Libya] in 1989, in which four crewmembers, 68 passengers and six persons on the ground were killed, the pilots who were arrested by the Libyan authorities were sentenced to life imprisonment and extradited to Korea," the authors say. "Following the midair collision in Zagreb [Yugoslavia, now Croatia] in 1976 in which all

176 people aboard both flights were killed, the upper-sector assistant ATCO [air traffic controller] who was on duty at the time of the accident was found guilty and actually served 27 months in prison before being released. In the Tuninter ATR 72 accident [*ASW*, 7/09, p. 26], the Italian courts sentenced the captains to 10 years' imprisonment, and in the accident that occurred at [Milano Linate Airport, *Accident Prevention*, 4/04], the courts imposed sentences ranging from six to eight years."

Sentences are sometimes reversed or reduced on appeal; occasionally, such as for the captain of the Airbus A320 that crashed during a demonstration flight at Habsheim, France, in 1988, courts have upheld and even increased the sentence, the authors found. Regardless of the outcome, legal cases typically continue for long periods. The Habsheim case took nine years to go to court and a further year for the appeal. The July 2000 fatal accident involving a Concorde at Paris — in which charges were filed against various managers at the Concorde division of Aerospatiale, Continental Airlines and two Continental Airlines maintenance personnel — did not go to trial until 2010. "Undoubtedly, the length of time that it takes for the completion of the judicial investigation, the laying of charges and the commencement of the court proceedings increases the financial and emotional burden on the accused and causes additional damage to their reputation," the authors say.

From a system safety standpoint, the jeopardy in which aviation professionals can find themselves because of prosecution is part of a larger picture. Prosecution requires evidence, and fruitful sources of evidence can include the findings of the accident technical investigation and sensitive, supposedly protected data. The authors cite examples of courts relying heavily on the accident investigation reports. In one criminal case, the court accepted the probable cause finding of the investigation report and admitted the entire report as evidence into the trial.

"Data from the CVR [cockpit voice recorder] and FDR [flight data recorder] have been extensively used during the criminal prosecutions against pilots, ATCOs, engineers and other aviation professionals," the authors say. As one example, they note that in the court case following the Tuninter accident, "the persuasive arguments by the prosecution that the pilot had panicked and did not discharge his legal duties to complete the 'Emergency' checklist were given weight the moment the CVR transcript was heard in court and the captain was heard praying."

In a survey of pilots and ATCOs conducted by the authors, most respondents expressed the belief that criminalization will have no effect, or a negative effect, on safety. "Pilots and ATCOs who are already working under great pressure to maintain a high safety level and achieve high productivity targets due to the economic pressures of the industry are alarmed that the additional fear of prosecution due to an error will increase their stress, and this will have a negative effect on their concentration, decision making and ultimately on their performance," the authors say.

Extracts from some of the survey responses suggest the rationale for their positions:

- "The judicial authorities will only be looking for such evidence that will show whether somebody is to blame and therefore can be successfully prosecuted. Inevitably, the search for such evidence concentrates on pilots, ATCOs, aircraft mechanics and so on. The deeper and more complicated potential institutional, structural and managerial causes of the accident, which are the province of the accident investigator, tend to be ignored (and in certain countries actively suppressed because the government is directly involved with the running of the aviation industry)."
- "ATCOs and pilots are not going to their work having in mind to produce an incident or an accident. They represent

Prosecution requires evidence, and fruitful sources of evidence can include the findings of the accident technical investigation.

the 'sharp end' of organizations, and thus they are more visible in the case of an accident/incident than the 'blunt end' of their organization. … It is unrealistically assumed that ATCOs and pilots can deal effectively with any kind of conceivable emergency situation they may face; ATCOs and pilots are normally intervening in many cases where management inefficiencies, system design problems and politically imposed constraints are hindering the normal flow of their everyday tasks."

- "Creating a blame culture will be counterproductive. It cannot be said that countries that have prosecuted pilots and ATCOs have a higher safety record. Having a healthy safety culture allows mistakes to be picked up and learned from. Prosecuting people discourages others from reporting their mistakes."

The authors say that "a very small number" of respondents felt that criminalization of accidents has had a positive effect on safety. They included comments such as these:

- "Someone has to pay if someone does something wrong and people get injured or die and there is no management or technical explanation."

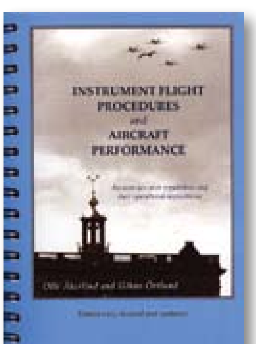
- "Criminal or multiple gross negligence should be prosecuted to clearly demonstrate that the aviation community does not tolerate this."

If criminal proceedings against aviation professionals must continue, is there a better way they could be performed? The authors suggest consideration be given to establishing a European aviation court — and presumably similar courts in other regions — with uniform rules and procedures, instead of the patchwork quilt of current jurisdictions. "The establishment of a European aviation court was overwhelmingly supported by the survey respondents, as it was thought that this would provide a court with a common legal basis to commence a criminal prosecution, dealing specifically with aviation matters and having the specialized knowledge and experience in such matters," they say.

The authors quote a respondent: "[Such a body would be] more professional and more experienced and will have experts in specific fields. If based on a just culture, it will ensure common standards and will be more fair and just."

Another respondent said, "Most of the legal world is not aware of the real nature of aviation. Of course, law is law and should be applied everywhere, but what about the special circumstances that both ATCOs and pilots undergo? A court of law with judges and lawyers that are experts would offer a better trial."

Revised and Updated



Instrument Flight Procedures and Aircraft Performance

Åkerlind, Olle; Örtlund, Håkan. Molkom, Sweden: Håkan Örtlund Prokuktion, 2010. <www.flightproc.com>.

The authors say this latest edition "deals with subjects heavily affecting the pilot's workday. Since this book was first introduced, rules and regulations concerning procedures and weather minimums have been subject to extensive revisions. As a consequence, the chapters dealing with flight procedures and weather minimums have been extended." The spiral-bound book is extensively illustrated with diagrams.

Fire Erupts During Maintenance Test

The Falcon's wheel brakes overheated during a series of accelerate-stop runs.

BY MARK LACAGNINA

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

JETS

Hydraulic Fluid Ignited

Dassault Falcon 2000. Substantial damage. No injuries.

Maintenance was performed on the Falcon in early November 2009 at Biggin Hill Airport in Kent, England, in response to a technical log entry that the aircraft was pulling to the left when the wheel brakes were applied. Maintenance actions included rigging checks and replacement of the two wheels and the brake system control units on the left main landing gear. Low-speed taxi tests performed by maintenance personnel indicated that this might have corrected the problem. However, the maintenance organization requested that the aircraft operator provide company pilots to conduct high-speed "taxi tests," said the report by the U.K. Air Accidents Investigation Branch (AAIB).

A crew comprising a commander, a copilot and a cabin attendant already had been dispatched to Biggin Hill to pick up the aircraft after the maintenance was completed. "At this stage, the crewmembers were unaware of the nature of the maintenance," the report said. On Nov. 10, the commander received a text message from the aircraft operator, assigning her to perform a "miscellaneous activity" the next day that would include "high-speed taxi requested by the maintenance department," the report said.

Apparently because the assignment involved only ground operation of the aircraft, it was not designated as an "operational check flight," which was defined by the company's operations manual as "a flight used to verify component, system or aircraft performance to determine correct operation after maintenance." The report noted that neither the commander nor the copilot had received training to conduct operational check flights.

When the crew arrived at the maintenance facility the morning of Nov. 11, they were briefed by the maintenance supervisor about the Falcon's tendency to veer left when the brakes were applied. "The maintenance team requested high-speed tests, which the crew agreed to," the report said, noting that the crew decided to "adopt an incremental approach starting [with a maximum speed] of 50 kt and increasing to 80 kt. The crew carried out performance calculations to ensure the runway length [5,910 ft (1,801 m)] was adequate for the task."

However, the pilots did not review information in the airplane flight manual regarding brake energy limits and minimum times required to cool the brakes following takeoffs rejected at various speeds. "The aircraft is fitted with a wheel well overheat warning system, but there is no measurement or [cockpit] indication of brake temperatures," the report said.

Hydraulic fluid was released at high pressure and ignited when it contacted the hot brake components.

The three crewmembers, the maintenance supervisor and two technicians boarded the aircraft. "The maintenance supervisor occupied the jump seat between the two pilots, and the two technicians were seated in the rear of the passenger cabin," the report said. "The cabin attendant gave a passenger brief to remind them of the main exits and [the requirement for] wearing seat belts.

"The crew commenced a series of accelerate-stop runs along the runway by selecting takeoff thrust, accelerating to the target IAS [indicated airspeed], then retarding the thrust levers and applying the brakes positively, bringing the aircraft to a stop," the report said.

The target airspeed for the first two runs was 50 kt. The pilots then turned the aircraft around on the runway and conducted two more uneventful runs up to 60 kt. After another turnaround, the crew accelerated to 80 kt before applying the brakes. This time, the commander had to apply full left brake to maintain directional control. Investigators later determined that, during this run, heat built up in the left brake and wheel assemblies to the point that the fuse plugs melted and the tires began to deflate. Another run to 50 kt was conducted before the aircraft again was turned around on the runway.

On the seventh run, the aircraft again was accelerated to 80 kt before the brakes were applied. This time, the commander was unable to prevent the aircraft from veering left but was able to stop it on the runway. "The maintenance supervisor and the flight crew discussed the findings, and it was agreed to carry out one more run," the report said. The crew taxied the Falcon to the end of the runway and turned around. The target airspeed for the eighth run was 80 kt, but the crew aborted the test at 30 kt, sensing that the tires on the left main landing gear were "flat."

"They informed ATC [air traffic control] and requested a tug; but, shortly after, the pilot of another aircraft holding at [a taxiway] informed ATC that there was a fire on the [Falcon's] left main landing gear," the report said. "ATC confirmed this visually and advised [the Falcon crew] that there was a fire and to evacuate the aircraft. The crew carried out the evacuation drills, and all those on board left the aircraft without difficulty through the normal airstair door."

Airport fire and rescue service personnel responded immediately and extinguished the fire. The aircraft was towed onto a taxiway, and an initial examination revealed "severe fire damage" to the left wing, landing gear and flap, the report said.

Recorded flight data showed that the eight accelerate-stop runs had been performed within about 15 minutes, causing the carbon brake assemblies on both main landing gear to overheat severely. "The protective coating on the carbon discs had been removed, indicating temperatures in excess of 1,200 degrees C [2,192 degrees F]," the report said. The excessive heat caused hydraulic fluid seals on the left main landing gear to fail. Hydraulic fluid was released at high pressure and ignited when it contacted the hot brake components.

After the accident, the aircraft operator revised its definition of "operational flight check" to include "high risk ground test activities, such as high-speed taxi trials and engine ground runs," the report said.

Taxiway Takeoff

Airbus A320-214. No damage. No injuries.

The A320 was 20 minutes behind schedule when it landed at Oslo Airport Gardermoen in Norway the afternoon of Feb. 25, 2010. After a short turnaround, the flight crew decided to save time by departing from the A3 intersection of Runway 01L, rather than taxiing to the threshold of the runway.

"Based on the airplane's takeoff mass of 61,700 kg [136,024 lb], as well as prevailing weather and friction conditions, the crew concluded that the available runway length from A3 was well within the necessary margins," said the report by the Accident Investigation Board of Norway.

The commander, the pilot flying, taxied the airplane westbound from the gate and turned left (south) onto Taxiway N, one of two parallel taxiways between Runway 01L and the terminal complex. The first officer was mostly head-down, reviewing checklists and the departure procedure, and setting the instruments for take-off. The safety pilot, who was aboard because the first officer was in training, was monitoring the first officer's actions.

The other parallel taxiway, Taxiway M, is located between Taxiway N and the runway. The airport traffic controller cleared the crew for takeoff from Runway 01L at A3 when the airplane was still being taxied southbound on Taxiway N. The commander later told investigators that he had expected to receive takeoff clearance "on the taxiway next to the runway" — that is, Taxiway M. When the airplane reached the A3 intersection, the commander made a right turn off Taxiway N, another right turn onto Taxiway M and proceeded to take off.

The controller was conversing with a colleague and was not watching the A320 when it began to roll on Taxiway M. "Under the prevailing conditions, Taxiway M was, by chance, long enough for the aircraft to take off," the report said. "The taxiway was [also] free of other traffic and obstacles. This prevented a more serious outcome of the incident."

The flight crew did not realize that they had departed from a taxiway until they were told by the controller that they had done so. The flight, with 60 passengers and four cabin crewmembers, continued without further incident to Moscow.

The report said that the taxiway takeoff was a serious incident that resulted from "deficient procedures and insufficient alertness in the cockpit, in combination with insufficient monitoring from the control tower and insufficient signposting in the maneuvering area."

Takeoff Rejected After Rotation

Boeing 777-300ER. Minor damage. No injuries.

After the 777 was landed at Lagos Aerodrome in Nigeria the night of Jan. 11, 2010, the captain quickly performed preparations for the next leg, to Paris, so that he could take a 40-minute rest break in the cockpit during the scheduled 1.5-hour stopover in Lagos.

Push-back and engine start began a few minutes before midnight, said the report by the French Bureau d'Enquêtes et d'Analyses. There were 218 passengers and 14 cabin crewmembers aboard when the flight crew was cleared to taxi to Runway 36L for departure.

During the takeoff briefing, the captain, the pilot flying, said that V_1 would be 138 kt and V_R would be 157 kt. The crew completed the takeoff checklist, and the copilot told the airport traffic control tower that they were ready for takeoff. At the time, the aircraft was 1,300 m (4,265 ft) from the holding point for Runway 36L.

The report said that about two minutes after the controller issued takeoff clearance, "the aircraft entered the runway, and the crew began the takeoff roll without stopping the aircraft." The captain had neglected to arm the autothrottle, and when he activated the takeoff/go-around (TOGA) switches, N_1, or engine low-pressure rotor speed, remained stabilized at 62 percent.

The captain announced, "We have a problem," and activated the TOGA switches again. He then noticed that the autothrottle had not been engaged, and he removed his hand from the thrust levers to arm the autothrottle switch on the mode control panel. However, he inadvertently engaged the autopilot instead.

The captain had neglected to arm the autothrottle.

The captain announced, "No thrust," and the copilot replied, "Do it by hand."

"During this exchange, the thrust levers were advanced to obtain N_1 of 92.5 percent," the report said. Soon after the copilot called out rotation speed, the captain called for a rejected takeoff. Airspeed reached a maximum of 165 kt, and the aircraft was stopped about 900 m (2,953 ft) from the end of the 3,900-m (12,796-ft) runway. No one was injured, but several wheel brake assemblies overheated, causing the fuse plugs to melt and the tires to deflate.

The captain told investigators that he rejected the takeoff because he sensed a blockage of the elevator control during rotation. The report said that the inadvertent engagement of the autopilot had significantly increased the manual control force required to rotate the aircraft.

The report noted that a few days after the serious incident, Boeing issued a service bulletin announcing a revision of autopilot software to prevent inadvertent engagement on the ground. The U.S. Federal Aviation Administration subsequently mandated installation of the new software in 777s.

Blind, Powerless Landing

Cessna Citation 550. Substantial damage. No injuries.

The captain told U.S. National Transportation Safety Board (NTSB) investigators that the Citation II encountered unforecast severe head winds, which increased fuel consumption, during a flight from the Dominican Republic to Wilmington, North Carolina, U.S., the night of Jan. 4, 2009.

The forecast for Wilmington International Airport called for visibilities greater than 6 mi (10 km) and a broken ceiling at 700 ft, the NTSB report said. When the Citation arrived, however, the visibility was 1/2 mi (800 m) in fog, and there was a broken ceiling at 100 ft and an overcast at 500 ft.

The crew was conducting the third missed approach when the left engine flamed out.

The flight crew requested and received clearance to conduct the instrument landing system (ILS) approach to Runway 24. At 0150 local time, the first officer told the approach controller that they were conducting a missed approach and requested clearance to "shoot another approach."

The controller cleared the crew for another ILS approach but advised them that weather conditions were "much better" at Albert J. Ellis Airport, 36 nm (67 km) north. The first officer replied that they needed to clear customs at Wilmington.

The crew conducted two more approaches but were unable to land because of the fog. They were conducting the third missed approach when the left engine flamed out. The first officer radioed, "We have an emergency, one engine out."

"Can you make it to Albert Ellis?" the controller asked. The first officer replied that they were low on fuel and requested vectors for another ILS approach to Wilmington.

"While the airplane was being vectored for a fourth approach, the right engine lost power," the report said. "Utilizing the global positioning system, the captain pointed the airplane toward the intersection of the airport's two runways." The Citation was about 50 ft above the ground when the captain saw a row of lights and turned to touch down parallel to the lights. He attempted to extend the landing gear; but, with both engines inoperative, there was no hydraulic pressure, and there was no time to use the emergency gear-extension system.

At 0209, the Citation "landed gear-up heading southwest near Taxiway G, which intersected Runway 6-24, … subsequently overran the runway and impacted several approach light stands for Runway 24, coming to rest 2,242 ft [683 m] past the point of initial touchdown," the report said. The pilots and their five passengers escaped injury. The lower fuselage of the airplane was damaged, and the pressure vessel was punctured in several places.

The report said that the flameouts of both engines were caused by fuel exhaustion that resulted from "the crew's inadequate in-flight fuel monitoring."

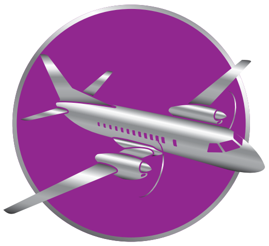
Asleep at the Wheel

Bombardier CRJ700. Substantial damage. One minor injury.

The driver of a fuel truck apparently released the wheel brake foot pedal when he fell asleep while waiting for the CRJ to arrive at Dallas–Fort Worth (Texas, U.S.) International Airport the afternoon of Dec. 18, 2009. The emergency brake had not been set, and the truck began to roll.

The driver "was unaware of what happened until the fuel truck collided with a parked airplane that had just arrived at the gate," the NTSB report said. The aft fuselage of the CRJ was substantially damaged, and a flight attendant sustained a minor injury. The report did not say whether the fuel truck driver was hurt during the collision.

TURBOPROPS



Pressurization Controls Neglected

Beech King Air C90. Destroyed. One fatality.

Soon after the King Air leveled at 17,000 ft during a flight from Hondo, Texas, U.S., to Goodyear, Arizona, the afternoon of Dec. 14, 2008, ATC radar "showed the airplane in a meandering flight path, increasingly off course," the NTSB report said. Although the controller issued several heading corrections and queries about the flight's status, the airplane's flight path continued to deviate from course.

After about six minutes at 17,000 ft, the pilot was cleared to climb to 24,000 ft. The airplane was passing through 18,000 ft when the pilot made his last radio transmission, acknowledging a heading correction. Several subsequent attempts to hail the pilot were unsuccessful.

ATC radar showed that the King Air climbed to 24,000 ft, descended gradually to 21,000 ft and then entered a rapid descent. Two witnesses saw the airplane spin to the ground near Rocksprings, Texas. One witness said that "he continued to see pieces of aluminum raining down for quite some time after impact," the report said.

Both engine bleed air switches were found closed, and the cabin pressurization switch was in the "DUMP" position. The report said that the probable cause of the accident was "the pilot's failure to configure the pressurization controls, resulting in his impairment and subsequent incapacitation due to hypoxia."

Reverse Thrust Reduces Control

Fokker F50. No damage. No injuries.

The Fokker was inbound with 20 passengers from London to Ronaldsway Airport on the Isle of Man the morning of Jan. 15, 2009. After conducting the ILS approach to Runway 26, the flight crew was cleared to land and was advised that the runway was wet and that the surface winds were from 180 degrees at 24 kt.

The AAIB report noted, however, that the wind was gusting over 33 kt, the recommended maximum crosswind for landing the aircraft on a *dry* runway.

The commander held a 20-degree left crab angle during final approach. "At about 50 ft AGL [above ground level], the commander began to decrab the aircraft by applying right rudder and left (into wind) aileron," the report said. The aircraft touched down at 91 kt, bounced on the runway, touched down again and began to veer left. The commander initially applied full right rudder and left aileron to maintain directional control but then selected maximum reverse power as the aircraft neared the edge of the runway. The Fokker turned more sharply to the left and ran off the runway. "The aircraft came to a stop with the nose and left main gear off the paved surface," the report said.

According to the aircraft manufacturer, the rudder is the most effective control surface for maintaining directional control on a runway at high speed, and the use of high reverse power disrupts airflow around the rudder and the ailerons, reducing the effectiveness of these control surfaces.

Fatigue Cited in Excursion

Mitsubishi MU-2B-60. Substantial damage. No injuries.

Inbound from Dallas with three charter passengers early on Feb. 4, 2010, the pilot was told by an Amarillo (Texas, U.S.) International Airport operations worker that the runway was covered with snow and ice. Visibility was 1/2 mi (800 m) in freezing fog, and there was an indefinite ceiling with vertical visibility of 110 ft.

The pilot conducted the ILS approach to Runway 04 and touched down about 20 kt faster than the recommended landing speed. "The airplane's right main landing gear touched down first, followed by the left main landing gear and the nose gear," the NTSB report said. "The airplane made an abrupt left turn [and] departed the left side of the runway." The MU-2 received damage to the right main landing gear, right wing spar and fuselage, but remained upright.

The report noted that the accident is part of an NTSB fatigue-investigation study. Although the pilot had been on duty for only 4 hours and 15 minutes, he had been awake for more than 19 hours when the accident occurred at 0215 local time.

Totalizer Tells Tall Tale

Beech King Air B200. Substantial damage. Three serious injuries.

The pilot intended to conduct a local flight with two maintenance technicians to evaluate some avionics equipment problems the morning of Nov. 9, 2009, before a phase inspection of the King Air was begun at Greenville Spartanburg (South Carolina, U.S.) International Airport. While preflighting the King Air, he noticed that there were 740 lb (336 kg) of fuel aboard, enough for about one hour and 10 minutes of flight.

After completing the preflight check, the pilot returned to the maintenance facility to await the technicians' arrival. The pilot was not aware that, during his wait, two mechanics performed a 45-minute ground run of the engines in preparation for the phase inspection, the NTSB report said. The mechanics noted that 200 lb (91 kg) of fuel remained in each of the two main tanks when they completed their ground runs. The B200 pilot's operating handbook states, "Do not take off if the fuel quantity gauges indicate in the yellow arc or indicate less than 265 pounds [120 kg] of fuel in each main tank system."

After the technicians arrived, the pilot did not check the fuel gauges but noticed that the flight management system (FMS) fuel totalizer indicated sufficient fuel for the avionics test flight. The mechanics had not activated the FMS; thus, the fuel quantity shown by the totalizer had not changed during the engine ground runs.

The King Air was on final approach after 23 minutes of flight when both engines flamed out due to fuel exhaustion. "The pilot attempted to glide to the runway with the landing gear and flaps retracted; however, the airplane crashed short of the runway," the report said.

PISTON AIRPLANES

Special VFR Into a Whiteout

Piper Chieftain. Substantial damage. One serious injury, five minor injuries.

As the Chieftain neared Nome (Alaska, U.S.) Airport on a commuter flight the afternoon of Feb. 19, 2009, a flight service specialist told the pilot that the weather conditions at the airport were below basic visual flight rules (VFR) minimums. The latest weather observation included 1 1/2 mi (2,400 m) visibility in light snow and mist, a broken ceiling at 900 ft and surface winds from 250 degrees at 20 kt, gusting to 25 kt.

The pilot requested, and received, a special VFR clearance to enter the Nome Class E airspace. "According to the pilot, he started a gradual descent over an area of featureless, snow-covered, down-sloping terrain in whiteout and flat light conditions," said the NTSB report. "A localized snow shower momentarily reduced the pilot's forward visibility, and he was unable to discern any terrain features." A passenger was seriously injured and the other five occupants sustained minor injuries when the Chieftain struck terrain about 5 nm (9 km) from the airport.

"The pilot reported that the accident could have been avoided if the flight had been operated under an instrument flight rules flight plan," the report said.

Engine Problems Lead to Ditching

Piper Twin Comanche. Destroyed. No injuries.

En route from the Channel Islands the morning of Dec. 16, 2009, the Twin Comanche was at 8,000 ft and about 38 nm (70 km) southeast of the destination — Ronaldsway Airport on the Isle of Man — when an overspeed of the right propeller occurred. The propeller did not respond to movement of the throttle or propeller lever, so the pilot shut down the engine and turned toward Blackpool Airport, on the west coast of England.

The aircraft was at 4,000 ft a few minutes later when manifold pressure in the left engine decreased to 17 in. Unable to maintain altitude and beyond gliding distance to Blackpool, the pilot decided to ditch the aircraft near an offshore platform support vessel.

"She prepared for the ditching by unlatching the door and placing her life raft and a 'grab bag' of essential supplies on the front seat," the AAIB report said. "At approximately 100 ft, she shut down the left engine. She then maintained 80 kt until the aircraft was at approximately 10 ft, then 'hauled back on the control column' in order to touch down tail-first. This caused the aircraft to 'belly flop' onto the water."

The pilot, who had received sea survival training in the Royal Navy, was wearing an immersion suit and life vest. "She swam to the life raft [which had fallen into the water] and inflated it but found that there were no steps or handholds to aid her boarding." She clung onto straps on the life raft for a few minutes until she was rescued by a boat launched from the platform support vessel.

The Twin Comanche was recovered from the seabed five months later. Investigators determined that the overspeed of the right propeller might have been caused by low air charge pressure or a stuck pilot valve in the propeller governor, and that the left engine power loss might have been caused by ice forming on the throttle servo valve impact tubes and restricting fuel flow to the engine.

HELICOPTERS

Brownout, Glare Spoil Landing

Eurocopter AS 350-B2. Substantial damage. No injuries.

The pilot was wearing night vision goggles (NVGs) during the emergency medical services positioning flight from Phoenix, Arizona, U.S., to pick up a patient who had been injured in a motor vehicle accident near Cave Creek, Arizona, the night of Feb. 22, 2009.

Nearing the landing zone — a dirt parking lot — the pilot asked ground personnel if the area had been watered down, to suppress dust. "The ground personnel replied that the landing area was not wetted down [but] 'looked damp,'" the NTSB report said. However, dust began to encircle the helicopter during the approach. At about 20 ft AGL, brownout conditions developed, and the pilot reduced power to expedite the landing.

"As the helicopter descended through about 10 ft AGL, the pilot lost visual reference through his [NVGs] due to lights from adjacent emergency service vehicles," the report said. The helicopter touched down hard, damaging the tail boom and fuselage. The pilot and the two medical crewmembers aboard the helicopter escaped injury, and no one on the ground was hurt.

Rotor Hits Parking Lot Lamppost

Sikorsky S-76B. Destroyed. Three minor injuries.

The pilot was transporting two passengers to Bettystown, Ireland, the afternoon of Sept. 18, 2008, for a business meeting with a hotel owner who had given the helicopter owner permission to land in the hotel parking lot. In a report issued in December, the Irish Air Accident Investigation Unit said that the parking lot was "unsuitable" for landing because it was small and located in a congested area.

As the helicopter neared the hotel, the pilot saw a car entering the parking lot, so he landed on a vacant public beach about 100 m (328 ft) away and shut down both engines. As the passengers disembarked, several sightseers began to approach the helicopter. The pilot decided to reposition the S-76 to the hotel parking lot.

While approaching the parking lot, the pilot established a hover momentarily to allow two people to exit the lot and then initiated a vertical descent to land. During the descent, the main rotor blades struck a metal lamppost. "The helicopter started to rotate violently and descended onto the top of a low wall [surrounding the parking lot]," the report said. "This wall tore out the bottom of the fuselage and ruptured the fuel tanks. … The escaping fuel fed the subsequent fire."

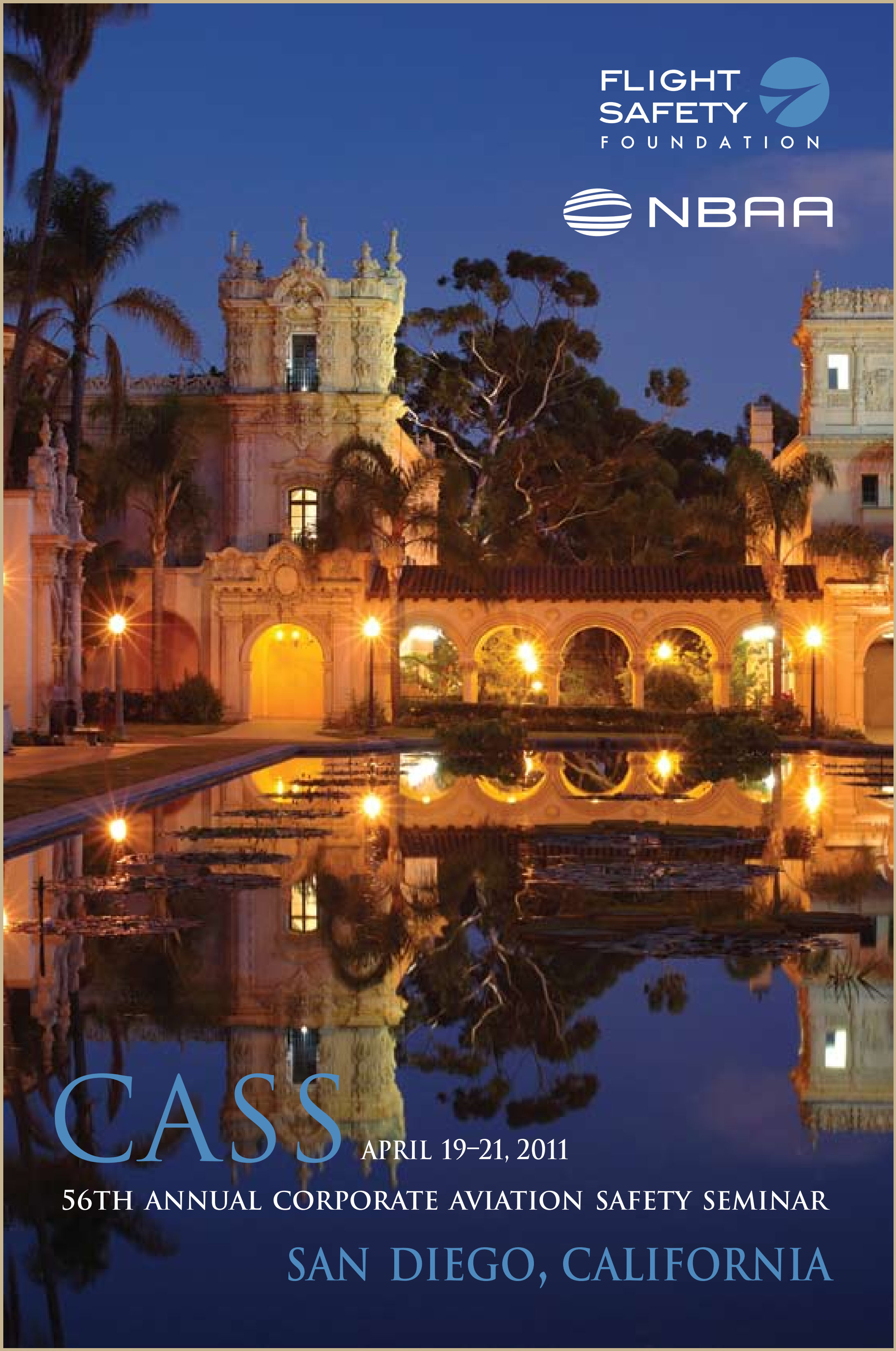
The pilot sustained minor injuries but was able to exit the helicopter before it was engulfed by fire. Debris from the impact caused minor injuries to two people on the ground and damage to several motor vehicles and buildings. The fire, which destroyed the helicopter, was extinguished by fire fighters.

Preliminary Reports, December 2010

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Dec. 1	Toledo, Ohio, U.S.	Cessna Citation 560XL	none	3 none
The Citation's rudder jammed during approach, but the airplane was landed without further incident. Ice was found around the rudder control cables and pulleys in the tail cone. An almost identical incident occurred in Birmingham, Alabama, on Dec. 13.				
Dec. 3	Pago Pago, American Samoa	Boeing 767	none	1 serious, 3 minor, 181 none
A flight attendant suffered a broken leg, and two flight attendants and a passenger sustained minor injuries when the 767 encountered clear air turbulence at 18,000 ft.				
Dec. 3	Maputo, Mozambique	Beech 1900C	destroyed	17 minor
The airplane struck the ground short of the runway during a night approach.				
Dec. 4	Moscow, Russia	Tupolev 154M	destroyed	2 fatal, 78 serious, 89 minor
The Tu-154 crashed during an emergency landing at the Domodedovo airport after all three engines failed on departure from the Vnukovo airport.				
Dec. 7	Mercantour National Park, France	Eurocopter AS 365N	destroyed	3 fatal
The helicopter crashed in thick fog in a ravine during a landslide inspection flight.				
Dec. 9	Bom Jesus do Galho City, Brazil	Beech B55 Baron	destroyed	4 fatal, 1 serious
The Baron crashed during a forced landing in mountainous terrain after an engine failed.				
Dec. 9	Cap-Chat, Quebec, Canada	Bell 206B	substantial	2 serious, 1 minor, 2 none
The helicopter crashed in low visibility on the shore of the St. Lawrence River during a survey flight.				
Dec. 10	Minneapolis, Minnesota, U.S.	Beech King Air 300	substantial	2 none
The King Air was landed without further incident after the cabin door separated during departure.				
Dec. 12	Londrina, Brazil	Beech King Air C90	destroyed	7 NA
No fatalities were reported when the airplane encountered wind shear on approach and crashed short of the runway.				
Dec. 13	Columbus, Ohio, U.S.	Piaggio P180 Avanti	none	4 none
The airplane was landed without further incident after the elevators jammed during approach. Ice was found around the elevator control cables in the fuselage bays.				
Dec. 14	Nassau, Bahamas	Beech 18	destroyed	2 fatal
Adverse weather conditions prevailed when the cargo airplane struck the ocean during approach.				
Dec. 14	Pokemouche, New Brunswick, Canada	Cessna 310R	destroyed	1 fatal
Strong winds and freezing rain prevailed when the 310 crashed near its destination during a positioning flight.				
Dec. 15	Palunge Hill, Nepal	de Havilland Twin Otter	destroyed	22 fatal
Low visibility was reported when the airplane struck the hill during a scheduled flight from Lamidanda to Kathmandu.				
Dec. 18	Sanikiluaq, Nunavut, Canada	Swearingen Metro II	substantial	3 none
The emergency medical services airplane veered off the runway while landing with a crosswind.				
Dec. 19	Samedan, Switzerland	Raytheon 390 Premier	destroyed	2 fatal
Marginal weather conditions prevailed when the airplane struck power lines and crashed on approach.				
Dec. 20	Mbeya City, Tanzania	Cessna U206F	substantial	1 fatal, 3 serious
The single-engine airplane crashed shortly after taking off for a charter flight.				
Dec. 20	Perris, California, U.S.	Aero Commander 680FL	destroyed	1 fatal
The airplane struck the top of a 2,500-ft mountain in IMC during a VFR flight from Palm Springs to Chino.				
Dec. 23	Camden, New South Wales, Australia	Piper Twin Comanche	substantial	2 minor
The airplane crashed during a training flight that apparently involved a simulated engine failure.				
Dec. 27	Columbus, Ohio, U.S.	Rockwell Commander 500B	destroyed	1 serious
The cargo airplane crashed after an engine failed on approach to Ohio State University Airport.				
Dec. 28	Krasny Oktyabr, Russia	Antonov 22A	destroyed	12 fatal
The military transport crashed out of control while returning to Tver after delivering a fighter to Voronezh.				
Dec. 29	Jackson Hole, Wyoming, U.S.	Boeing 757-200	none	181 none
Snow was falling when the 757 overran the runway on landing.				

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.


FLIGHT
SAFETY
FOUNDATION
NBAA
CASS APRIL 19–21, 2011
56TH ANNUAL CORPORATE AVIATION SAFETY SEMINAR
SAN DIEGO, CALIFORNIA