AeroSafety WORLD

SAFETY IMPROVES
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FATIGUE REVIEW
Measures, study and rules

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CHECKS MISSED WEIGHT MISTAKE

INPUT ERROR

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

FEBRUARY 2012


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Gathering Storm

A lot of people who read this column spend their days looking for the next safety threat to their airline, their flight, their maintenance shop or so on, focused on the micro level. I guess my contribution is to look for broader safety threats to the industry, a macro view. Let me see if I can describe such a threat that many may not see coming.

We got a glimpse of the gathering storm recently with the LightSquared debacle in the United States. This is a political disaster of epic proportions that I don't want to get in the middle of, but I'll try to summarize the situation. Basically, a really big company spent billions of dollars getting government approval to deploy a new wireless mobile broadband network in a frequency band near the global positioning system signal space. On paper, the company thought it worked, but when tested with existing receivers in the real world, it didn't. Politicians and lawyers probably will spend the next decade figuring out what went wrong and who pays.

This mess should remind us that the global aviation industry depends on telecommunications, and we are hanging onto a massive amount of incredibly valuable radio spectrum. It is almost impossible to conceive how valuable this spectrum is. But consider this possibility: The spectrum we hold may well be worth more than the value of the entire global aviation industry. I am talking trillions of dollars. Every time somebody creates a new broadband app, or a teenager runs up her phone bill texting, the value of that spectrum goes up. The LightSquared case serves as a warning. Our spectrum is becoming incredibly valuable, and at some point we will not be able to hang onto it.

Of course nobody wants aviation to go away. But patience is wearing thin. If we moved all of our avionics to a modern digital standard, we could have a better and safer system than we have today while likely using only a few percent of the spectrum band presently allocated to aviation. This is especially true for voice communication. The bad news is that efforts to move from analog to digital over the last few decades have been blocked by bickering countries, competing engineers and the next best idea. The U.S. NextGen and European SESAR programs re-inventing air traffic control technology would normally be the place to look for a solution, but right now those programs are struggling with massive budget cuts and fiscal uncertainty. Bold new digital standards and 20-year transition plans are not likely to be at the front of their agenda.

So there lies the safety threat that reaches beyond crowded airport frequency congestion. We are about a decade late starting transition to a new aviation communication digital standard that does not yet exist. To keep the system safe, the right technologies have to be identified and the transition carefully planned. Efforts to do that during better times have failed. If we are lucky, the global aviation industry may get one more chance to chart its own course through this transition. If we don't, the rest of the world, hungry for more frequencies, will force the change upon us; the economic cost of inaction will be unbearable.

To transition safely, we have to end the gridlock now. It would be a good time for somebody to lead.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafety WORLD

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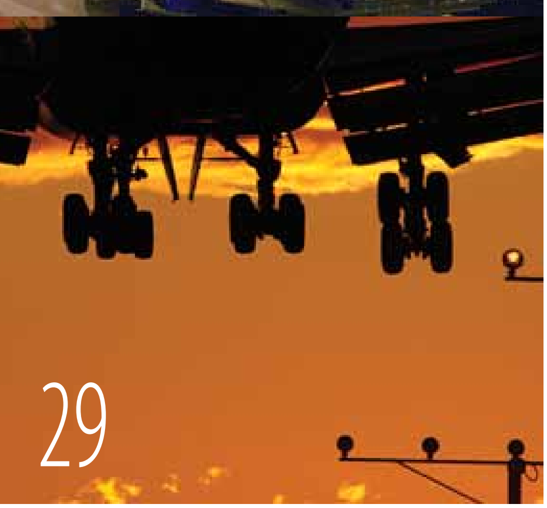

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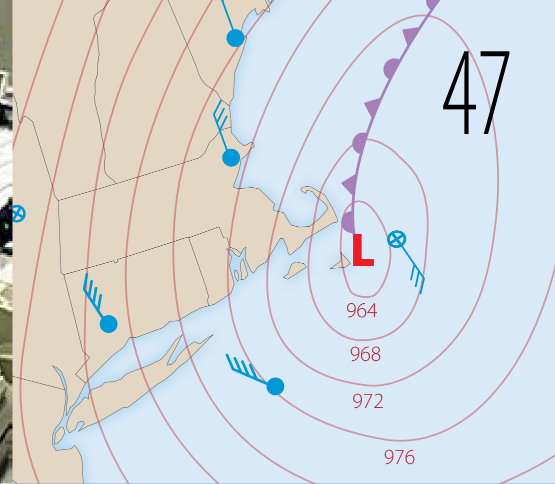

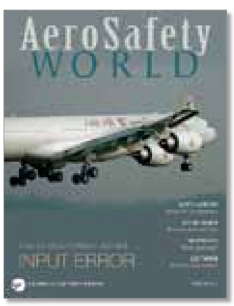

About the Cover
The crew of this Emirates A340-500 didn't catch the weight input error.
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Surprise!

Reining in government spending has become a political fixation in North America and Europe, with Europe engaging in, at times, draconian budget cutting. In the United States, the wisdom of further cutting government spending while the economy is struggling to regain its vigor is still a point of heated debate. However, while early returns from the European experience are not encouraging, that's not the point of this discussion.

What is the point is the stunning news from Capitol Hill in Washington that a deal has been crafted to fund the Federal Aviation Administration (FAA) for four full years, including development of the NextGen revolution of air traffic control (ATC). If you're not a close observer of politics, this might seem to be merely good news. But if you've been watching FAA operate for five years without a real budget — using 23 separate short-term continuations to stay in business, plus two weeks of partial shutdown — then this is a bombshell of immense proportions. The fact that this Congress, which has been straitjacketed by too many points of demagoguery to count, was able, to use a word much out of fashion in the United States of late, to *compromise* on numerous points of contention and get this done is truly mind-blowing.

This tremendous affirmation of the importance of a safe, efficient aviation system to the economic life of any nation points to the power of that reality. But not all nations see it the same way. This is often a problem in developing nations that can be overcome with dedication and wisdom, as Nigeria is demonstrating. But now some developed nations are lagging in providing proper funding. As Bill Voss pointed out in his recent column (*ASW*, 10/11, p. 1), there are signs that European nations have come to accept their very high level of safety as a constant that cannot be threatened by budget cutting or the lack of political will to move ahead with funded staffing hires.

To be honest, this column started life in my head as a rant against all nations that are starving their regulators and ATC system developments as part of an overall attack on spending, no matter what. Now the U.S. Congress, of all places, comes in with an unexpected boon to many in America — and outside, as FAA's impact reaches far beyond national borders.

Taking a major role in this funding breakthrough was Sen. Kay Bailey Hutchison (R-Texas), ranking minority member of the Senate Committee on Commerce, Science, and Transportation, who I first met more than a few years ago when she was Kay Bailey, acting chairman of the National Transportation Safety Board, showing how far the safety community can spread.

She said, "We are finally at a point where we're going to have four years of stability in this industry. It is a huge accomplishment. … NextGen can't be done in six months or one-year extensions. That is a huge technological advance for our air traffic control system to meet the standards for the rest of the world, and we need a satellite-based system. We would never be able to get a start on that without having this four-year [period] of stability, knowing it's going to be an ongoing process that is built in the proper way."

So, for a change, and happily, I take my hat off to the folks in a seat of government power for doing the right thing. Hurray!

Now, about these other folks…

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

Serving Aviation Safety Interests for More Than 60 Years

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

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Foundation Operations

It has been about 18 months since I came aboard the Foundation as executive vice president, and a day doesn't go by that I don't learn something new about what we have done or are about to do. Therefore, I approached Jay Donoghue, *AeroSafety World* (*ASW*) editor-in-chief, and asked him if it would be beneficial to publish in our magazine some of the Foundation's operations news. We agreed that our members and readers should know more about what the Foundation is doing and how it might relate to them.

To begin with, you need to know that we have a small but multi-talented staff. I would venture to say that you may not be aware that we have two locations of operation. Headquarters is in Alexandria, Virginia, U.S., with 18 full-timers and one contract staffer, and the other office is in Melbourne, Australia, with eight employees. The Alexandria office oversees the world operation and the production of *ASW*. The Melbourne office is responsible for the Basic Aviation Risk Standard program, referred to as BARS. That office reports to the chief operating officer — my new title — in Alexandria. Both sets of office staff wear many hats in order to make the Foundation operate as efficiently as possible.

The Foundation has many programs — some are ongoing and others are not. One ongoing program involves the annual safety seminars. There are officially, and presently, three. The biggest seminar is our International Air Safety Seminar, which will be held this year in Santiago, Chile, a location picked to help solidify Foundation safety efforts in the Latin American region. The next largest is our Corporate Aviation Safety Seminar, to be held this year in San Antonio. We also conduct the European Aviation Safety Seminar, being held this year in Dublin, Ireland. These three seminars provide our membership and other paid attendees a chance to hear top aviation professionals present cutting-edge safety information. Please take a look in this issue or on our website for the dates, locations and agendas. Besides your welcome dues contributions, the seminars contribute a large part of the revenue that maintains the Foundation. As we move forward, we continually will evaluate the effectiveness of the seminars through your feedback, and move to perhaps add others that we deem to be relevant and timely.

Our BARS program is now beginning its official third year in operation. I mentioned earlier that it is administered from our Australian office in Melbourne. The reason for that is the location of most of the clients it serves. BARS primarily provides an audit risk standard for the aviation operators that serve the mineral and mining industry. It is similar in structure to the International Air Transport Association Operational Safety Audit and now has 19 BARS member organizations. For more information, there will be regular news updates in this magazine and on the website.

These are just two of the several Foundation programs that provide a valuable safety service to the aviation industry as a whole. In the future editions of *ASW*, I will cover the other programs and how the Foundation operates — all appropriate topics for a COO to keep you informed about, don't you think?

Be Safe!

Capt. Kevin L. Hiatt
Chief Operating Officer
Flight Safety Foundation

FEB. 15–16 ➤ Training and Qualification Initiative Conference. International Air Transport Association and Royal Aeronautical Society. London. <www.iata.org/events/Pages/itqi.aspx>.

FEB. 27–28 ➤ Legal Liability and Criminalization of Post-Holders and Airline Managers Course. ALSTCO Aviation. Amsterdam Schiphol. <bit.ly/xOZSmc>.

FEB. 27–MARCH 2 ➤ Human Factors for Accident Investigators. Southern California Safety Institute. San Pedro, California, U.S. <registrar@scsi-inc.com>, <www.scsi-inc.com/HFAI.php>, 800.545.3766; +1 310.517.8844, ext. 104.

FEB. 28–29 ➤ Air Charter Safety Symposium. Air Charter Safety Foundation. Ashburn (near Dulles Airport), Virginia, U.S. <www.acsf.aero/symposium>, 888.723.3135.

FEB. 28 ➤ European Fatigue Risk Management Symposium. Flight Safety Foundation. Dublin, Ireland. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/eass>, +1 703.739.6700, ext. 101.

FEB. 29–MARCH 1 ➤ European Aviation Safety Seminar. Flight Safety Foundation, European Regions Airline Association and Eurocontrol. Dublin, Ireland. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/eass>, +1 703.739.6700, ext. 101.

MARCH 1–2 ➤ Overview of Aviation Safety Management Systems Training. ATC Vantage. Tampa, Florida, U.S. Theresa McCormick, <tmccormick@atcvantage.com>, <atcvantage.com/sms-workshop.html>, +1 727.410.4759.

MARCH 5–9 ➤ Helicopter Accident Investigation. Southern California Safety Institute. San Pedro, California, U.S. <registrar@scsi-inc.com>, <www.scsi-inc.com/HAI.php>, 800.545.3766; +1 310.517.8844, ext. 104.

MARCH 8–9 ➤ Global ATM Operations Conference. Civil Air Navigation Services Organisation. Amsterdam. Anouk Achterhuis, <events@canso.org>, <www.canso.org/events/globalatmoperationsconference 2012>, +31 (0) 23 568 5390.

MARCH 19–23 ➤ Aircraft Maintenance Investigation. Southern California Safety Institute. San Pedro, California, U.S. <registrar@scsi-inc.com>, <www.scsi-inc.com/AMI.php>, 800.545.3766; +1 310.517.8844, ext. 104.

MARCH 26–30 ➤ CRM Instructor's Course. Integrated Team Solutions. London Gatwick. <sales@aviationteamwork.com>, <bit.ly/w3AIYA>, +44 (0) 7000 240 240.

APRIL 3–6 ➤ AEA International Convention and Trade Show. Aircraft Electronics Association. Washington, D.C. <www.aea.net/convention/DC2012>, +1 816.347.8400.

APRIL 16–17 ➤ Emergency Response Planning Workshop. National Business Aviation Association and The VanAllen Group. San Antonio, Texas, U.S. Donna Raphael, <draphael@nbaa.org>, <bit.ly/yurqwz>, +1 202.478.7760.

APRIL 18–19 ➤ Corporate Aviation Safety Seminar. Flight Safety Foundation and the U.S. National Business Aviation Association. San Antonio, Texas, U.S. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/cass>, +1 703.739.6700, ext. 101.

APRIL 16–20 ➤ OSHA/Aviation Ground Safety Course. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, <case@erau.edu>, <bit.ly/wtWHIn>.

APRIL 23–27 ➤ Aviation Safety Program Management Course. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, <case@erau.edu>, <bit.ly/wtWHIn>.

APRIL 25 ➤ AViCON: Aviation Disaster Conference. RTI Forensics. New York. <www.rtiforensics.com/news-events/avicon>, +1 410.571.0712; +44 207 481 2150.

MAY 14–16 ➤ SMS Audit Procedures Course. Aerosolutions. Ottawa. <aerosolutions@rogers.com>, <bit.ly/wdrCOC>, +1 613.821.4454.

MAY 14–16 ➤ European Business Aviation Convention and Exhibition (EBACE). European Business Aviation Association and U.S. National Business Aviation Association. Geneva. Gabriel Destremaut, <gdestremaut@ebaa.org>, +32 2-766-0073; Donna Raphael, <draphael@nbaa.org>, +1 202.478.7760; <www.ebace.aero/2012>.

MAY 15–16 ➤ Third European Safety Management Symposium. Baines Simmons. London. <info@bainessimmons.com>, <bit.ly/ttot0B>, +44 (0)1276 855412.

MAY 20–22 ➤ FAA/AAAE Airfield Safety, Sign Systems and Maintenance Management Workshop. American Association of Airport Executives and U.S. Federal Aviation Administration. Houston. <AAAEMeetings@aaae.org>, <bit.ly/u5aSjh>.

JUNE 11–12 ➤ Flight Operations Manual Workshop: Employing IS-BAO. National Business Aviation Association. Chicago. Sarah Wolf, <swolf@nbaa.org>, <bit.ly/ye4ei9>, +1 202.783.9251.

JUNE 18 ➤ Implementing a Just Culture. Baines Simmons. Surrey, England. <info@bainessimmons.com>, <bit.ly/whV9l4>, +44 (0)1276 855412.

JULY 9–15 ➤ Farnborough International Airshow. Farnborough, England. <www.farnborough.com/airshow-2012>.

AUG. 13–16 ➤ Bird Strike Committee USA Meeting. Bird Strike Committee USA and American Association of Airport Executives. Memphis, Tennessee, U.S. Natalie Fleet, <natalie.fleet@aaae.org>, <events.aaae.org/sites/120701/index.cfm>, +1 703.824.0500, ext. 132.

AUG. 27–31 ➤ ISASI Annual Seminar. International Society of Air Safety Investigators. Baltimore, Maryland, U.S. Ann Schull, <isasi@erols.com>, <www.isasi.org/isasi2012.html#>, +1 703.430.9668.

OCT. 10–11 ➤ EASA Annual Safety Conference. European Aviation Safety Agency. Cologne, Germany. <bit.ly/y2HfJp>.

OCT. 22–24 ➤ SAFE Annual Symposium. SAFE Association. Reno, Nevada, U.S. Jeani Benton, <safe@peak.org>, <www.safeassociation.com>, +1 541.895.3012.

OCT. 23–25 ➤ International Air Safety Seminar. Flight Safety Foundation. Santiago, Chile. Namratha Apparao, <apparao@flightsafety.org>, <flightsafety.org/aviation-safety-seminars/iass>, +1 703.739.6700, ext. 101.

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

If you have a safety-related conference, seminar or meeting, we'll list it. Get the information to us early. 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.

Safety News

LightSquared Alleges 'Rigged' GPS Testing

© Evgeny Terentev/iStockphoto

LightSquared, a U.S. company preparing to launch a wireless mobile broadband network (*ASW*, 7–8/11, p. 26), has protested a Jan. 13 finding by nine federal departments and agencies. The National Space-Based Positioning, Navigation and Timing Executive Committee (PNT ExCom), after the government's November 2011 tests and analysis of further LightSquared modifications to the originally proposed network, says in part, "There appear to be no practical solutions or mitigations that would permit the LightSquared broadband service, as proposed, to operate in the next few months or years without significantly interfering with GPS. As a result, no additional testing is warranted at this time."

PNT ExCom had planned next to evaluate LightSquared's receiver-filtering solutions for mitigating interference with GPS high-precision and timing receivers, including those used in aviation and national security. Jeff Carlisle, the company's executive vice president for regulatory affairs and public policy, had said on Dec. 23, 2011, that its own early testing "shows that properly filtered high-precision GPS devices do not suffer any loss of accuracy in the presence of LightSquared's signals."

On Jan. 13, LightSquared charged that PNT had demonstrated "bias and inappropriate collusion with the private sector" and "systematic disregard for fairness and transparency," prompting the company to file a conflict of interest complaint with the National Aeronautics and Space Administration and to demand unbiased retesting. On Jan. 18, LightSquared added, in part, that the process used by U.S. Air Force Space Command to conduct testing for PNT ExCom was "rigged by manufacturers of GPS receivers and government end users to produce bogus results."

—Wayne Rosenkrans

A380 Wing Inspections

The European Aviation Safety Agency (EASA) says operators of 20 Airbus A380s must conduct detailed visual inspections of the airplanes' wings by early March to check for cracks.

According to Airworthiness Directive (AD) 2012–0013, published Jan. 20, the inspection requirement applies to airplanes that have completed more than 1,300 flights. Airplanes that have completed more than 1,800 flights were to be inspected "within four days of [Jan. 24, 2012]," EASA said.

The AD was issued after cracks were found during an unscheduled internal inspection of an A380 wing, EASA said, adding that subsequent inspections of other A380s revealed additional cracks involving rib feet within the wings.

Airbus has established repair procedures to be implemented if cracks are found during the inspections, EASA said.

The agency said it is continuing to review the matter and additional actions may be required.

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New Equipment

The Australian aviation industry will be given as long as five years to install new aircraft navigation systems — such as automatic dependent surveillance–broadcast and traffic-alert and collision avoidance system II — in existing aircraft, John McCormick, director of aviation safety for the Civil Aviation Safety Authority (CASA), says.

CASA is reviewing industry responses to its proposal for retrofitting existing aircraft with the equipment and plans to develop a notice of proposed rulemaking later this year to discuss exactly what will be required.

"For such significant equipage retrofits of existing aircraft … whenever possible, CASA will always endeavor to provide industry with a minimum period of four to five years from publication of a mandate to the compliance date," McCormick said.

He added that CASA will wait at least four years before ADS–B requirements are imposed on operators of visual flight rules aircraft in much of the country's airspace.

Category 2

Curaçao and Sint Maarten have received U.S. Federal Aviation Administration (FAA) Category 2 ratings, which signify that they do not comply with aviation safety standards established by the International Civil Aviation Organization (ICAO).

The Category 2 rating means that a country "either lacks laws or regulations necessary to oversee air carriers in accordance with minimum international standards, or that its civil aviation authority … is deficient in one or more areas, such as technical expertise, trained personnel, record keeping or inspection procedures," the FAA said.

Curaçao and Sint Maarten previously were part of the Netherlands Antilles, which had an FAA Category 1 rating, which signified that it had the laws and regulations required to oversee air carriers in accordance with ICAO standards.

Under the Category 2 rating, air carriers based in Curaçao and Sint Maarten will be permitted to continue existing service to the United States but may not establish new service.

FAA Faulted on Training Oversight


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U.S. Federal Aviation Administration (FAA) oversight of air carrier pilot training and proficiency programs "lacks the rigor needed to identify and track poor-performing pilots and address potential program risks," the U.S. Department of Transportation Office of Inspector General (OIG) says.

An OIG report criticizes the FAA for not providing sufficient training for its inspectors on how to evaluate the air carriers' basic training assessments. In addition, the report said that the FAA "does not provide sufficient oversight of check airmen, who perform the majority of proficiency checks on air carrier pilots."

The OIG also faulted the FAA for an information-request process that "hinders air carriers' ability" to obtain information maintained by the agency to aid in evaluating pilot competence and qualifications.

The report contained seven recommendations, and the FAA agreed, at least in part, with all seven. The recommendations included a call for the FAA to require its inspectors to "select a representative sample of air carrier proficiency and line check rides each year to analyze the results for trends and take action if needed, in accordance with FAA guidance."

The recommendations also said that the FAA should renew the authority of check airmen every two years "to increase accountability in the system," develop a standardized procedure for air carriers to use in reporting pilot failures of proficiency checks and implement standardized training for aviation safety inspectors on the administration of U.S. Federal Aviation Regulations Part 121 check rides and check airman observations.

EASA Sees Safety Improvement

Aviation safety worldwide recorded a "modest improvement" in 2011, the European Aviation Safety Agency (EASA) says.

EASA's preliminary safety data for 2011 indicated that the number of fatal accidents decreased to 45, down from 46 in 2010.

Wikimedia

The fatal accident in 2011 involved an aircraft from an EASA member state — the crash of a Fairchild Metro III in Cork, Ireland, in which six people were killed, EASA said. The single accident in 2011 followed a year without fatalities.

"Safety performance continues to show important regional differences," EASA said. "The region of non-EASA member states in Europe shows the highest number of fatalities with a total of 138. This is followed by the African region with 87 fatalities."

In Other News …

The Australian Civil Aviation Safety Authority has asked for public comment on proposed new rules for some types of **pilot training**, including multi-crew pilot license training, and contract training and checking for smaller airline operations. … Eurocontrol is marking the 10th anniversary of the **reduced vertical separation mimimum (RVSM)** program, first implemented in January 2002 over the North Atlantic. The decade-long implementation concluded in November 2011 in airspace above the Russian Federation and other Eurasian states.

Compiled and edited by Linda Werfelman.

Absence of Reasonableness

A 100-tonne takeoff weight error eluded several checks.

BY MARK LACAGNINA

The Airbus A340 was 100,000 kg (220,460 lb) heavier than the takeoff weight entered into its computers and did not respond to normal control pressure at the calculated rotation speed. When the first officer, the pilot flying, increased back pressure on the sidestick, the aircraft rotated but still was moving too slowly to lift off. The captain realized that something was not right and applied full power. The A340 finally became airborne after running off the runway and destroying several lights and localizer antennas. Damage was substantial, but there were no injuries.

During its investigation of the March 20, 2009, accident at Melbourne Airport, the Australian Transport Safety Bureau (ATSB) found similarities to several other recent occurrences in which flight crews apparently were unable to perform "reasonableness checks" that likely would have revealed gross errors in the data used for calculating takeoff performance parameters such as V-speeds and thrust settings (see InfoScan, p. 53).

"Equally significant was that the degraded takeoff performance [resulting from the gross errors] was generally not detected by the flight crews until well into the takeoff run, if at all," the bureau said.

The data-entry error that set up the accident at Melbourne led to calculations of a thrust

This A340 was substantially damaged in a tail strike and overrun at Melbourne Airport.

Australian Transport Safety Bureau

© Lars Hentschel/Airliners.net

setting and V-speeds that were too low. In its report on the accident, ATSB said that distractions and "the effect of expectation" rendered ineffective several subsequent checks and cross-checks of the takeoff weight and performance calculations. Further, the flight crew's ability to gauge the "reasonableness" of the calculations was found to have been affected in part by large variations in the size and performance of the aircraft that they routinely flew.

The report also cited the limited ability of humans to perceive acceleration, especially at night, as a significant factor in the crew's late recognition of the aircraft's relatively sluggish performance.

Ahead of Schedule

The aircraft was being operated as Emirates Flight EK407, with 257 passengers and 18 crewmembers bound for Dubai, United Arab Emirates (UAE). The flight had begun that morning in Auckland, New Zealand. The leg from Auckland to Melbourne had been flown by other members of the augmented flight crew. "The flight was several minutes ahead of schedule, and there were no time pressures affecting the flight crew," the report said.

Both pilots assigned to the leg from Melbourne to Dubai regularly flew the A330-243 and the A340-313K, as well as the accident aircraft, an A340-541 registered in the UAE as A6-ERG. The captain had 8,195 flight hours, including 1,372 hours in the A340-541. The first officer had 8,316 flight hours, including 425 hours in the -541.

"The pre-departure preparation included the use of an electronic flight bag laptop computer (EFB) to calculate the performance parameters (takeoff reference speeds and flap and engine settings) for the takeoff from Runway 16," the report said. Among the data required to be entered into the EFB were wind speed and direction, outside air temperature and takeoff weight (Figure 1, p. 14).

The loadsheet showed a takeoff weight of 361.9 tonnes. "So that flights were not unnecessarily delayed [due to last-minute changes such as late passenger arrivals], the operator permitted the flight crew to make minor alterations to the weight and balance information on the loadsheet without the need to issue a new loadsheet," the report said. Accordingly, the first officer added 1,000 kg (1 tonne, or 2,200 lb), the maximum alteration allowed by Emirates.

"When entering the takeoff weight into the EFB, however, the first officer inadvertently entered 262.9 tonnes, instead of the intended 362.9 tonnes, and did not notice that error," the report said. In human factors terminology, the data-entry error was a *slip*. "Most likely, the first officer made a typing slip, where the '2' key was accidently pressed instead of the adjacent '3' key," the report said.

The first officer transcribed the takeoff weight and calculated performance parameters from the EFB onto the master flight plan while discussing an apparently confusing aspect of an assigned departure procedure with the captain. The weight error again went unnoticed.

The first officer then handed the EFB to the captain, so that he could check the data per standard operating procedure (SOP). "There was a lot of activity in the cockpit at that time, and it is likely that the associated distractions degraded the captain's checks," the report said, noting that there were several people in the cockpit and in the forward galley area, including maintenance technicians, flight attendants and the other members of the augmented flight crew.

The captain might have been further distracted from a thorough check of the EFB data by the first officer's radio communication with air traffic control (ATC) regarding the departure clearance, and thus another opportunity to detect the erroneous takeoff weight was lost, the report said.

Company SOP did not require available non-operational flight crewmembers to check performance calculations. “Although not required by the operator’s procedures, had the augmenting captain had the opportunity to perform his own check of the takeoff performance calculations, he may have detected the takeoff weight entry error,” the report said.

‘Just Numbers’

The inadvertent entry of 262.9 tonnes into the EFB had yielded calculations of 143 kt for V_1, which the report defined as “decision speed,” and 145 kt for V_R, rotation speed. (The correct speeds for the actual takeoff weight, 362.9 tonnes, were 149 kt and 161 kt, respectively.)

Based on the incorrect takeoff weight, the EFB also provided a flex temperature — an assumed temperature used in calculations for a reduced-thrust takeoff — of 74 degrees C. (The correct temperature was 43 degrees C.)

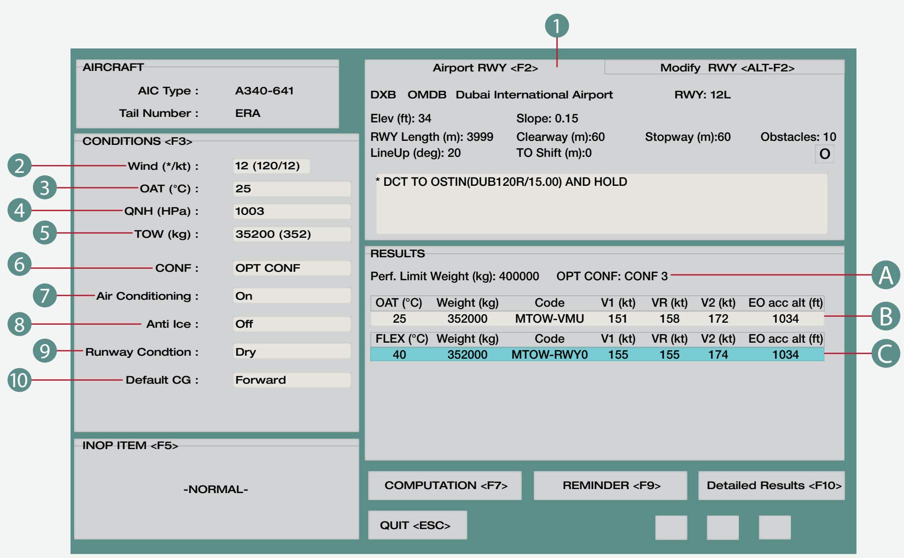
The first officer later told investigators that the flex temperature calculated by the EFB “looked high” and that he intended to check it. However, he “became distracted by other tasks and believed that subsequent checks would detect whether the figure was inaccurate,” the report said.

The captain entered the EFB performance figures into the aircraft’s flight management guidance system (FMGS) and began a silent check of the data. However, “while completing this check, he became distracted by other tasks and activities in the cockpit,” the report said. “This diverted his attention away from checking the EFB for a short period.”

The captain momentarily engaged in a discussion with the first officer about the departure clearance and in a nonpertinent conversation with another person in the cockpit. The pilots then verbally cross-checked the takeoff performance calculations that had been entered by the captain into the FMGS against those that the first officer had recorded on the master flight plan. They did not realize that both sets of figures were based on an incorrect takeoff weight.

Except for the first officer’s momentary concern about the flex temperature, the calculations did

EFB Takeoff Performance Screen (example)



1. Desired runway
2. Wind speed and direction
3. Outside air temperature
4. Altimeter setting
5. Proposed takeoff weight
6. Flap configuration
7. Air conditioning status
8. Anti-ice selection
9. Runway surface conditions
10. Aircraft center of gravity position

EFB = electronic flight bag

Note: Selection of the COMPUTATION button calculated the takeoff performance data and displayed (A) performance-limited takeoff weight and optimum flap configuration for the selected runway and entered conditions; (B) takeoff speeds and the engine-out acceleration altitude for the proposed takeoff weight using full takeoff thrust at the actual outside air temperature; and (C) takeoff speeds and engine-out acceleration altitude for the proposed takeoff weight using less than full takeoff thrust based on a computed flex takeoff thrust temperature value.

Source: Australian Transport Safety Bureau

Figure 1

not seem unreasonable to the crew. They were accustomed to seeing takeoff reference speeds that varied by up to 50 kt in the aircraft they flew: the A340-541, with a maximum takeoff weight of 372 tonnes; the A340-313K, 275 tonnes; and the A330-243, 230 tonnes. The takeoff weights of the aircraft that the crew had flown in the two months preceding the accident had ranged from 150 to 370 tonnes.

"The flight crew reported observing a wide range of takeoff performance parameters during normal operations, as well as significant variations in passenger loads across routes and aircraft types," the report said. "Both the captain and the first officer reported that this resulted in the takeoff performance figures losing significance and becoming 'just numbers.'"

Tail Strike

Visibility was greater than 10 km (6 mi) and there were no clouds below 5,000 ft when the crew began the takeoff from Runway 16 at 2230 local time. The pilots recalled that the takeoff seemed normal until the aircraft was 1,043 m (3,422 ft) from the departure end of the 3,657-m (11,999-ft) runway and the captain called "rotate."

"The first officer, who was the pilot flying, applied a back-stick (nose up) command to the sidestick, but the nose of the aircraft did not rise as expected," the report said. "The captain again called 'rotate,' and the first officer applied a greater back-stick command. The nose began to rise, but the aircraft did not lift off from the runway."

The A340 was 57 m (187 ft) from the end of the runway when the captain applied takeoff/go-around (TO/GA) thrust. The aircraft was accelerating through 157 kt as it overran the runway, the 120-m (394-ft) clearway and the 60-m (197-ft) stopway.

"The aircraft became airborne three seconds after the selection of TO/GA, but before gaining altitude it struck a Runway 34 lead-in sequence strobe light and several antennas, which disabled the instrument landing system for Runway 16," the report said, noting that the outcome might have been far more serious if the captain had not applied full thrust.

A cockpit annunciator and a radio call from ATC alerted the crew that a tail strike had occurred. The captain declared an urgency and coordinated with ATC to jettison fuel before returning to the airport. When the crew retrieved the EFB to make landing performance calculations, they noticed the 100-tonne takeoff weight error.

The A340 was landed on Runway 34 at 2336 and, after a brief inspection by aircraft rescue and fire fighting personnel, was taxied to the terminal, where the passengers disembarked normally. Examination of the aircraft revealed severe abrasion of skin panels on the bottom of the rear fuselage, deformation of fuselage frames and stringers in the area, and a cracked rear pressure bulkhead.

Gauging Acceleration

The flight crew told investigators that they had perceived the aircraft's acceleration during the takeoff roll as typical of a heavy A340. "They did not realize that there was a problem with the aircraft's acceleration until they had nearly reached the end of the runway and the red runway end lights became more prominent," the report said. "Both [pilots] reported that during operations from some runways at other airports, it was common to see the red runway end lights as the aircraft lifted off."

Performance certification standards and takeoff performance calculations *assume* that an aircraft will accelerate sufficiently, the report said. Over the years, several attempts to develop cockpit takeoff performance monitoring systems have been abandoned due to the complexity of the systems and the excess workload they would impose on the flight crew.

"At the time of the accident, there was no means available to the flight crew to monitor the performance of the aircraft during the takeoff roll," the report said. "The safety of the takeoff relied on the accuracy of the takeoff performance calculations and on the flight crew detecting any degraded performance during the takeoff roll."

Lacking a quantitative method of measuring acceleration, pilots must rely on previous experience to judge an aircraft's takeoff performance, the report said. "A human's ability to determine acceleration is neither an accurate nor reliable means to assess takeoff performance. Furthermore, that accuracy and reliability are further degraded in darkness."

During the accident investigation, ATSB queried the European Aviation Safety Agency (EASA) and the U.S. Federal Aviation Administration (FAA) on progress toward the development of takeoff performance monitoring systems. EASA replied that it is cooperating with the European Organisation for Civil Aviation Equipment on reviewing "state of the art options" that might lead to the establishment of standards for developing such systems. The FAA said that although it had found the idea of such systems "with all their inherent complexity to be more problematical than reliance on adequate airmanship," it nevertheless "would be happy … to revisit the issue in the light of new information or ideas."

This article is based on ATSB Transport Safety Report AO-2009-012, "Tailstrike and Runway Overrun; Melbourne Airport, Victoria; 20 March 2009; A6-ERG, Airbus A340-541," Dec. 16, 2011. The report is available at <atsb.gov.au>.

The FAA issues a long-awaited fatigue-fighting rule, and cargo pilots challenge their exclusion.

REGULATING Rest

BY LINDA WERFELMAN

Flight and rest requirements for U.S. commercial passenger airline pilots — issued by the U.S. Federal Aviation Administration (FAA) in January, after a development process that lasted several years — are facing a court challenge by cargo pilots who want to be included among those covered by the new rule.

Those pilots should not be denied the protections of the new requirements, which call for, among other things, longer rest periods before reporting for work (see "Specifics," p. 18), the Independent Pilots Association (IPA), which represents more than 2,600 UPS pilots, said in papers filed with a federal appeals court.

The new scheduling requirements — published as a final rule in January in the U.S. *Federal Register* — will take effect in January 2014. The IPA court action does not seek to delay their implementation for pilots of passenger airliners.

Publication of the final rule capped a rule-making process that had begun in 2009 — about 15 years after a previous rule-making effort had collapsed, largely because of airline opposition to the projected costs, as well as what the industry said was insufficient supporting data.

Transportation Secretary Ray LaHood said the new rule represents "a major safety achievement," adding, "We made a promise to the traveling public that we would do everything possible to make sure pilots are rested when they get in the cockpit. This new rule raises the safety bar to prevent fatigue."

Acting FAA Administrator Michael Huerta added, "Every pilot has a personal responsibility to arrive at work fit for duty. This new rule gives pilots enough time to get the rest they really need to safely get passengers to their destinations."

The rule specifies that commercial passenger airline pilots must have a 10-hour minimum rest period before they report for duty — two hours longer than currently required — to provide them with an opportunity for eight hours of uninterrupted sleep. Flight time will be limited to either eight or nine hours, and duty time will be limited to between nine and 14 hours, depending on the pilot's starting time and other factors.

The rule says, "The FAA believes that its current regulations do not adequately address the risk of fatigue. The impact of this risk is greater in passenger operations due to the number of persons placed at risk. Presently, flight crewmembers are effectively allowed to work up to 16 hours a day (regardless of the time of day), with all of that time spent on tasks directly related to aircraft operations. The regulatory requirement for nine hours of rest is regularly reduced, with flight crewmembers spending rest time traveling to or from hotels and being provided with little to no time to decompress."

Deborah Hersman, chairman of the U.S. National Transportation Safety Board (NTSB), characterized the final

Cargo pilots will be covered by the new flight and rest requirements only if cargo operators voluntarily comply.

rule as a "huge improvement" over current regulations — many of which have been in place since the 1960s and which have been targeted by the NTSB for revision since 1990.

Nevertheless, she expressed disappointment that the rule would apply only to commercial passenger airline pilots — those operating under U.S. Federal Aviation Regulations Part 121 — and not to pilots of smaller commercial airplanes or cargo airplanes. Although the final rule did not cover those operations, generally regulated under Part 135, the FAA has said that those pilots and operators should expect the FAA to propose a similar rule to cover the Part 135 community.

"A tired pilot is a tired pilot, whether there are 10 paying customers on board or 100, whether the payload is passengers or pallets," Hersman said.

IPA President Robert Travis agreed, adding, "To potentially allow fatigued cargo pilots to share the same skies with properly rested passenger pilots creates an unnecessary threat to public safety. We can do better."

The FAA, however, said that the cost of including cargo operators under the new rule would have been too great, compared with the benefits they likely would have received. In addition, some cargo airlines have improved rest facilities for pilots while cargo is being loaded and unloaded,

Specifics

Many requirements of the U.S. Federal Aviation Administration's final rule on pilot fatigue vary, depending on such factors as when a pilot's workday begins and the number of flight segments he or she is scheduled to fly.

Maximum flight time limits are eight hours if the pilot reports for duty between 2000 and 0459 local time or nine hours if he or she begins work between 0500 and 1959.

Flight duty period limits for single-crew operations range from nine hours to 14 hours. The nine-hour limit, for example, applies to pilots who report for duty between 0000 and 0359, regardless of how many flight segments they fly, and to those who report later in the day and fly four segments or more. The 14-hour limit applies to those who report between 0700 and 1159 for no more than two flight segments (Table 1).

For augmented operations involving more than two pilots, the maximum flight duty period increases, depending on the exact number of pilots in the flight crew, the type of in-flight rest facilities available to them and their scheduled starting time (Table 2). The maximum allowable flight duty period is 19 hours — for pilots in four-pilot crews who have access to Class 1 rest facilities[1] and who report for duty between 0700 and 1259 acclimated time.[2]

The rule also establishes flight time limits of no more than 100 hours in "any 672 consecutive hours" — 28 days — and no more than 1,000 hours in any 365 consecutive days.

Flight duty periods may be no longer than 60 hours of any 168 consecutive hours — seven days — or 190 hours of any 672 consecutive hours.

—LW

Maximum Flight Duty Period for Unaugmented Operations[1]

Scheduled Time of Start (Acclimated[2] Time)	Maximum Flight Duty Period (hours) For Pilots Based on Number of Flight Segments						
	1	2	3	4	5	6	7+
0000–0359	9	9	9	9	9	9	9
0400–0459	10	10	10	10	9	9	9
0500–0559	12	12	12	12	11.5	11	10.5
0600–0659	13	13	12	12	11.5	11	10.5
0700–1159	14	14	13	13	12.5	12	11.5
1200–1259	13	13	13	13	12.5	12	11.5
1300–1659	12	12	12	12	11.5	11	10.5
1700–2159	12	12	11	11	10	9	9
2200–2259	11	11	10	10	9	9	9
2300–2359	10	10	10	9	9	9	9

Notes

1. Unaugmented operations are flights in which no reserve flight crew is required.
2. "Acclimated" is defined in the rule as "a condition in which a flight crewmember has been in a [specific area] for 72 hours or has been given at least 36 consecutive hours free from duty."

Source: U.S. Federal Aviation Administration

Table 1

Maximum Flight Duty Periods for Augmented Flight Crews[1]

Scheduled Time of Start (Acclimated Time)	Maximum Flight Duty Period (hours) Based on Rest Facility and Number of Pilots					
	Class 1[2] Rest Facility		Class 2[2] Rest Facility		Class 3[2] Rest Facility	
	3 Pilots	4 Pilots	3 Pilots	4 Pilots	3 Pilots	4 Pilots
0000–0559	15	17	14	15.5	13	13.5
0600–0659	16	18.5	15	16.5	14	14.5
0700–1259	17	19	16.5	18	15	15.5
1300–1659	16	18.5	15	16.5	15	14.5
1700–2359	15	17	14	15.5	13	13.5

Notes

1. An augmented flight crew is a crew with more than the minimum number of flight crewmembers required to operate the aircraft.
2. A Class 1 rest facility is defined in the rule as a "bunk or other surface that allows for a flat sleeping position and is located separate from both the flight deck and passenger cabin in an area that is temperature-controlled, allows the flight crewmember to control light and provides isolation from noise and disturbance." A Class 2 facility is an aircraft cabin seat "that allows for a flat or near-flat sleeping position, is separated from passengers by a minimum of a curtain to provide darkness and some sound mitigation and is reasonably free from disturbance by passengers or flight crewmembers." A Class 3 facility is a seat in the cabin or flight deck that "reclines at least 40 degrees and provides leg and foot support."

Source: U.S. Federal Aviation Administration

Table 2

Notes

1. The final rule defines a Class 1 rest facility as "a bunk or other surface that allows for a flat sleeping position and is located separate from both the flight deck and passenger cabin in an area that is temperature-controlled, allows the flight crewmember to control light, and provides isolation from noise and disturbance."
2. The final rule defines "acclimated" as "a condition in which a flight crewmember has been in a [specific area] for 72 hours or has been given at least 36 consecutive hours free from duty."

the FAA said. Nevertheless, the agency said that it "encourages cargo operators to opt in to the new rule voluntarily, which would require them to comply with all of its provisions."

Travis questioned whether cargo operators would voluntarily comply with the rule.

"Giving air cargo carriers the choice to opt in to new pilot rest rules makes as much sense as allowing truckers to opt out of drunk driving laws," he said.

The IPA's court challenge argued that cargo operations should be subject to the same fatigue-fighting requirements as commercial passenger airlines.

"The internal inconsistency of the final rule is remarkable," said IPA General Counsel William Trent. "For example, the FAA states that current regulations do not adequately address the risk of fatigue and that the maintenance of the status quo presents an 'unacceptably high aviation accident risk.' Yet two of the very factors that the FAA cites as exacerbating the risk of pilot fatigue — operating at night and crossing multiple time zones — are more present in cargo operations than in passenger operations."

The FedEx Master Executive Council, the FedEx branch of the Air Line Pilots Association, International (ALPA), called issuance of the rule a "political failure" and complained that it "completely ignores the safety of cargo pilots."

ALPA, which represents more than 53,000 pilots at 37 airlines in the United States and Canada, expressed disappointment that the rule would not apply to cargo operations but nevertheless praised its requirements. ALPA President Lee Moak said publication of the final rule "marks historic progress in what must be an unrelenting commitment to ensuring the highest safety standards throughout the airline industry."

Moak noted that ALPA has campaigned for decades in favor of regulations that are "based on modern science; apply equally to all types of airline operations, including domestic, international and supplemental; and enable air carriers to establish fatigue risk management systems."

He added that ALPA will continue to press for "one level of safety for all types of flight operations and across the airline industry."

Steve Chase, president of the Southwest Airlines Pilots' Association, agreed, calling the rule "a step in the right direction," although it "misses the mark on one level of safety."

"Cargo pilots are no less susceptible to fatigue than passenger pilots," Chase said. "It is our hope that lawmakers will reconsider the cargo carrier exemption."

The FAA says officials considered recent developments in fatigue science in establishing new requirements for pilot flight time, duty time and rest. Among the considerations were "the time of day pilots begin their first flight, the number of scheduled flight segments and the number of time zones they cross," the FAA said.

The previous requirements, the FAA said, "were not necessarily consistent across different types of passenger flights and did not take into account factors such as start time and time zone crossings."

Those factors and others must be considered in determining the allowable length of a flight duty period, which varies from nine to 14 hours for single-crew operations, and the allowable flight time of eight or nine hours.

In addition to the requirement for at least 10 hours of rest before beginning a flight duty period, other requirements provide for at least 30 consecutive hours off duty every week, an increase of 25 percent over the previous requirement.

The required rest time must be increased to at least 56 hours — including at least three nights' rest — if a pilot "travels more than 60 degrees longitude during a flight duty period or a series of flight duty periods that require him or her to be away from home base for more than 168 consecutive hours," the rule says.

The FAA said that it "expects pilots and airlines to take joint responsibility when considering if a pilot is fit for duty, including fatigue resulting from pre-duty activities such as commuting." If a pilot reports being fatigued or "unfit for duty" at the beginning of a flight segment, "the airline must remove that pilot from duty immediately," the FAA said.

Another provision of the rule says an airline may develop a different program for managing pilot fatigue by implementing a fatigue risk management system — a scientific, data-based method of evaluating fatigue that must be "validated by the FAA and continuously monitored," the agency said.

Fatigue risk management includes educating pilots and airline management on the effects of fatigue, which can be caused not only by overwork but also by commuting long distances to report for duty.

Training will be provided every two years on the impact of sleep — or lack of sleep — on pilot performance and on methods of mitigating fatigue. Training topics will include the effects of lifestyle — including nutrition, exercise, family issues, sleep disorders and commuting — on fatigue.

The FAA estimated that the U.S. aviation industry would spend $297 million to implement the rule and that it would result in benefits to the industry of between $247 million and $470 million.

BY SIMON BENNETT

Reporting Climate

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For a fatigue risk management system (FRMS) to work effectively, the host airline must develop a strong safety reporting climate, according to a report published by the International Civil Aviation Organization (ICAO).[1] In a paper describing their own research, Michelle Harper and Robert Helmreich explain "reporting climate" as "a component of safety climate that is characterized by the beliefs and attitudes that operators hold towards the reporting of their own errors and the behaviors that characterize the use of reporting systems."[2]

The ICAO report says, "Both SMS [safety management systems] and FRMS rely on the concept of an 'effective safety reporting climate,' where personnel have been trained, and are constantly encouraged, to report hazards whenever observed in the operating environment." This advice is repeated throughout the document.

The consequences of operating an FRMS in the context of a deficient or nonexistent safety reporting climate are potentially catastrophic. An FRMS is an example of a single-loop control system. In a single-loop control system, data (feedback) are used to regulate and optimize. A heater-thermostat combination is an example of a single-loop control system: By monitoring the physical environment, the thermostat generates control inputs. Acting as the interface between the heater and its physical environment, the thermostat ensures that the system operates within an acceptable, pre-programmed, range.

As with home heating, so too with rostering: Fatigue and incident reports, debriefings, sleep logs, Samn-Perelli scores,[3] reaction time tests and actigraphy traces[4] generate the data required to validate and optimize flight crew rosters, such that a balance is maintained between resource utilization, or economic performance, and fatigue, or safety performance. By mediating the relationship between rostering and the operating environment, fatigue data analysis — the cornerstone of an FRMS — ensures the system operates within acceptable parameters, synthesized from national and international regulations, productivity agreements and the scientific literature.

As mentioned above, problems arise when feedback is stymied. In 2010–2011, the author investigated the pilot lifestyle.[5] The research, funded by the British Air Line Pilots' Association, generated interview data, 433 questionnaire returns and more than 130 sleep logs (SLOGs), most of which ran to several thousand words (*ASW*, 10/11, p. 47). The data showed that some pilots preferred to report sick rather than admit to being fatigued.

'You can work to the rules and still be very, very fatigued.'

Typical comments were these:

- "We tend to position home after early shifts, making our days 12 hours long on average. I have called in sick numerous times, simply because I felt the company's response to 'I am fatigued' would be harmful to my career."
- "My fatigue report has been rejected. The only way to do it is to go sick. It saves a call from the management."
- "On these runs of five earlies, particularly on days four and five, you are absolutely buggered. But because it happens all the time, you get used to the fact that that is how you feel. So you turn up anyway. If you don't, you get snotty emails. You get pulled into the office. People get disciplined for being off sick. They have even started saying that people use 'fatigue' far too often. So one of the few things we can say without being questioned is now being questioned, because they think we say it too often."
- "You can work to the rules and still be very, very fatigued. Airlines are now working you right up to the very limit of the rules. My airline is quite good. If I say I am fatigued, they won't question it. Not all airlines are like that. They say if it's legal, you have to come to work, despite being fatigued. There was no system for reporting fatigue at my previous airline. It was either report sick, or go to work."
- "I had two days of the simulator with a CAA [U.K. Civil Aviation Authority] inspector in the right seat who told me I looked absolutely exhausted, and that I should go sick for my next trip! It took someone *that* senior to tell me to do it or I might still have gone to work (stupid, I know!)."
- "[I have refused a duty] only once, when due to do a four-sector day starting at 0615. I had trouble sleeping and was still wide awake at 0300. It was recorded by the company as sickness."

A reluctance to report fatigue is not peculiar to Europe-based pilots, as noted in this report by the U.S. National Transportation Safety Board (NTSB):

- "Some of the air carrier pilots reported using [fatigue risk management programs] successfully, whereas other pilots reported that they hesitated to use such programs because of fear of retribution. … In addition, other pilots reported that they attempted to call in as fatigued but encountered company resistance."[6]

Without data, rosters cannot be certified as safe. The possibility then arises that unsafe rosters permeate airline operations. Unsafe rosters may be thought of as latent errors or resident pathogens — "bugs," if you like. Under certain conditions, such bugs may cause or contribute to incidents or accidents: Latency becomes active. The problem is compounded by the fact that it is impossible to predict the conditions for activation. Given these facts, it is best to minimize the possibility of unsafe rosters at the outset ... by ensuring that fatigue is *unfailingly* and *accurately* reported. To invoke the heater-thermostat metaphor, one must ensure that the thermostat is *fully functional and correctly calibrated at all times*.

On the face of it there is a simple answer to the problem of non-reporting or masking

— reporting climate surveys. Harper and Helmreich argue that a reporting climate is influenced by five factors:[7]

- Perceptions of agency — "The degree to which a person sees a reporting system as a viable place to create change will be a strong determinant of the organization's reporting rate."
- Protections — "Those reporting systems that offer higher levels of protection [from disciplinary action and litigation] will benefit from higher reporting rates."
- Employee confidence in management's commitment to safety — The greater the employees' confidence in management's commitment to safety, the higher the reporting rate.
- Ease of use —The more user-friendly the reporting system(s), the higher the reporting rate.
- Notions of personal responsibility — "Operators [in this case, pilots] with stronger opinions of personal responsibility will be more likely to use a reporting system."

A reporting climate questionnaire should evaluate *at least* the five dimensions listed above. The questionnaire should quantify masking and non-reporting. Explanations should also be sought from pilots via questionnaire and/or interview. The questionnaire should be anonymous and issued to all pilots, including management pilots. Approval of an airline's FRMS should be conditional upon the successful completion of regular reporting climate surveys, and, if required, of remedial action.

Reporting climate surveys are problematic. Survey response may be influenced by several factors, including the perceived credibility of those conducting the survey. In recent years, there has been a move toward "light touch" regulation, with those regulated bearing a greater responsibility for performance monitoring and remedial strategies.[8] While self-assessment is attractive on financial grounds, because the logistical burden is passed to those regulated, self-assessments may be considered less credible than assessments conducted by third parties. Even if an airline's assessment is demonstrably objective, it is still possible the assessment will be viewed as biased in favor of commercial interests. Perceptions of bias may reduce participation levels to the point where the survey lacks credibility. To eliminate this risk, the reporting climate survey *must* be administered by a disinterested third party.

To summarize: Fatigue risk management systems work only if there is a sufficiency of data. For there to be a sufficiency of data, pilots must *unfailingly* report fatigue episodes. Non-reporting or masking undermine fatigue risk management systems because the data required to validate rosters are lost. Non-validated rosters represent latent errors or resident pathogens within flight operations. When unpropitious circumstances accumulate to the point where system defenses are breached, such errors may become active ("live") with possibly catastrophic results. Given the potential consequences of non-reporting or masking, the approval or re-approval of an airline's FRMS *must* include a reporting climate survey administered by a disinterested third party. If the regulator is perceived to be too close to the airline's management, the survey must be administered by another party — for example, by a consultancy or university familiar with reporting climate surveys.

Simon Bennett, director of the University of Leicester's Civil Safety and Security Unit, has a doctorate in the sociology of scientific knowledge. He has been a consultant to the airline industry for more than a decade.

Notes

1. ICAO, International Air Transport Association and International Federation of Air Line Pilots' Associations. *Fatigue Risk Management Systems — Implementation Guide for Operators.* Montreal: ICAO, 2011.
2. Harper, M.L.; Helmreich, R.L. "Creating and Maintaining a Reporting Climate." In *Proceedings of the 12th International Symposium on Aviation Psychology*. Dayton, Ohio: Ohio State University, 2003.
3. The subjective Samn-Perelli checklist measures fatigue on a seven-point scale.
4. An actigraph is a small device worn on the wrist that contains an accelerometer to measure movement and a memory chip to store "activity counts" at regular intervals such as every minute.
5. Bennett, S.A. *The Pilot Lifestyle: A Sociological Study of the Commercial Pilot's Work and Home Life*. Leicester, England: Vaughan College, University of Leicester, 2011.
6. U.S. National Transportation Safety Board. *Runway Overrun During Landing, Shuttle America Inc., Doing Business as Delta Connection Flight 6448, Embraer ERJ-170, N862RW, Cleveland, Ohio, February 18, 2007*. Washington, D.C.: NTSB.
7. Harper and Helmreich, *op. cit.*
8. According to the *Safety and Health Practitioner*, the U.K. government's Transforming Regulatory Enforcement program involves "a review of all regulators … to make sure each one is making the fullest possible use of alternatives to conventional enforcement methods." *Safety and Health Practitioner*, December 7, 2011. <www.shponline.co.uk>.

BARS

BASIC AVIATION RISK STANDARD

FLIGHT SAFETY FOUNDATION

UPDATE

Greg Marshall,
BARS Program Managing Director

Since the first Basic Aviation Risk Standard (BARS) audit was conducted in December 2010, some 116 aircraft operators from across the globe have either completed a BARS audit or are about to have one.

A number of developments took place at the end of 2011, as Mincor Resources, Barrick Gold and International SOS joined the program as BARS member organizations.

Our second audit review and technical advisory committee meetings were held in Singapore in November, coinciding with Flight Safety Foundation's 64th annual International Air Safety Seminar, and were attended by representatives from each of the audit companies.

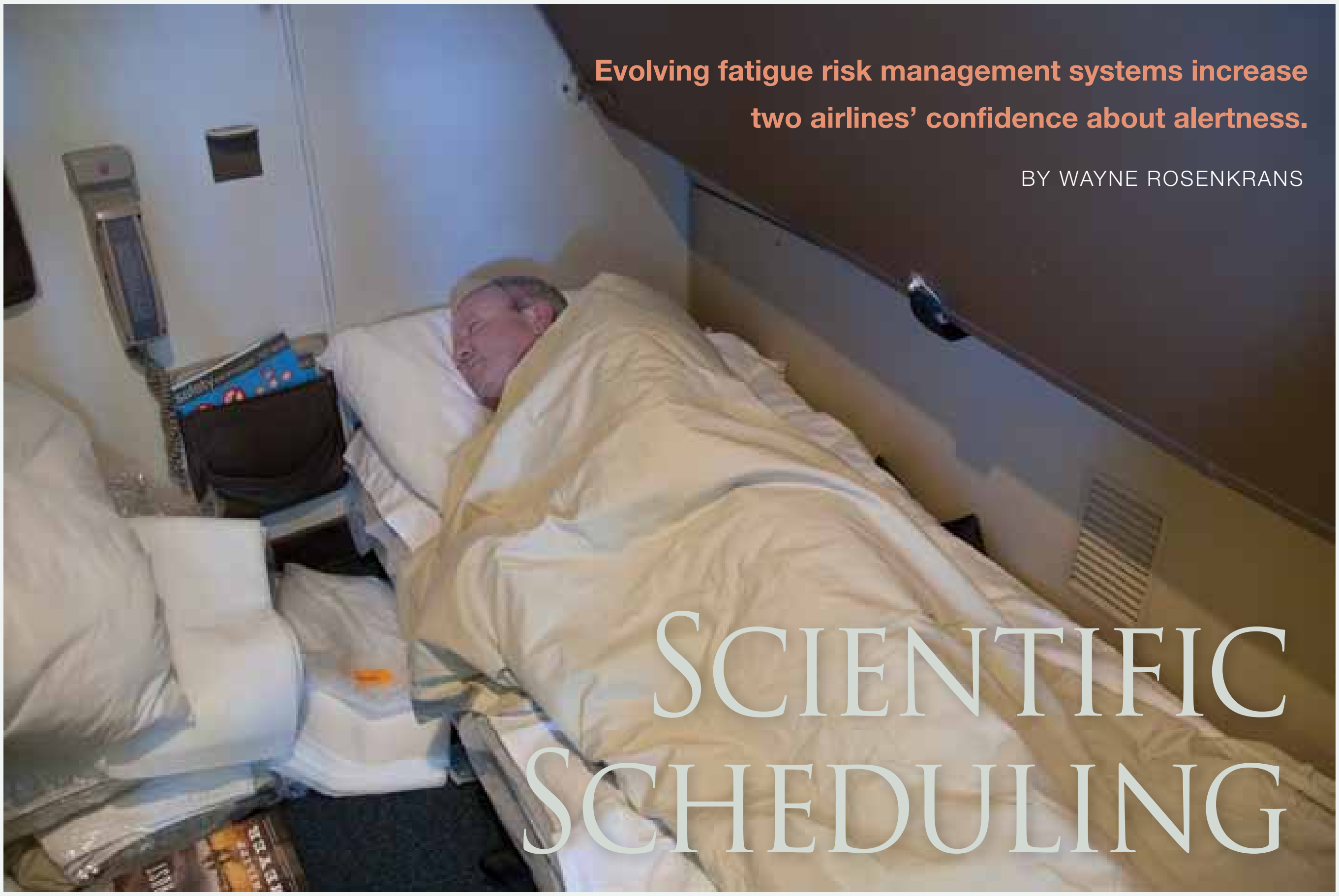
The audit review meetings are held twice a year to evaluate the conduct and outcome of audits as part of continual program improvement. Discussions covered subjects such as defining and describing the audit scope; development of an initial audit summary; timelines in support of audit preparation; quality control of audit reports; BARS auditor training; and the BARS Quality Assurance program. BARS Technical Manager Graham Rochat delivered a presentation on the BARSoft database development program, the central repository for all related data.

The BARS program office has compiled an action list of improvement items. This list has been circulated to each of the audit companies for confirmation, with work on many of the items under way. The next audit review meeting is scheduled for March 19–20 in Brisbane, Australia, just before the Aviation Logistics for the Resource Sector conference on March 21–22.

In another development, the Foundation's website was updated to give BARS a prominent and convenient interface for easy access to BARS information. This change aims to offer a more interesting, informative and user-friendly online experience. The added tab on the FSF home page dedicated to the BARS program provides easy access to a more comprehensive overview of the program and its components. The new pages have an easy-to-download document about the BAR Standard, available in multiple languages, as well as a dedicated page on how to join the BARS program. Visitors to the site can download application forms for the latest courses and the BARS newsletter. It has the latest list of BARS member organizations, with direct links to their websites, and a dedicated page and link to each of our registered audit companies.

Finally, our BARSoft database is undergoing a significant revision to improve user access and data retrieval. After testing, it is expected to be released to users soon. As with all new systems, a number of improvements have been identified from comments provided by users during the testing. The resulting changes provide a more intuitive access to the system and simplify access to information relevant to specific user groups.

A computer-based training package has been introduced, is being used for BARS auditor recurrency training and is accessible through BARSoft.



Evolving fatigue risk management systems increase two airlines' confidence about alertness.

BY WAYNE ROSENKRANS

SCIENTIFIC SCHEDULING

For about 15 years, Air New Zealand periodically assessed pilots and flight attendants during flight operations and attempted to scientifically identify links between measured levels of fatigue and safety indicators. Today, fatigue risk management systems (FRMSs) "mirror the pillars of safety management systems," says David Powell, aviation medicine specialist for the airline. Nevertheless, airlines are finding that discussing an FRMS is easy while actually implementing all the elements is "particularly hard to do," he told Flight Safety Foundation's 64th annual International Air Safety Seminar (IASS) in Singapore in November.

A few years ago, a company study focused on two-crew flights for the Christchurch, New Zealand–Brisbane, Australia, city pair, on which the same pilots departed from Christchurch between 2100 and 2200 local time and arrived back at Christchurch at about 0700 the following day. "It is the sort of duty done around the world," Powell said.

"Changing the aircraft [Boeing 737-300/Airbus A320] doesn't make any difference, but providing a night stop in Brisbane makes a big difference. Reaction time [on in-flight psychomotor vigilance tests], compared with that in all of our studies, was quite high towards the end. … [Objective] reaction time data and the [pilots' self-reported] subjective data tend to tell exactly the same story." From such studies, predictive analyses have red-flagged situations requiring changes in the timing of departures, crewing level or details of the pattern to mitigate fatigue. Equally valuable, he said, has been confirmation by both types of data that fatigue levels are reasonable and fatigue predictions are sufficiently accurate.

The company recently monitored for three months the benefits of pilots self-reporting their fatigue level about 30 minutes before the safety-critical top of descent phase on every flight. In all, 9,000 paper-form responses represented long-haul, regional and domestic operations. One finding for regional trips was that starting duty from morning to midday kept the peak fatigue level well within an acceptable range, but starting duty in the evening or the middle of the night could cause fatigue levels to increase quickly toward an unacceptable level. Ability to isolate risk factors within this "wealth of data" then convinced the company to require top-of-descent alertness ratings from each Boeing 777 pilot on the flight deck on every flight.

Using the Samn-Perelli alertness scale of 1 to 7 (Figure 1), flight crews reported a higher fatigue level on the return sectors of out-and-back, daylight flights from Auckland, New Zealand, to Melbourne, Australia, for the 0800 local time departure compared with similar-duration flights at different departure times. "There is probably a little bit of truncation of [pilots'] sleep," Powell explained. Another finding, from a three-crew variant of this flight, was that "the benefit of a third pilot for a daylight sector is less obvious [than assumed]," he said.

Powell told IASS attendees, "You can monitor fatigue across your entire operation easily and cheaply [together] with your flight data analysis programs." Airlines should expect to frequently encourage crewmembers to keep up their in-flight ratings over time; find ways to gauge FRMS effectiveness in relation to measures in international guidance; and produce validated, reliable measures of safety performance.

"In terms of making the call on what is safe enough, we have got a long way to go," Powell said. "There are not enough data out there on fatigue linking with safety, so I'm here to appeal for [research on safety metrics]." A promising avenue of inquiry is how some crews with a high fatigue level or restricted sleep can perform tasks in a flight simulator or line operations safety audit as effectively as well-rested crews, or can exhibit fewer — but more serious — recorded exceedances of normal flight parameters.

Finnair Crew Vulnerability

Tomas Klemets, head of scheduling safety, Jeppesen Systems, described to IASS attendees Finnair's early experience with its evolving, incomplete FRMS in a presentation co-authored with Gabriela Hiitola, the airline's head of crew scheduling. Finnair operates widebody jets connecting Europe with long-range destinations in Asia via Helsinki. In 2007, the airline began to work with Helsinki University to study crew fatigue levels on long-range flights, and in 2008, the researchers expanded data collection to narrowbody aircraft.

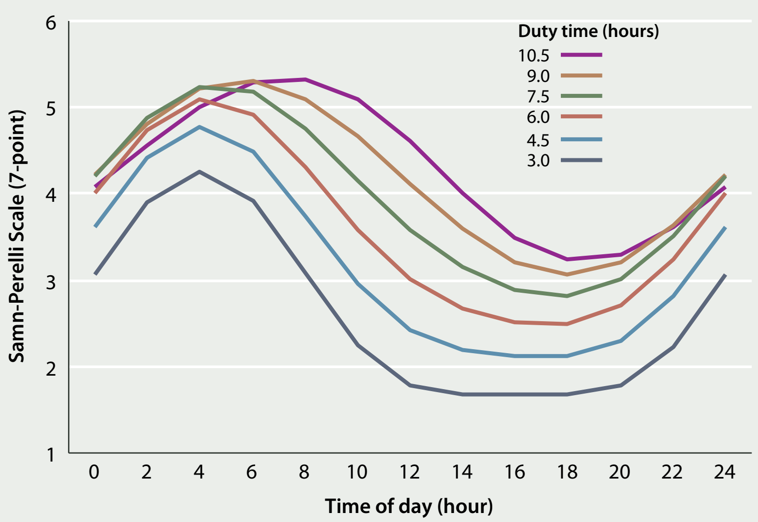
"In 2008, we asked, 'What are the possibilities of introducing a fatigue model to actually influence the construction of the schedules from the very beginning, rather than just measuring fatigue after the process is completed? Could [we] influence those sequences of flights to end up in the best possible context?'" Klemets said. This work led to the design and early 2011 launch of an Apple iPhone application (app) for building alertness into crew scheduling, developed with design input from company pilots.

"Finnair pilots actually fly rosters that have been produced … using a fatigue model guiding the overall construction," he said. Each "planning horizon" is continually revisited and refined from the long-term planning stage to the day of operation under the FRMS, he added.

Some risk factors are inherently tough to mitigate, however. "When an airline decides to operate to a certain station with certain equipment at a certain departure time, that will inevitably lead to a certain level of fatigue that will be very difficult to avoid," Klemets said. Pairing construction, roster construction by automated optimizers and FRMS monitoring have far less influence in those situations, he said.

The airline also has added scheduler and pilot training on key performance indicators (KPIs) of safety. "What Finnair does today is to trend what we call the PA5, the average predicted level of alertness on the 5-percent 'worst' flights," he said. For any dramatic improvement, however, the airline "would need to relax or remove some [regulatory/contractual] constraints or sacrifice some other KPIs," Klemets added.

Two-Crew Fatigue at Top of Descent



Notes: The earliest research using pilot self-assessment on paper forms before top of descent, during two-crew regional operations, enabled Air New Zealand to derive trend curves based on duty start time and approximate duty duration. Higher values on the vertical scale mean greater fatigue.

Source: David Powell, Air New Zealand

Figure 1

ASSURING SAFETY IN Aviation's Second Century

BY DEBORAH A.P. HERSMAN

The 185 delegates from 52 states who participated in the 1944 Chicago Convention that created the International Civil Aviation Organization (ICAO) fully intended for the aviation community to investigate, learn and adapt from accidents so the deadly past would not be repeated.

Thanks to their vision in 1944 — and to the efforts of so many more — today's global airline accident rate is at its lowest ever. The International Air Transport Association (IATA) reports that last year the global rate was one accident for every 1.6 million flights, a 42 percent improvement since 2000.

Three key areas helped get us to that low rate: data, technology and design.

Those Chicago Convention pioneers recognized the importance of data. From the beginning, ICAO was to be a center for the collection, study, and distribution of information on all significant aircraft accidents. This focus was essential. After all, between 1946 and 1950, on average, U.S. carriers had a major aviation accident every 16 days.

Early foil flight recorders, followed by their second- and third-generation descendants, contributed significantly to today's outstanding global safety record. You could fill a book with lists of accidents solved thanks to information obtained from data recorders. Much of that information led directly to technological improvements, such as the enhanced ground proximity warning system (EGPWS), which have contributed immensely to aviation safety. EGPWS has all but solved controlled flight into terrain (CFIT) accidents. And, with Doppler radar and so much more, aircraft now fly more safely in all kinds of weather conditions. The traffic alert and collision avoidance system (TCAS) has helped prevent midair collisions.

As for design, in civil aviation's first century, the community learned a tremendous amount — the hard way — about aircraft design issues from a number of accidents, including the McDonnell Douglas DC-10 with its poorly designed cargo door latches and the Boeing 737 and metal fatigue.

As we ended that first century, we saw further design improvements on the workhorses of the airline industry — remedies for the rudder design issues in the 737 and the flammability of the Boeing 747 center fuel tank. Today, we find fewer and fewer equipment and design failures.

While there is greater safety in civil aviation's second century, there are greater challenges in investigating accidents and assuring safety. One reason is that while modern technology has made aircraft more efficient, they are also far more complex.

Old "steam" gauges have been replaced by electronic displays. Hand flying has been supplanted by increasing automation. Many flight controls now rely on electronic actuators rather than control cables. Also, there are more and more composite structures.

While these all provide advantages, they require adjusting how accident investigators acquire evidence and information. The evidence and failure signatures relied upon in yesterday's investigations are not always available today.

For example, in 2001, when the National Transportation Safety Board (NTSB) pulled the vertical fin of the Airbus A300 out of New York's Jamaica Bay, it took a long time to figure out how the failure began and why. This is because the vertical fin was a largely composite structure and the typical overstress signatures that were available with metal were not present.

The good news is that investigators have access to more data sources. Today's flight recorders collect thousands of parameters. Investigators are also able to retrieve information from non-volatile memory sources, which can be recovered from electronic components, including digital engine controls, flight control and maintenance computers, and more.

Even when these devices are severely damaged, chip-level data extraction has successfully contributed to accident investigations. Data are also transmitted from onboard reporting systems, such as the aircraft communications addressing and reporting system (ACARS), which can provide investigators with critical real-time information. We are also seeing an immense amount of video data from surveillance cameras and personal cameras, as well as information from global positioning system (GPS) devices and electronic flight bags.

Yet, even with all the data sources, investigators continue to deal with the most complicated piece of equipment in aviation — the human — for which there is no data recorder.

Human factors accidents are harder to investigate, because often there is little evidence to document the decision-making process that led to the accident. Unlike airplanes that come off the assembly line designed to be exactly the same and perform to predictable and repeatable specifications, human beings are not always predictable.

There's only so much data on the cockpit voice recorder (CVR), often the most scrutinized piece of equipment on an accident airplane. Investigators listen for inflections in the pilots' voices — yawns, straining on the controls, and many other subtle changes in speech — to determine why pilots responded the way they did or did not respond as expected.

One of the most frustrating things investigators encounter is listening to a CVR and hearing a pilot say, "Look at that!" It can take years of painstaking effort to finally determine what "that" was and its relevance to the accident.

Adding to the complexity of accident investigation in aviation's second century is aviation's increasing globalization. There is no longer a clear distinction between domestic and international accidents. Accidents involving U.S. operators and U.S. equipment can and do occur anywhere in the world. Likewise, accidents may happen in the

Deborah A.P. Hersman is the chairman of the U.S. National Transportation Safety Board.

United States, but involve a foreign-operated or foreign-manufactured aircraft.

As we plan ahead, to prevent accidents in aviation's second century, we must recognize the increasing importance of working together. The accident investigation framework provided by ICAO Annex 13 is crucial since it provides the foundation — the protocols, the rights and responsibilities — for the states to work together.

With globalization, accident investigation will depend far more on data and cooperation than in the past. While time honored tin-kicking will never go away, it is increasingly being joined by sophisticated data analysis.

Accident investigation will depend far more on data and cooperation than in the past.

The investigation of the Jan. 17, 2008, crash landing of a British Airways Boeing 777 illustrates the 21st century model of accident investigation and the importance of data and cooperation. This flight, which originated in Beijing, was on short-final approach at 720 ft above ground level when the right engine and then the left engine stopped responding to auto-throttle. Through outstanding airmanship, over busy roadways and dense population, the pilots brought the plane to land just beyond the perimeter fence at Heathrow. The U.K.'s Air Accidents Investigation Branch (AAIB) led the investigation, which the NTSB joined as an accredited representative.

The flight data recorder (FDR), CVR and quick access recorder were recovered; there were some 1,400 parameters on the data recorders. The pilots gave extensive interviews. None of this told the team precisely why both engines failed. Nor did tests of the fuel, of fuel water content, examining where the airplane was last serviced, and more. Everything came up blank.

Yet, with a rich store of data, the team reviewed thousands of similar flights. One key finding was that the accident plane flew longer at a low fuel flow in cold temperatures than other flights. Temperatures on the accident flight's routing reached as cold as minus 74 degrees C.

This, in turn, led to scrutiny of fuel delivery to the engines. Lab tests looked at the effect of extreme cold temperatures and long idle times. Of particular interest was the fuel-oil heat exchanger, which uses cold fuel to take heat away from the oil and leads to the engine running cooler, especially the bearings.

The investigative team performed tests running a fuel system mockup for hours with cold fuel. They saw ice crystals collect on the face of the fuel-oil heat exchanger. If the engine throttle was applied, the newly formed ice broke up. But, with no throttle applied, the ice continued to form.

It turned out that this perfect flight — with minimal throttle usage to conserve fuel — led to slushy ice forming within the fuel system. When throttle was applied during the later stages of approach, the accumulated ice traveled to the fuel-oil heat exchanger and restricted the fuel flow.

Corrections included interim procedures that were followed by a redesign of the fuel-oil heat exchanger. Safety was served, which was enabled by data and cooperation.

In this era of dynamic growth and greater complexity, collecting and analyzing data are more important than ever. Accident investigators need all the data available to put together the big picture of what happened.

I applaud the agreement reached last year at the ICAO 37th Assembly to foster data sharing through the creation of the Global Safety Information Exchange. This information can be vital to learning what really happened and determining what can be done to improve safety. The recent General Assembly initiated an important dialogue about data sources. This is essential in setting standards of protection for the use of data in accident investigations.

Looking ahead, no matter how proud we are of the strong safety record the aviation community has achieved, we must not be complacent. We must make a constant commitment to further improve aviation safety by using data and further improving international cooperation.

This article is adapted from remarks made by NTSB Chairman Deborah A.P. Hersman at the 8th Annual Kotaite Lecture *to the Montreal Branch of the Royal Aeronautical Society on Dec. 8, 2011.*

BY JAMES M. BURIN

Down Time

Accidents involving Western-built commercial jets reached a new low in 2011, but CFIT accidents cast a shadow on commercial jet and turboprop safety.

The global major accident rate in 2011 for Western-built commercial jets was the lowest ever recorded, at 0.27 accidents per million departures.

Last year, the static accident rate that has existed for a decade started downward. And 2011 was the first year with no commercial jet loss of control accidents. The corporate jet fleet, which normally averages about 10 major accidents a year, showed an improvement, with seven major accidents in which 12 people died, compared with 18 fatalities in 2010.

Not all the data were so encouraging. The number of Eastern-built commercial jet accidents was above average.[1] Four of the 14 commercial jet major accidents were controlled flight into terrain (CFIT), the largest number of this type of accident involving commercial jets in eight years. CFIT accidents continue to dominate the turboprop fatality numbers.

The commercial turboprop fleet had an average year, with 23 major accidents, just slightly below the five-year average of 23.4. Deaths in those accidents declined from 262 in 2010 to 177 last year.

In 2011, approximately 6 percent of the turbojet fleet was Eastern-built, while 21 percent of the turboprop fleet was Eastern-built. The commercial turbojet numbers increased approximately 2.5 percent from the 2010 numbers, while the

Major Accidents, Worldwide Commercial Jets, 2011

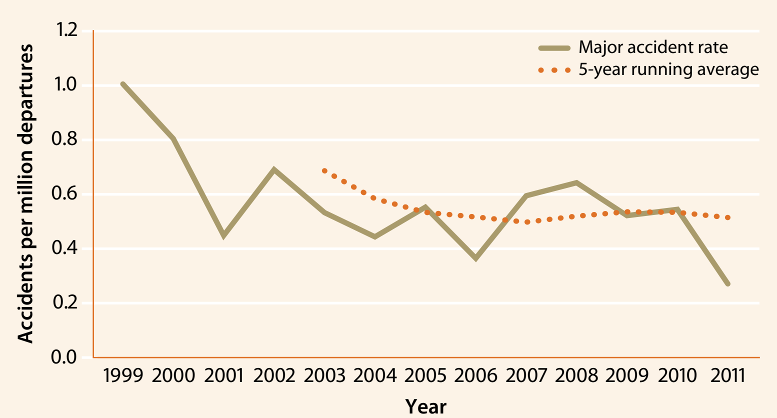
Date	Operator	Aircraft	Location	Phase	Fatal	
Jan. 1	Kolavia	TU-154	Surgut, Russia	Taxi	3	
Jan. 9	Iran Air	727	Orumiyeh, Iran	Landing	78	
March 5	VASO	AN-148	Garbuzovo, Russia	En route	6	
April 4	Gegorian Airways (UN)	CRJ-100	Kinshasa, DRC	Approach	32	
May 18	Omega Air Refueling	707	Point Mugu, CA, USA	Takeoff	0	
June 20	RusAir	TU-134	Petrozavodsk, Russia	Landing	45	● CFIT
July 6	Silk Way Airlines	IL-76	Bagram, Afghanistan	Approach	9	● CFIT
July 8	Hewa Bora Airways	727	Kisangani, DRC	Landing	83	● CFIT
July 28	Asiana Airlines	747F	Jeju, South Korea	En route	2	
July 30	Caribbean Airlines	737	Georgetown, Guyana	Landing	0	● Runway excursion
Aug. 20	First Air	737	Resolute Bay, Canada	Approach	12	● CFIT
Sept. 7	YAK Service	YAK-42	Yaroslavl, Russia	Takeoff	44	
Sept. 16	TAME	EMB-190	Quito, Ecuador	Landing	0	● Runway excursion
Dec. 28	Kyrgyzstan	TU-134	Osh, Kyrgyzstan	Landing	0	

● Controlled flight into terrain (CFIT) accident ● Runway excursion

Source: Ascend

Table 1

Western-Built Commercial Jet Major Accident Rates, 1999–2011



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

Source: Ascend

Figure 1

commercial turboprop numbers grew 1 percent. As usual, the business jet numbers grew the greatest amount, approximately 3 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. That includes 40 percent of the Eastern-built commercial jet fleet. Approximately 15 percent of the turboprop fleet is inactive. Four percent of the business jets were inactive, the third year in a row that there were inactive business jets.

There were 14 major accidents involving commercial jets in 2011 (Table 1), killing 314 people, down from 564 in 2010.[2] Eight of these involved Western-built aircraft. Eight major accidents were approach and landing accidents.[3] There were four CFIT accidents. Two of the 14 commercial jet major accidents were runway excursions.

The past two years have not been good for Eastern-built commercial jets. From 2000 to 2009, they averaged 2.4 major accidents a year. In 2010, they accounted for four of the 19 major accidents, or 21 percent, and in 2011, six of 14, or 43 percent. Although Eastern-built commercial jets made up only 3 percent of the active commercial jet fleet in 2011, they accounted for 43 percent of the major accidents. This does not reflect directly on the safety of these aircraft, but does raise concerns about the operators, their regulators and the regions in which the aircraft were operating.

The major accident rate for Western-built commercial jet aircraft in 2011 was 0.27 accidents per million departures. This rate is a great improvement from the 0.57 rate for the past decade, and the 0.54 rate of 2010. The decreasing trend from the 1990s had leveled off in the last decade, but the rate again has an encouraging downward trend (Figure 1). This accident rate is 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 seven major accidents involving corporate jets in 2011 (Table 2), below the 2000–2011 average of 9.9 per year. Although accurate worldwide exposure data are not available for corporate jets, the number of aircraft and the number of departures have been increasing steadily, so their accident rate is estimated to be decreasing.

There were 23 major accidents involving Western- and Eastern-built commercial turboprop aircraft with more than 14 seats in 2011 (Table 3). This is almost identical to the average of 23.4 over the previous five years.

The most significant safety challenge for commercial turboprops continues to be CFIT accidents. Over the previous three

Major Accidents, Worldwide Corporate Jets, 2011

Date	Operator	Aircraft	Location	Phase	Fatal
Jan. 6	Priester Aviation	Learjet 35	Springfield, Illinois, U.S.	Landing	0
Feb. 4	Sky Lounge	Hawker 900	Sulaymaniyah, Iraq	Climb	7
Feb. 18	Escuela de Aviación	Learjet 24	Villasana, Mexico	Landing	2
March 28	Hong Fei General	Citation II	(Missing) China	En route	3
May 5	Jorda	HS-125	Loreto Bay, Mexico	Approach	0
May 25	Jet Suite Air	EMB Phenom	Sedona, Arizona, U.S.	Landing	0
Nov. 29	Wings Over Africa	Gulfstream II	Huambo, Angola	Takeoff	0

Source: Ascend

Table 2

Major Accidents, Worldwide Commercial Turboprops, 2011

Date	Operator	Aircraft	Location	Phase	Fatal	
Feb. 10	Flightline	Metro III	Cork, Ireland	Landing	6	
Feb. 12	Sabang Air Charter	CASA 212	Bintan, Indonesia	En route	5	
Feb. 14	African Air Services	LET-410	Mont Biega, DRC	En route	2	●
Feb. 14	Central American Airways	LET-410	Cerro de Hula, Honduras	En route	14	●
March 4	Air Iceland	DHC-8	Godthab, Greenland	Landing	0	
March 8	Desert Sand Leasing	DHC-6	Clayton County, Georgia, U.S.	Takeoff	2	
March 21	Trans Air Congo	AN-12	Pointe Noire, Congo	Landing	9	
April 1	Fugro Aviation Canada	CASA-212	Saskatoon, Saskatchewan, Canada	Apporach	1	
May 7	Merpati Nusantara	MA-60	Kaimana, Indonesia	Approach	25	●
May 18	SOL Líneas Aéreas	SAAB 340	Prahuaniyeu, Argentina	En route	22	
June 6	Solenta Aviation	AN-26	Libreville, Gabon	Approach	0	
July 11	Angara Airlines	AN-24	Strezheov, Russia	Approach	6	
July 11	Trans Maldivian	DHC-6	Male, Maldives	Landing	0	
July 13	Noar	LET-410	Recife, Brazil	Approach	16	
Aug. 8	IrAero	AN-24	Blagoveshchensk, Russia	Landing	0	
Aug. 9	Avis Amur	AN-12	Omsukchan, Russia	En route	11	
Sept. 6	Aerocon	Metro III	Trinidad, Bolivia	Approach	8	
Sept. 20	Salsa d'Haiti	Beech 99	Milot, Haiti	En route	3	
Sept. 22	Arctic Sunwest Charters	DHC-6	Yellowknife, Northern Territories, Canada	Approach	2	
Sept. 25	Buddah Air	Beech 1900	Kathmandu, Nepal	Approach	19	●
Sept. 29	Nusantara Buana Air	CASA 212	Medan, Indonesia	En route	18	
Oct. 12	National Regional Transport	EMB-120	Port Gentil, Gabon	Landing	0	
Oct. 13	Airlines PNG	DHC-8	Madang, PNG	Approach	28	

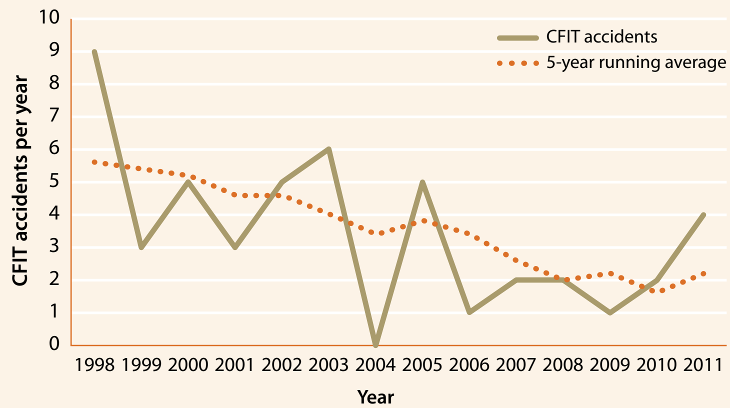
● Controlled flight into terrain (CFIT) accident

Note: Accidents involved aircraft with more than 14 seats.

Source: Ascend

Table 3

CFIT Accidents, Worldwide Commercial Jets, 1998–2011



CFIT = controlled flight into terrain

Source: Flight Safety Foundation

Figure 2

years, 18 of the 70 turboprop major accidents, or 26 percent, were CFIT. To put it another way, one of every four turboprop major accidents involved CFIT. CFIT has not been eliminated in commercial jets, but the industry is making progress in reducing it. For turboprops, it is not the same positive story.

The worst year in the past eight years for commercial jet CFIT accidents was 2011 (Figure 2). None of the eight commercial aircraft involved in a CFIT accident in 2011 — jets and turboprops combined — had a functioning terrain awareness and warning system (TAWS). In fact, in the more than 50 commercial aircraft CFIT accidents over the past five years involving jets and turboprops, only two of the aircraft were equipped with TAWS. In both cases, the TAWS functioned normally and gave the flight crews sufficient warning of the impending CFIT accident.

As has been the case for the past 25 years, CFIT, approach and landing, and loss of control continue to account for the majority of accidents and cause the majority of fatalities. As identified in Flight Safety Foundation's early work on approach and landing accidents, unstabilized approaches and a failure to go around when warranted are major risk factors.

Failure to go around was a factor in 83 percent of approach and landing accidents,[4] and it was the leading cause of landing runway excursions.[5] Data show a consistent, disturbing trend. From multiple studies involving millions of flights, we know that 3 to 4 percent of all approaches are unstabilized. These same data reveal that more than nine of every 10 unstabilized approaches continue to landing. To address this challenge, the Foundation has developed safe landing guidelines (*ASW*, 10/11, p. 14). These are an extension of the Foundation's 20-year approach and landing accident reduction (ALAR) effort and came about after the completion of the recent runway excursion risk reduction project. That project revealed some gaps that were not addressed sufficiently in the ALAR effort.

The Foundation does not advocate that the safe landing guidelines be copied and handed out to crews. They should be used as their title indicates — as guidelines for an organization to use, in conjunction with information from its aircraft manufacturer, to create its own rules and policy. Every operator should have a standard operating procedure (SOP) addressing this high-risk area and should monitor its operational data to determine the effectiveness of its SOP.

James M. Burin is Flight Safety Foundation's director of technical projects.

Notes

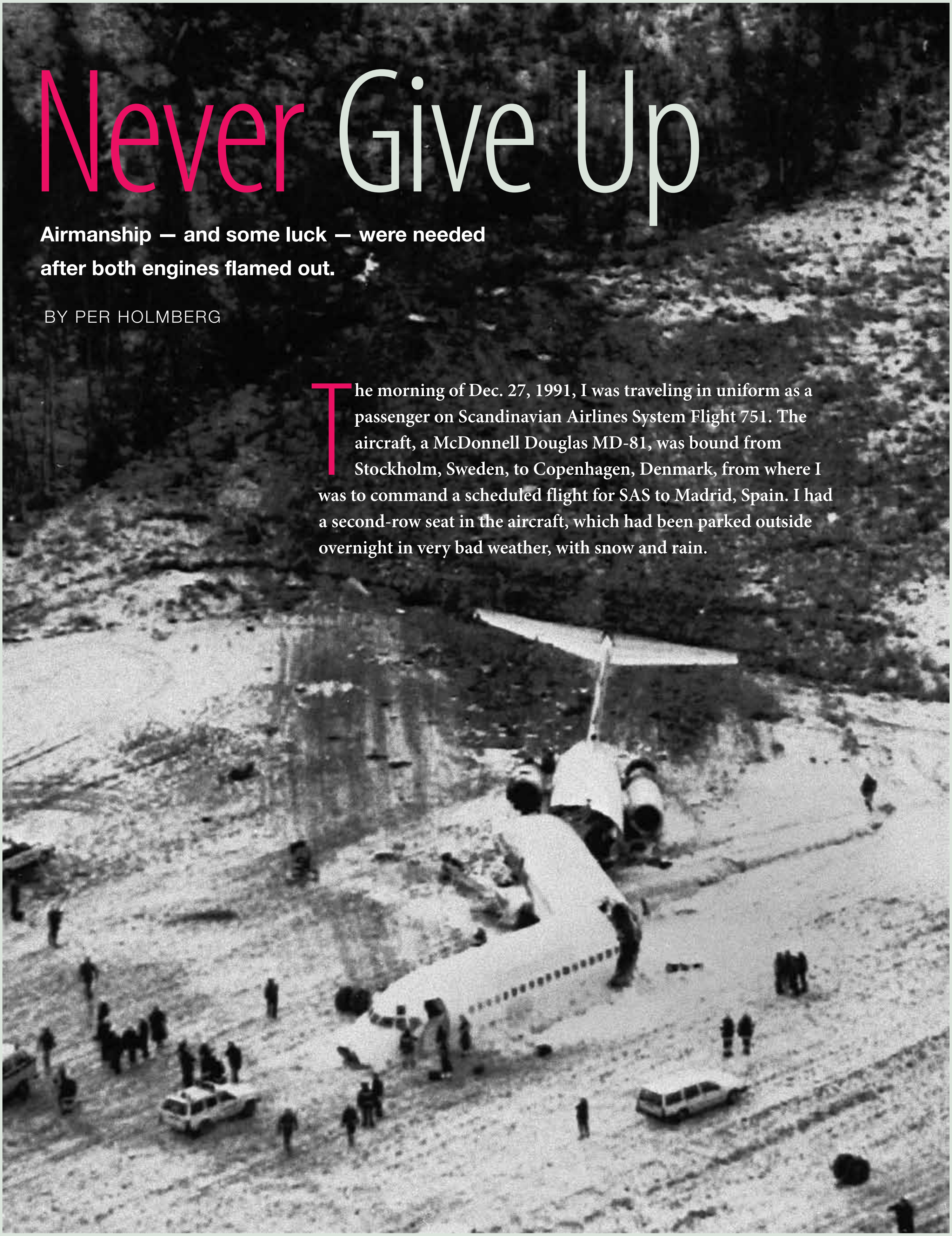
1. "Eastern-built" means manufactured in the Soviet Union, its satellite countries, the Russian Federation or China.
2. The data include all scheduled and unscheduled passenger and cargo operations for Western- and Eastern-built commercial jet aircraft.
3. The Jan. 9 accident is not considered an approach and landing accident because it seems to have been caused by fuel exhaustion.
4. "Killers in Aviation: FSF Task Force Presents Facts About Approach-and-landing and Controlled-flight-into-terrain Accidents." *Flight Safety Digest* 17(11–12)/18(1–2). November–December 1998/January–February 1999.
5. Flight Safety Foundation. "Reducing the Risk of Runway Excursions." June 2009.

Never Give Up

Airmanship — and some luck — were needed after both engines flamed out.

BY PER HOLMBERG

The morning of Dec. 27, 1991, I was traveling in uniform as a passenger on Scandinavian Airlines System Flight 751. The aircraft, a McDonnell Douglas MD-81, was bound from Stockholm, Sweden, to Copenhagen, Denmark, from where I was to command a scheduled flight for SAS to Madrid, Spain. I had a second-row seat in the aircraft, which had been parked outside overnight in very bad weather, with snow and rain.



© AP photo/Borje Thursesson

I counted four or five more surges and started to get worried.

After the aircraft was deiced, the takeoff roll was started on Runway 08 at Arlanda Airport. About 25 seconds after rotation, I heard an engine surge, an appalling sound similar to a cannon firing. I counted four or five more surges and started to get worried.

Looking through the open cockpit door, I saw a lot of warnings on the overhead annunciation panel but had the impression that nothing was happening between the two pilots — no giving of orders, no dialogue, no hands on the throttles or other arm movements. Then I got really worried, wondering if the captain had suffered a heart attack. I also had the feeling that the passengers were looking at me, wondering why I was sitting there, doing nothing.

I set aside my morning paper, unbuckled my seat belt and walked quickly to the cockpit. As I reached the cockpit door, I heard the fire bell sound and the first officer ask, "Shall I pull?" Before getting any answer from the captain, he pulled the fire handle, extinguishing the fire that was consuming titanium components in the left engine.

"Do you want help, boys?" I asked.

The captain replied, "Yes, start the APU." After spending some time trying unsuccessfully to start the auxiliary power unit, I gave up and directed my efforts to more important things.

No Checklist Required

The first officer had handed me the emergency checklist when I entered the cockpit. He had begun to look for the procedure for engine surge but could not readily find it because it was so far back in the book. (The procedure has since been placed in a more conspicuous place in the checklist, and the major items for dealing with engine surge are required to be memorized.)

I tossed the checklist aside because the situation we were in required no checklist. With both engines out, half of the flight instruments blacked out and the aircraft in clouds, the only things that were required were good airmanship, a hunch about what the landing configuration should be and, of course, some luck.

A "Power Out Checklist" that I had developed for myself was in my flight bag, back in the cabin. I had to try to remember what flap and landing gear configuration we ought to have. But the most important thing to remember was: Don't stall the aircraft.

'Look Straight Ahead'

I told the captain, who was flying manually, to look straight ahead. I repeated that at least 20 times during the rest of the flight. Why? Flying a 50,000-kg aircraft is a full-time job, especially when you don't have any engine power. I wanted the captain to do nothing else but fly the aircraft with exact control of speed and attitude.

At one point, the captain began to use the public-address system but dropped the handset on the floor. I was immediately on him again, saying, "Look straight ahead."

Just after we reached our highest altitude, 3,318 ft, which also was the top of the first cloud layer, the captain's two electronic flight instrument system (EFIS) displays went blank, leaving him with only a simple standby horizontal situation indicator and an analog airspeed indicator.

As we began our journey back down through the clouds, I scanned the first officer's EFIS displays, which were working OK, and saw that our airspeed was decreasing. As I scanned all the available instruments, I also kept an eye out through the windows so I could get contact with the ground as soon as possible to find a place to land.

The captain said a few times, "Prepare for on-ground emergency." I relayed that instruction, shouting at the top of my voice through the cabin door. The message was received, and the cabin crew began to instruct the passengers.

About 1,500 ft above the ground, I observed the flap handle in the slats-out position. Knowing that we were approaching a stall, I started to extend the flaps without saying anything. Airspeed at the time was 163 kt and decreasing. The stall speed at 54 tonnes and slats out is around 120 kt.

Descending through about 1,300 ft, we started to get visual contact with the ground. I saw two locations for a possible forced landing.

The closest was approximately 25 degrees to the right of our track, a little field surrounded by forest. I gave the captain directions to turn the aircraft toward that field.

At 1,100 ft over the ground, the captain said, "Flaps, eh … eh."

I responded, "Yes, we have flaps. We have flaps. Look straight ahead." The landing configuration should have been gear down and flaps 28. As I was afraid that we would stall on the way down, I had selected flaps 40, or full landing flaps. We were holding on landing gear extension.

At 491 ft, we got the first aural warning of "too low gear." The first officer asked, "Shall we take the gear?"

"Yes, gear down, gear down," I said. The landing gear was down and locked five seconds before impact, and was broken off immediately when it hit the ground, probably helping to reduce the forward energy a lot.

When I saw the trees starting to hammer the aircraft, I had rushed from the cockpit and braced myself against the forward cabin wall, knowing that I did not have time to return to my seat, fasten the seat belt and brace for impact. I felt the aircraft bank right as I left the cockpit and reached the wall, which was carpeted and relatively soft, just as the aircraft hit the ground. I was knocked unconscious.

The aircraft was banked 40 degrees right, and the right engine hit the ground first, followed by the tail. The aircraft rolled wings-level, but with the nose high in the air. Then came the whiplash when the whole airframe hit the ground and broke into three pieces before coming to a stop within 110 m (361 ft).

The impact forces in the forward part of the aircraft reached +30 g (that is, 30 times standard gravitational acceleration). It is unbelievable that so many passengers survived relatively unharmed.[1] I was unconscious for approximately 20 minutes. My left shoulder must have taken most of the impact, because it was dislocated.

The captain dragged me to the forward cabin door, where I was taken care of by some passengers. The slide did not inflate when the crew opened the door because the distance to the ground was too small. Later, the crew removed the slide and inflated it. I sat on that slide for a long time, maybe an hour. It was cold, my shoulder hurt, and I had only one shoe. I was told later that I was very angry that the aircraft was destroyed.

The information flow during that short flight was tremendous, exceeding many times the amount of information that even an experienced pilot can assimilate. In this special case, the only remedy was reverting to the old-fashioned way of flying, using the standby horizon, the airspeed indicator and the seat of your pants.

Especially with today's fancy automated systems, it is crucial for pilots to be able to fly manually, to think critically and control the aircraft. Whatever happens, never forget that you are the pilot. When anything starts to go wrong, use good airmanship and never, *never* give up until you are at a standstill on the ground again.

Per Holmberg is a retired Swedish air force J35B Draken fighter pilot and SAS DC-9 and MD-80 captain with more than 12,000 flight hours.

Note

1. In its final report, C 1993:54, the Swedish Board of Accident Investigation (SHK) said that, of the 129 people aboard the aircraft, eight were seriously injured and 84 sustained minor injuries; there were no fatalities. The SHK concluded that the accident was caused by the airline's inadequate "instructions and routines" for deicing, which resulted in the MD-81 departing with its wings contaminated by clear ice that dislodged and was ingested by the engines.

FirstPerson is a forum for sharing personal experiences that have yielded lessons about aviation safety. We welcome your contributions. Send them to J.A. Donoghue, director of publications, Flight Safety Foundation, 801 N Fairfax St., Suite 400, Alexandria VA 22314-1774 USA or donoghue@flightsafety.org.

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Fractured Gear

BY LINDA WERFELMAN

A metallic particle was the only sign of the impending fatal failure of the AS332's main rotor gearbox.

Twelve seconds after a routine radio transmission, the commander of a Eurocopter AS332 L2 Super Puma was back at the microphone, declaring an emergency as his helicopter fell 2,000 ft from cruise flight to the surface of the North Sea. The two pilots and all 14 passengers were killed, and the helicopter, which lost its main rotor during the plunge to the sea, was destroyed in the April 1, 2009, crash.

The U.K. Air Accidents Investigation Branch (AAIB), in its final report, said the crash followed the catastrophic failure of the main rotor gearbox,

The main rotor blades separated from the helicopter before impact and were pulled from the North Sea during the recovery effort.

which resulted from a fatigue fracture of "a second stage planet gear in the epicyclic module."

The report added that the only indication of a pre-existing problem was the discovery during maintenance on March 25, 2009 — 36 flight hours before the accident — of a metallic particle on the epicyclic chip detector and that "the possibility of a material defect in the planet gear or damage due to the presence of foreign object debris could not be discounted."

The report cited as a contributing factor actions taken after discovery of the magnetic particle, which "resulted in the particle not being recognized as an indication of degradation of the second stage planet gear."

The report cited two additional contributing factors:

- After the March 25 maintenance, "existing detection methods did not provide any further indication of the degradation of the second stage planet gear"; and,
- "The ring of magnets installed on the AS332 L2 and EC225 main rotor gearboxes reduced the probability of detecting released debris from the epicyclic module."

The accident flight was one of a series of flights on April 1 between Aberdeen, Scotland, and various North Sea oil platforms (Figure 1, p. 38). The helicopter's only known mechanical problem was a deferred defect involving the ice detection system, but this was not a factor on a day when there were no clouds below 3,000 ft and the temperature was about 13 degrees C (55 degrees F), the report said.

The pilots who had flown the helicopter immediately before the accident flight said they had no problems during their round-trip flight between Aberdeen and the Bruce Platform and had observed no abnormalities during their inspection of the helicopter.

The accident crew boarded the helicopter, in a "rotors-running crew change," when it returned from the Bruce Platform. The commander of the previous flights told the commander of the accident flight that the helicopter was serviceable, except for the deferred defect, and that the daily in-flight checks had been completed satisfactorily.

After refueling and passenger-boarding, the helicopter took off at 1042 local time for the 67-minute flight to the Miller Platform, where the outbound passengers disembarked. Several told investigators later that, five or 10 minutes before landing, they heard a sound "similar to a heater or air conditioning unit being turned off" but did not consider this a problem and did not mention it to the crew, the report said.

After 14 passengers boarded for the flight to Aberdeen, the helicopter took off at 1203, and climbed to 2,000 ft.

"Approximately 20 minutes before the expected arrival time at Aberdeen, the copilot made a routine call to the operating company, stating that the helicopter was inbound with 14 passengers, it was serviceable and was expected to arrive at 1314 hours," the report said.

Two "mayday" calls — one from the commander and one from the copilot — followed seconds later.

Two nm (4 km) away, a worker on the vessel Normand Aurora heard the helicopter and then saw it in a rapid descent to the water. He told investigators that the main rotor blades had separated from the helicopter before it fell

U.K. Air Accidents Investigation Branch (© Crown)

Route of Accident Flight

ADN VOR = Aberdeen VHF omnidirectional radio

Source: U.K. Air Accidents Investigation Branch

Figure 1

into the sea and that he saw no smoke until after the impact.

He sounded an alarm and turned the Normand Aurora toward the accident site, 11 nm (20 km) northeast of Peterhead; a Normand Aurora fast rescue boat arrived "very promptly," as did a nearby helicopter whose crew had been asked by air traffic control to "examine the sea in the area where the helicopter was last seen on radar," the report said. Other search and rescue equipment arrived within 40 minutes, and recovery efforts began later the same day.

Pilot Training

The helicopter's commander, who had an air transport pilot license for helicopters, had accumulated 2,575 flight hours, including 1,870 hours in type. The copilot held a commercial pilot license for helicopters and had 395 flight hours, including 140 hours in type. Both pilots had AS332 L2 type ratings and had completed all required training and testing.

The helicopter was manufactured in 2004 and owned by Bond Offshore Helicopters; it had 7,728 total airframe hours. It was equipped with two Turbomeca Makila 1A2 turboshaft engines. Accident investigators said it was certified, equipped and maintained according to regulations in place at the time. Calculations performed after the accident confirmed that the helicopter was being operated within weight and balance limitations when the crash occurred.

Chip Detection

The AS332 L2 was designed so that the shafts from the two engines drive the main and tail rotors by way of the main gearbox, which is divided into two sections — the main module and the epicyclic reduction gearbox module. The epicyclic module planet gears had an operational life of 6,600 flight hours.

The main gearbox contains magnetic chip detectors, designed to "detect and retain any chips of magnetic material shed, for example, from the gears or their bearings," the report said, noting that the main module detector generates a warning when "a chip of sufficient size, or an accumulation of small chips, is detected."

As part of normal turnaround maintenance on March 25, maintenance personnel observed a health and usage monitoring system (HUMS) alert about an epicyclic module chip detection warning. They conducted a subsequent inspection of all main gearbox magnetic chip detectors and found no particles. Nevertheless, they replaced the body of the main module chip detector because it appeared to be loose.

After a second alert, a maintenance technician found "a small metallic particle" on the magnetic chip detector but believed this probably was associated with the replacement of the conical housing/rotor head earlier in the month.

"He informed the engineering supervisor of the presence of the magnetic particle," the report said. "As he had already removed and inspected the epicyclic chip detector, he informed another engineer, who had been tasked with inspecting the magnetic chip detectors as part of the 25-hour check, that he would inspect the remaining magnetic chip detectors. He then checked the other two magnetic chip detectors. The work card for the completion of this task was subsequently signed off later that evening."

Although the particle was removed from the epicyclic chip detector, maintenance personnel did not remove the epicyclic module or recover any particles that might have accumulated on the magnets that were part of the gearbox separator plate. "However," the report said, "as a result of the discovery of the magnetic particle, the operator had initiated a plan to remove [the helicopter's main gearbox] and replace it with a unit from another helicopter undergoing heavy maintenance."

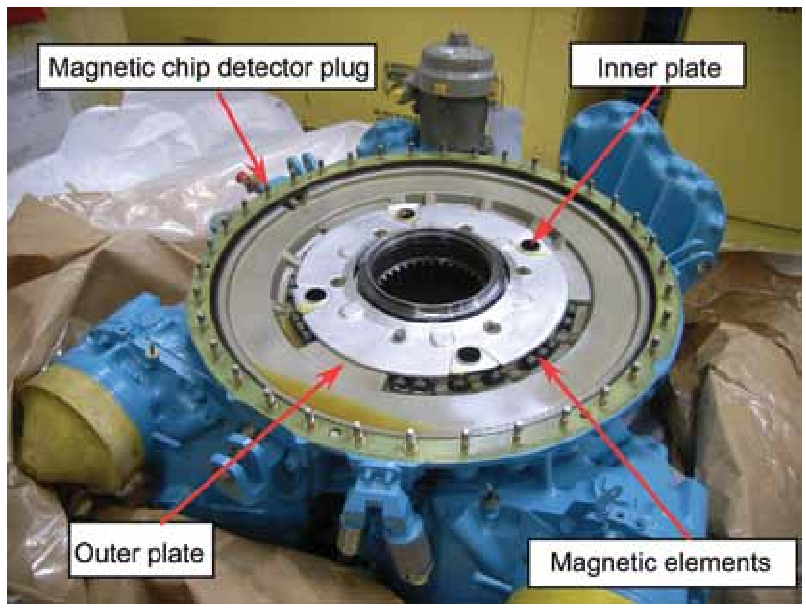
Manufacturer's representatives, in phone calls and emails, issued several recommendations to the operator's maintenance personnel and said that "if nothing abnormal is found [while carrying out the recommended actions], there is no need to ground the aircraft and you can go flying tomorrow morning."

Manufacturer's representatives later told accident investigators that they believed all three relevant tasks described in the aircraft maintenance manual had been completed. However, the final write-up of the problem and the related work did not mention one of the three tasks, which called for removal of the epicyclic module and examination of the ring of magnets on the oil separator plates.

The maintenance personnel examined the particle in accordance with the manufacturer's recommended maintenance task information and concluded that it was "a piece of scale," probably silver or cadmium plating, and therefore required neither close monitoring nor replacement of the gearbox, the report said, noting that the planned replacement was canceled. Subsequent testing determined that the particle was not silver or cadmium but 16NCD13 steel, planet gear outer race/gear material.

The operator ordered inspections of the epicyclic and main module chip detectors after every

Photographs from the accident report show the main module of an AS332 L2's main rotor gearbox, with the epicyclic module removed, above, and the epicyclic module ring gear from the accident helicopter, soon after it was recovered from the sea, below.



shutdown for the next 25 flight hours. The inspections continued for 31 flight hours — until the day of the accident — and no additional particles were found.

When the accident occurred, the epicyclic module had accumulated 4,467 operating hours since new, and its planet gears had accumulated 3,623 hours since new. It had been overhauled and installed in the accident helicopter in April 2008.

A review of HUMS data revealed no recorded chip detector warnings from the installation date until March 23, 2009. On March 24, an epicyclic module chip detector warning was recorded while the helicopter was in cruise flight.

"The cumulative chip detection warning count then increased for the remainder of the operations of 24 March 2009, reaching a total of 667," the report said. "The helicopter manufacturer considered such a high chip warning count as unusual. … They considered the most likely explanation was a chip of a size which only just bridged the chip detector elements, making or breaking the electrical contact, depending on the oil flow in the gearbox."

The HUMS card "did not close down normally" on March 24, so any alerts that were generated were not displayed on the ground station, the report said.

Multiple epicyclic chip detection warnings were recorded during each of two operations on March 25; none was recorded from March 26 through March 31. During the accident flight, recorded data indicated damage to the second stage epicyclic ring gear, and HUMS recorded four chip detector warnings in the four minutes preceding the crash. Other data showed a main gearbox oil low pressure warning, a master warning and the loss of right engine torque as the helicopter deviated from cruise flight. The last four seconds of the cockpit area microphone recording included a "grinding noise," and the combined voice and flight data recorder (CVFDR) recording and radio transmission recording contained the commander's voice "expressing alarm."

The CVFDR recording ended before the impact, limiting the data available for the latter part of the accident sequence, but HUMS data showed "a number of status and warning indications, including [main gearbox] chip detections, engine Ng[1] difference warnings, engine 2 oil chip detections and engine bleed air selections," the report said.

Debris Contamination

The accident investigation focused on the failure of the gearbox epicyclic module. Investigators found considerable damage throughout the epicyclic module, "consistent with it operating for a period of time whilst contaminated with debris," the report said.

Examination of the metallic particle that had been removed on March 25 from the epicyclic module magnetic chip detector confirmed that it had come from the surface of the outer race of a second stage planet gear bearing, the report said. The same area was the point of origination for a fatigue crack, which grew until the gear failed and broke into several sections. The section where the crack originated was not recovered from the sea.

The accident investigation did not determine the reason for initiation of the crack, but "the possibility of a material defect within the gear or foreign object debris could not be discounted," the report said.

The report noted a similar accident in 1980 involving the failure of a stage two planet gear on an SA330J Puma. In that accident, "large quantities of metallic debris had been collected over a number of weeks, and the inner race had typical evidence of severe spalling" — the breaking off of chips or scales, the report said.[2]

The report also noted that the introduction of a ring of magnets on the main rotor gearbox in AS332 L2s and EC225s "reduced the possibility of [detecting] metallic debris, generated in the epicyclic module, by the main module magnetic chip detector or by inspection of the oil filter."

Safety Recommendations

The AAIB issued 17 safety recommendations as a result of its investigation, including those calling on Eurocopter to "introduce a means of warning the flight crew of the AS332 L2 helicopter in the event of an epicyclic magnetic chip detector activation" and to "introduce further means of identifying in-service gearbox component degradation, such as debris analysis of the main gearbox oil."

The European Aviation Safety Agency (EASA) should research methods for "improving the detection of component degradation in helicopter epicyclic planet gear bearings," the AAIB said.

Other recommendations said that EASA and the U.S. Federal Aviation Administration should take steps to minimize the loss of data from helicopter cockpit voice recorders and flight data recorders in the event of an accident.

This article is based on AAIB Aircraft Accident Report 2/2011, Report on the Accident to Aerospatiale (Eurocopter) AS332 L2 Super Puma, Registration G-REDL, 11 nm NE of Peterhead, Scotland on 1 April 2009. *The report, issued Nov. 24, 2011, is available at <www.aaib.gov.uk/sites/aaib/publications/formal_reports.cfm>.*

Notes

1. The report defined Ng as engine gas generator shaft rotational speed.
2. The helicopter crashed into a swamp forest in Brunei, killing both pilots and all 10 passengers.

Investigators failed to 'connect the dots' in their analysis of language factors in the 2006 collision over the Amazon.

Speaking Outside the Box

Second of Two Parts

© DECEA

BY ELIZABETH MATHEWS

Although the final accident investigation report on the 2006 collision of a Boeing 737-800 and an Embraer Legacy 600 over the Amazon identifies findings involving communication and language, the report does not draw a connection between inadequate English language proficiency and the communication failures cited as causal factors (*ASW*, 12/11–1/12, p. 22).

In particular, there is evidence that air traffic controllers had inadequate English language proficiency and may have experienced a resulting degree of "communication apprehension," a factor that could explain the otherwise nearly inexplicable failure of at least two controllers to communicate routine, key and required information.

The Legacy pilots, in turn, demonstrated a lack of awareness of their responsibility to adhere to International Civil Aviation Organization (ICAO) language requirements and of the threats inherent in cross-cultural and cross-linguistic communication. In addition, they demonstrated inadequate communication strategies, perhaps partly as a result of a degree of inhibition in response to several instances of difficult or failed communication with controllers.

Taken together, these factors helped establish the latent conditions upon which the active operational failures depended to generate the unlikely but calamitous result — the Sept. 29, 2006, collision of the two aircraft, which killed all 154 people in the 737.

The Stage Is Set

The report by the Brazilian Aeronautical Accident Investigation and Prevention Center (CENIPA) detailed various distractions on the flight deck of the Legacy, including the pilots' focus on a laptop computer, which interfered with their situational awareness, their monitoring of instruments and their communication with air traffic control (ATC).

In addition to the evidence that the pilots allowed themselves to be distracted on the flight deck and did not maintain an adequate level of vigilance, it is noteworthy that by the time the Legacy had crossed the Brasília VHF omnidirectional radio (VOR), they had experienced several communication failures with ATC.

Communication breakdowns introduce stress into the interaction and can cause a subsequent reluctance to engage in further communication.

Communication Strategies

One minor problem occurred when a Legacy pilot failed to use ICAO phraseology to tell ATC how many people were in the airplane. He spoke about "souls on board," instead of the ICAO-required "persons on board."

A second communication breakdown centered on the delivery of clearance information. The episode — described in the CENIPA report — provides insight into the effect that communication difficulties can have. The report noted that, on two occasions, "the Legacy crew tried to learn the altitude to be maintained at the OREN SID [standard instrument departure], but the pilot did not get a correct answer from the ATC unit."

A review of the transcript of this exchange reveals a number of subtle linguistic phenomena.

Because the clearance had omitted the initial altitude to be maintained, the Legacy pilot queried the controller, "And what initial altitude for clearance?" The controller asked the pilot to "Say again, please." The pilot's reply was difficult to hear because of radio interference, and only "... altitude for takeoff?" is intelligible.

At this point, according to the CENIPA report, "Either due to having misunderstood or because he did not feel comfortable to ask the pilot to repeat, [the controller] replied that the aircraft was authorized to taxi up to the holding point of Runway … 15 of São José airport." That is, the controller responded to the pilot but did not answer his question.

CENIPA identified the discomfort that instances of failed communication cause. When confronted with communication difficulties, participants have two choices: They can use strategies that will help them achieve their communication goals (achievement strategies) despite the difficulties, or they can employ "reduction strategies" and reduce their communication goals in response to the difficulties.[1]

Topic avoidance is one example of a reduction strategy. Responding without answering the pilot's question could be a face-saving technique; feeling too uncomfortable to once more ask the pilot to "say again," the controller provided other information, unrelated to the pilot's question, avoiding the topic.

When the pilot sought clarification a third time, he implemented a number of achievement strategies within his request of, "Yes sir, after takeoff, what altitude you'd like (unintelligible)." In the face of his own probable discomfort over having to repeat his question, the pilot sought to maintain rapport by employing politeness strategies: He prefaced his query with "Yes sir" and used a polite question form, "you'd like" (for "you *would* like.") He also rephrased his request, placing key information

— "After takeoff" — at the beginning of his question. He attempted to simplify the request and clarify his question, from his original "initial altitude for clearance" to "after takeoff, what altitude."

Again, the controller replied — "After takeoff, report Oren Departure, Oscar Romeo Echo November, Transition Poços de Caldas" — but did not answer the pilot's question. After these three tries, the pilot gave up and continued to taxi, another example of a communication reduction strategy: The pilot abandoned the communication.

Although this was a minor exchange with no seemingly direct bearing on the critical communication breakdown over the Brasília VOR, it is worthwhile, nonetheless, to consider how this early communication breakdown may have influenced pilot expectations for the tenor of future communication with ATC.

Both the literature on crew resource management and linguistic research confirm the chilling effects of inadequate early communication on subsequent communication.[2,3,4]

Robert Young and William Faux found, in a 2010 study, that when confronted with difficult communication with non-native English speakers, native English speakers "quit, withdrew or made no attempt to continue with difficult conversations" more frequently when they perceived that the non-native English speaker's limited proficiency caused a failure in the execution of his or her job responsibilities. That is, native speakers were less tolerant of communication difficulties when it was perceived that the language problems interfered with the ability of the non-native speaker to do his or her job.[5] Communication breakdowns introduce stress into the interaction and can cause a subsequent reluctance to engage in further communication.

The inadequate communication to ATC by the Legacy pilots — cited in the CENIPA report as a factor in the accident — may be attributed, in some part, to their reaction to a series of difficult or inadequate communication from ATC, beginning with their earliest communication. That is, they responded in a way that research suggests is

Opinion: It's Not Someone Else's Problem

This topic cannot be concluded without a final note regarding the criminal trial of at least one of the controllers involved and the chilling effect that such legal action has on aviation safety.

Criminalizing aviation errors, even those with tragic results, misplaces the energy for action that inevitably is invoked by tragedy. Only an uninhibited probe of all aspects of an accident or incident can provide the information the industry requires to improve safety. If operational personnel fear the threat of prosecution, they are not able to be forthcoming with vital information.

More urgently, at a personal level for the controller in this case, if, as the evidence suggests and as his attorney claims, language proficiency was an underlying factor in his failure to communicate the required information, then culpability for his air traffic control communication failures would most certainly not be his, but would instead belong to the system that placed a controller without adequate English language proficiency into a position for which he was not adequately trained.

English language proficiency is not optional for air traffic control; it is fundamental. Controllers and pilots have the right to effective training to ensure their English proficiency is adequate to safely manage all requirements of their jobs.

Passengers have the right to expect that the pilots and controllers on whom their safety depends are able to communicate effectively and safely in all instances.

Extending that argument to a legitimate conclusion, the case is made that the "system" in this case is *not* simply the Brazilian air navigation service provider. International Civil Aviation Organization language proficiency requirements are of such importance to global aviation safety, and the training required to achieve proficiency is so extensive, that adequate communication should not be considered the responsibility of any single individual or any one organization — or nation — but rather a burden that should be shared by the industry.

To consider English standards in the industry as "someone else's problem" — solvable with one or another short commercial course selected by administrators who cannot easily identify high quality language training in an unregulated market and who must rely on commercial aviation language training providers who may misunderstand the elements required for successful language learning programs — is to underestimate the challenge of implementing effective language training for aviation professionals.

The aviation industry is a global industry; this is a safety issue that requires better global leadership from those organizations able to make a difference.

—EM

a normal human reaction to communication difficulties — with avoidance strategies — including avoiding subsequent communication. Supporting this hypothesis, the pilots "reported difficulty with the ATC use of the English language" to accident investigators, an opinion further bolstered by one pilot's expression of frustration ("I've no idea what the hell he said") after a routine but difficult communication with an en route controller.

These early communication failures are important to the accident investigation in two regards. First, they provide evidence of a lack of awareness of the requirements imposed on pilots by the ICAO language standards — to use ICAO phraseology, to use appropriate communication strategies to exchange messages and to recognize and resolve misunderstandings. More importantly, they may provide insight into why the pilots failed to proactively initiate and maintain communication with ATC.

Recommendations

The linguistic analysis of the accident investigation report suggests a number of safety recommendations for the industry, including:

- Investigators should be thoroughly familiar with the International Civil Aviation Organization (ICAO) language proficiency requirements: the standards and recommended practices in Annexes 1, 5, 10 and 11, and guidance in Document 9835.
- Investigators should be more aware of the role of language as a human factor in aviation.
- Protocols should be developed for the investigation of language as a potential factor in aviation accidents and incidents.
- When language proficiency or language use is suspected as a factor, specialists in applied linguistics should assist with that aspect of the investigation.
- Transcriptions of cockpit voice recordings should be linguistically precise, that is, prepared without corrections or modifications, and made available to applied linguists for review or research.
- Pilots and controllers should be trained to adhere to ICAO English phraseology in international operations.
- Pilots and controllers should receive cross-cultural and language awareness training for international aviation operations.

—EM

Confounding Failures

Just as subtle linguistic clues help us better understand the pilots' lack of proactive communication with ATC around Brasília — cited as a factor in CENIPA's report — they also help make better sense of the otherwise confounding communication failures from ATC to the Legacy during the same timeframe. In its comments on the report, the U.S. National Transportation Safety Board (NTSB) cited a "lack of timely ATC action after the loss of the Legacy's transponder and two-way radio communication," as a deficiency in the ATC system that is not "sufficiently supported with analysis or reflected in the conclusions or cause of the accident."

The CENIPA report cited a number of ATC communication failures by the controllers in Sector 5 — the early handoff and the failure to issue level change instructions — and Sector 7 — the failure to issue level change instructions and the failure to notify pilots of the loss of their transponder signal. However, with a vagueness that was inconsistent with the rest of the report, the communication failures were attributed to a procedural breakdown, although the report acknowledged a lack of any discernible "plausible reason" for not just one, but a series of procedural and communication failures by multiple controllers.

So the question remains: Why did two consecutive controllers not follow prescribed communication procedures in the crucial minutes preceding the collision, and what motivated the Sector 5 controller to make such an early handoff, cited by the NTSB as a latent failure in the accident?

The CENIPA report discussed, at some length, a number of hypotheses to explain these communication failures by controllers in Sectors 5 and 7, including their aptitude and knowledge, the possibility of low situational awareness due to other distractions, complacency, poor judgment, lack of communication between supervisors and controllers, and poor team resource management.

Although CENIPA did not have direct access to the controllers involved for questioning and reported inadequately organized or updated training records, accident investigators were able to determine that the Sector 5 controller's "priority in relation to that aircraft would be a quick hand-over to the next sector." The report noted that at the time of the transfer, the number of aircraft in his sector was not excessive. Investigators surmised that the failures of one air traffic control officer (ATCO) in Sector 7 might have been due to his either not knowing the procedures or preferring not to adopt them; in either case, the CENIPA report said, he demonstrated an attitude of passivity and complacency.

Although CENIPA was not able to uncover information concerning the English proficiency of the Sector 5 controller, the brief exchange with the Legacy pilots cited earlier suggested inadequacy.

CENIPA said that the Sector 7 ATCO "showed difficulty mastering the English language, with an effect on his use of the related phraseology" and that his result on the English language evaluation was "non-satisfactory." It was this controller who was sentenced in 2010 in connection with the collision, and whose lawyer claimed, in his defense, "He does not speak English and was obliged to coordinate a flight involving foreign pilots," and that his lack of proficiency in English "hindered his ability to alert the pilots"[6] (see "Opinion: It's Not Someone Else's Problem," p. 43).

A second Sector 7 ATCO, who also noticed but failed to adequately manage the transponder failure, was reported to have attended "beginning and intermediate" English courses; his test results were reported as "inadequate."

In general, there is no evidence provided in the report to indicate that any of these three controllers had adequate English language proficiency; there is, however, evidence of *inadequate* English language proficiency. Nonetheless, this factor does not appear to have been considered as a possible explanation for the serious communication failures that occurred in the hour or so preceding the collision. In contrast with an otherwise thorough investigation of possible explanations for the communication failures over the Brasília VOR, the consideration of language proficiency as a possible factor is not explicitly addressed.

A valid investigative question that remains unanswered is whether inadequate English language proficiency inhibited these controllers from engaging in what necessarily would have been non-routine communication.

Why did two consecutive controllers not follow prescribed communication procedures in the crucial minutes preceding the collision?

Communication Apprehension

Although the language required to communicate about a transponder failure could be fairly simple — such as, "N600XL, check your transponder" — it would have called for the use of English "outside the box" of the standardized ICAO phraseologies typically used by en route controllers. In addition, initiating an exchange about a non-routine event — "Check your transponder," or "I am not receiving your transponder signal" — would inevitably open up a nonstandard dialogue calling for the use of English beyond standard ICAO phraseology. It would be impossible to predict, even in the tightly constrained linguistic environment of ATC communication, how the pilot would respond to the controller's notification of loss of signal. A particularly stressful feature of initiating communication with a native speaker is that it is impossible to predict possible responses. For a controller with limited English proficiency, initiating such an unpredictable and open-ended dialogue would have been daunting.

Communication apprehension is a documented linguistic phenomenon, defined as "an individual's level of fear or anxiety associated with either real or anticipated communication with another person or persons."[7] Furthermore, research shows that individuals with high communication apprehension tend to use communication reduction strategies more frequently, including topic avoidance, or to simply avoid communicating at all.[8,9]

The possibility that weak English proficiency — and a resulting degree of communication apprehension — is the underlying cause of the controllers' operational failures deserves to be investigated with as much rigor as other possible causal factors.

Investigating Language

While it does not change the fundamental conclusions of the report, a careful linguistic analysis illuminates an area affecting flight safety that too often remains obscure in accident and incident investigations. The failings of the CENIPA and NTSB reports to more systematically investigate the possible role of controller language proficiency or pilot language awareness as contributory factors is not a failing unique to this accident or to these accident investigation teams. Rather, in general, aviation accident investigators and human factors specialists, even those who specialize in communication — an academic area of study that is distinct from linguistics — generally have neither the linguistic training and expertise to consider the subtle role that language use may have in aviation communication nor access to standardized tools that would enable them to more easily uncover language proficiency problems (see "Recommendations," p. 44).

The possibility that weak English proficiency is the underlying cause of the controllers' operational failures deserves to be investigated with as much rigor as other possible causal factors.

The Fundamental Lesson

The aviation industry naturally tends to place a high priority on issues that capture people's attention. Only by accurately perceiving the full extent of underlying causes of the communication failures can we adequately implement safety improvements. At the most fundamental level, if the link between language proficiency and safety is not made explicit, if only the most glaring language issues are detected and the more subtle, yet still powerful, influence of less obvious language and language awareness deficiencies goes unnoticed, then the industry will continue to misunderstand the critical need for language training to become a priority and a long-term, industrywide commitment.

Elizabeth Mathews, an applied linguist who led the international group that developed ICAO's English language proficiency requirements, researches the role of language as a factor in aviation communication and advocates for improving the quality of aviation English training and teacher training.

Notes

1. Corder, S.P. "Strategies of Communication." In Faerch, C.; Kaster, G. (editors) *Strategies in Interlanguage Communication.* London: Longman. 1983.
2. Ginnett, R.C. "The Formation Process of Airline Flight Crews." <www.faa.gov/library/online_libraries/aerospace_medicine/sd/media/ginnett_r.pdf>. 1987.
3. Hines, W.E. "Teams and Technology: Flight Crew Performance in Standard and Automated Aircraft." The University of Texas at Austin: Unpublished doctoral dissertation. 1998.
4. Sexton, B.J.; Helmreich, R.L. "Using Language in the Cockpit: Relationships With Workload and Performance." In R. Dietrich (editor), *Communication in High Risk Environments*. Berlin: Humboldt Universitat zu Berlin. 2003. 57–73.
5. Young, R.; Faux, W.V. "Descriptions of Difficult Conversations Between Native and Non-Native English Speakers: In-Group Membership and Helping Behaviors." *The Qualitative Report* Volume 16 (March 2011): 494–508.
6. Lehman, Stan. "Brazil Air Controller Convicted Over 2006 Crash." The Associated Press. 27 October 2010.
7. McCroskey, J.C. "Oral Communication Apprehension: A Summary of Recent Theory and Research." *Human Communication Research* 4. 78–96. 1977.
8. Horwitz, E.K.; Horwitz, M.B.; Cope, J. (1991). "Foreign Language Classroom Anxiety." In E.K. Horwitz and D.J. Young (editors), *Language Anxiety: From Theory and Research to Classroom Implication*. New Jersey: Prentice-Hall.
9. MacIntyre, P.D. "How Does Anxiety Affect Second Language Learning? A Reply to Sparks and Ganschow." *The Modern Language Journal* Volume 79 (Spring 1995): 90–99.

U.S. National Aeronautics and Space Administration

BY ED BROTAK

Heavy snowfall and high wind from monster storms called bomb cyclones periodically disrupt aviation operations.

Winter Hurricanes

On Oct. 29, 2011, U.S. weather maps showed a benign-looking 1007-millibar (29.74-in Hg) low pressure area off the coast of North Carolina at 1200 coordinated universal time (0800 local). As the low moved up the East Coast, it began to deepen explosively. With abnormally cold air being pulled in from Canada, rain changed to snow at many locations.

Some reporting stations recorded snowfall rates of 2 to 4 in (5 to 10 cm) per hour and visibilities at local airports dropped to near zero. The town of Peru in extreme western Massachusetts received 32 in (81 cm) of snow, a record for so early in the season. Locations that escaped heavy snow still had to deal with strong winds.

Nantucket, Massachusetts, observations reported sustained winds of 40 kt with gusts to 60 kt. Aviation operations along the entire northeastern corridor were dramatically affected. At Newark (New Jersey) Liberty International Airport (EWR), heavy rain changed to heavy snow during the day and visibilities dropped to 1/4 mi (400 m). For a time, all flights were canceled. John F. Kennedy International Airport (JFK) and LaGuardia Airport in New York City had five-hour delays. By the morning of Oct. 30, a powerful 977-millibar (28.84-in Hg) low sat just south of Nova Scotia. The pressure had fallen 30 millibars (0.90 in Hg) in 24 hours.

Consecutive 'Bombs'

Less than a year before this storm, an even more powerful one had affected the same U.S. region. Having left snow as far south as Georgia and Alabama on Dec. 25, 2010, an already potent low pressure area (992 millibars [29.29 in Hg]) started moving up the coast on Dec. 26. By the next morning, a 962-millibar (28.41-in Hg) low sat just off of Cape Cod, Massachusetts.

All three major airports servicing New York City — Kennedy, LaGuardia and Newark — were closed on Dec. 27 and did not reopen until the morning of Dec. 28. More than 1,400 flights were canceled. At the height of the storm, JFK reported a visibility of zero in heavy snow with winds gusting to 49 kt.

Across the Hudson River, EWR reported visibility of 1/8 mi (200 m) for hours with snow accumulating at rates of 2 to 3 in (5 to 8 cm) per hour. Winds gusted to 39 kt. Newark wound up with 24 in (61 cm) of snow and JFK with 16 in (41 cm). Farther up the coast in Massachusetts, winds continued to increase through the night and into the morning of Dec. 27. Nantucket reported gusts of 50 kt from the southeast ahead of the low and from the northwest following the storm's passage. Logan International Airport in Boston measured 18 in (46 cm) of snow. Meteorologists call such extreme winter storms *bomb cyclones* or simply *bombs.*

Fred Sanders, a professor of meteorology at the Massachusetts Institute of Technology, coined the term *bomb* in 1980 to classify rapidly developing extratropical cyclones. These are the extreme winter storms. To officially qualify as a bomb, a low must deepen at least 24 millibars in 24 hours. Meteorologists even call the development/intensification process *bombogenesis.*

Phenomenal Origin

These super storms develop in the colder months at higher latitudes, usually those from 40 degrees toward the North Pole. They are the result of intense temperature contrasts and powerful jet streams. They also are often associated with copious amounts of precipitation, and, because these are cold-season phenomena, the precipitation is often in the form of snow. Regardless of amounts or types of precipitation, bombs are always prolific wind-makers. Winds of 50 kt are common, and winds in excess of 100 kt have been recorded.

In aviation, these storms produce a wide variety of problems and hazards. The dangers of heavy snow to aviation operations are well documented and include reduced visibility, aircraft icing and slick runways. The strong winds often pose an even greater threat. Besides the high sustained winds at the surface, excessive gusts are also common.

Typically, gusts can run 20 kt or greater than the mean wind. This is indicative of strong vertical wind shear. Higher winds just above the surface are mixed down in the gusts. For the December 2010 storm, a sounding taken just outside New York City in the evening of the 26th showed winds of 50 kt just 1,000 ft above the surface, with winds increasing to 77 kt at 3,600 ft.

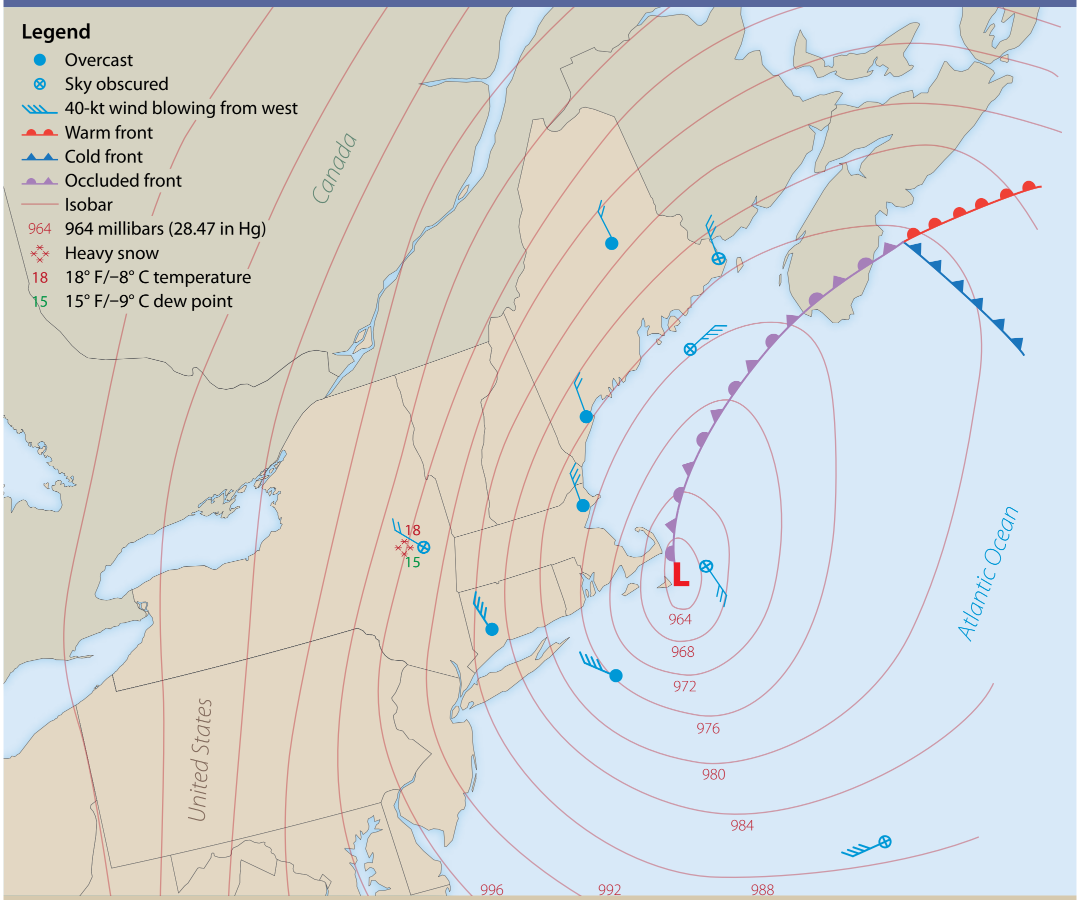
For the October 2011 storm, vertical wind profiles taken near Nantucket indicated winds of 60 kt within 1,000 ft above ground level. Winds of this strength at a terminal make takeoff and landing extremely difficult, especially if there is a crosswind. Just above the ground, the extreme wind shear generates severe turbulence. Airplane crews in flight having to deal with strong headwinds face significant delays in their arrivals.

What causes a low to "bomb out"? The answer is that the same atmospheric processes that produce typical extratropical cyclones are at work, but they are in overdrive. To briefly review the physics involved, atmospheric pressure is just the weight of a column of air above a point. Surface pressure will fall when air is removed from above a point. This occurs when the wind speed increases with height or when air is spread out over a larger area. This is called *divergence.*

So, to explain what is happening at the surface, we must look aloft. Divergence aloft is found in certain regions of the jet stream and ahead of upper-level troughs of low pressure. On the east side of these troughs in the Northern Hemisphere, the airflow is spread out, creating the divergence needed to lower the surface pressure (Figure 1). With a favorable jet stream configuration, development can be rapid. Exacerbating the problems caused by these storms is the fact that they tend to slow down when they are intensifying rapidly. They can even become stationary. The problems associated with these storms can last for a day or more at some locations.

As previously noted, strong wind associated with these storms is a major risk factor to aviation operations. This wind is generated by differences in pressure, with air always trying to go from higher to lower pressure. The greater the difference in pressure, the faster the winds. On a surface weather map, this is indicated by the pressure gradient, that is, the distance between the isobars or lines of equal pressure. If

Bomb Cyclone Surface Analysis



Note: Examples of data from 1200 coordinated universal time on Dec. 27, 2010, show a deep center of low pressure (L) along the northeastern coast of the United States. Selected weather stations show the winds and one (center) includes temperatures and precipitation.

Source: Ed Brotak and U.S. National Oceanic and Atmospheric Administration

Figure 1

these lines are close together, we have a tight pressure gradient, and strong winds can be expected. Low pressure areas, especially ones that are deepening rapidly, have very tight pressure gradients and resulting strong winds.

Familiar Features

People often consider these storms as "winter hurricanes," and at times they can resemble tropical cyclones. They can have eye-like features, small clear areas at the center of the storm. They can also have active convection. The December 2010 storm featured "thundersnow" (*ASW,* 10/10, p. 18) in the New York/New Jersey metropolitan region. Convective bands also were noted, similar to the so-called "spiral bands" in tropical cyclones. For bombs, the bands have been associated with the strongest winds and heaviest snowfalls. These storms are always associated with surface fronts and strong jet stream winds aloft.

Although surface winds may not be quite as strong as in the strongest tropical cyclones, the lows in the case of bomb cyclones cover a much bigger area. Tropical cyclones are relatively small, averaging a few hundred miles across, but the diameter of the winter storms is often much larger, at times approaching 1,000 mi (1,600 km).

Typically, bomb cyclones begin to develop over water. Warm currents typically found off the east coasts of continents are active breeding grounds. The mild air over the warm waters contrasts greatly with the bitterly cold arctic air that moves off the continents at high latitudes. The extreme temperature difference between air masses — in addition to energy derived from condensation in the clouds — fuels the cyclone. So bombs are technically extratropical, not tropical, because they get their energy from the contrast of air masses, not just from warm tropical waters.

Interestingly, tropical cyclones occasionally can turn extratropical in the late fall, especially at higher latitudes. Sometimes, tropical cyclones will "bomb out" and become major storms again. This commonly occurs in the

Pacific Ocean in October and November when typhoons in the western Pacific become major winter-type storms in the North Pacific.

International Locations

Areas most commonly affected by these storms in the Pacific Basin include eastern Asia from Japan northward, coastal Alaska and British Columbia, and occasionally the Pacific Northwest of the United States. On the Atlantic side, the affected areas tend to be the U.S. East Coast from North Carolina northward, through the Canadian Maritimes, coastal areas of Greenland and Iceland, and sometimes as far east as Western Europe.

Bomb cyclones also develop over the Mediterranean Sea in the colder months. And powerful extratropical cyclones are not limited to the Northern Hemisphere. New Zealand and southern Australia, as well as southern South America, can be affected. A bomb that hit southern Brazil and Uruguay in August 2005 produced winds of 80 kt, with a peak gust of 100 kt.

But warm water is not essential for bombogenesis, and strong cyclones also can develop over the interiors of continents. Inland cyclones, often deprived of a significant moisture source, have less precipitation. Therefore, the aviation problems associated with rain and, especially, heavy snow are often greatly reduced. However, the hazards produced by strong winds are still present.

On Oct. 25, 2010, an already-potent low pressure area moved into the U.S. western Great Lakes. Fueled by a 165-kt jet stream and a 40-degree F (20-degree C) temperature difference across the cold front, the low "bombed out." By late on the following day, a 955-millibar (28.21 in Hg) low was located over extreme northeastern Minnesota. This was the lowest recorded pressure ever in the central United States and is comparable in pressure to a Category 3 hurricane.

The magnitude of the storm is illustrated (p. 47) by the fact that five U.S. states and considerable portions of southern Ontario and Manitoba in Canada experienced wind gusts exceeding 60 kt. At Chicago's O'Hare International Airport, winds increased throughout the day on Oct. 26 and continued blowing hard on the 27th. Sustained winds of 20 kt with gusts to 44 kt were recorded. Hundreds of flights were canceled at O'Hare alone. Pierre Regional Airport in South Dakota endured winds gusting to more than 40 kt for a 32-hour period.

These winter storms are even stronger at higher latitudes. The Bering Sea and Gulf of Alaska have many powerful cyclones in the winter, but on Oct. 25, 1977, a low-pressure area rewrote the record books. Dutch Harbor in the Aleutians recorded a pressure of 926 millibars (27.35 in Hg), the lowest pressure ever recorded in North America for an extratropical system. Winds at nearby Adak gusted more than 80 kt for 12 hours with a peak gust of 110 kt.

Cyclones in the North Atlantic Ocean have gotten even stronger. The storm that severely damaged the luxury liner Queen Elizabeth II in 1978 had a central pressure drop of 60 millibars (1.77 in Hg) in 24 hours. In January 1993, a storm in the North Atlantic had a central pressure of 913 millibars (26.96 in Hg). If it had been a tropical system, it would have qualified as a Category 5 hurricane, the strongest storm ranking.

Bombs, by their nature, can develop very quickly. Fortunately, today's computer forecast models are pretty good at spotting major cyclone development days or sometimes even a week in advance. These models work best for the upper levels of the atmosphere, so the upper-level troughs which produce the surface cyclones are usually well handled. In particular, the model looks for injections of very cold air into existing troughs. This will intensify the trough and the jet stream winds.

The roles of moisture and other low-level features are also dealt with more efficiently now than a few decades ago. In fact, it was a bomb off the Mid-Atlantic coast — the infamous Presidents' Day Snowstorm of February 1979, which dropped an unforecast 20 to 30 in (51 to 76 cm) of snow — that prompted much of the research that identified this class of storms and refined the techniques to forecast them.

Forecasts are not perfect, and occasionally, a storm will be missed. Warnings for the December 2010 blizzard were sent out only 24 hours in advance. The various forecast models all predicted major *cyclogenesis,* the process of development or intensification of a cyclone, but some predicted that the storm would move up the East Coast while others took it harmlessly out to sea. In situations where forecast models don't agree, meteorologists are left in a quandary as to which model to believe.

A bomb-induced snowstorm in the U.S. northeastern megalopolis during any Christmas–New Year holiday week — or similar major air travel period in a densely populated region in any country — can be expected to have major consequences. U.S. forecasters decided to wait in the 2010 example until the models came into better agreement, which, in this case, left little lead time for warnings.

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

BY RICK DARBY

Unsafe Acts

A study of accidents in Alaska provides evidence that it's best to follow the rules.

Skill-based error accidents were the most prevalent, followed by decision error accidents, in an analysis of accidents in Alaska, U.S., involving fatality or serious injury.[1] But those that involved rule violations were the most deadly.

The accidents — which involved airplanes and helicopters — were categorized by researchers according to the Human Factors Analysis and Classification System (HFACS) devised by Douglas Wiegmann and Scott Shapell. The full HFACS taxonomy includes a hierarchy of four levels, but for this study only the lowest level, "unsafe acts," was used. That in turn was subdivided into skill-based error, perceptual error, decision error and violations.

The study analyzed 97 accidents occurring from 2004 to 2009. Of those, 55 involved aircraft flown under U.S. Federal Aviation Regulations Part 91, *General Operating and Flight Rules*; 18 involved Part 91 flights in business use, designated by the researchers as Part 91c; and 24 involved flights under Part 135, which covers commuter and on-demand operations. Of the accident total, 56 were fatal; 41 resulted in serious injury only. The report on the study noted that "general aviation activity in Alaska has always been extremely vital to that state's economy and industry."

More than 70 percent of Part 91c accidents and 60 percent of Part 91 accidents were fatal. Only in Part 135 accidents were the majority, 58.3 percent, non-fatal. Pilots in the Part 135 accidents had an average 8,330 flight hours, compared with 4,168 for Part 91 pilots and 6,396 for Part 91c pilots.

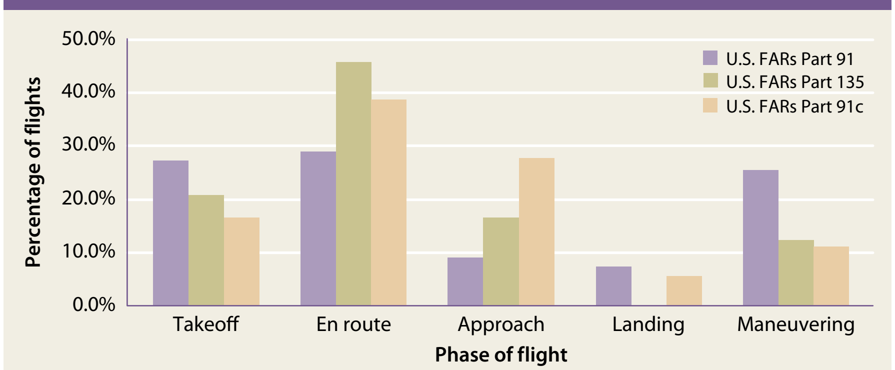
The takeoff and en route phases of flight accounted for the largest percentages of accidents, 23.7 percent and 35.1 percent respectively. "Maneuvering," such as instructional flights, hovering helicopters and flying other than between two points, was the third most frequent phase at 19.6 percent. Landing was the least frequent, including 5.2 percent of the accident total.

"There were no accidents during the landing phase for Part 135 operations," the report says. "In addition, there were more accidents during the approach phase than during the maneuvering phase." En route accidents represented the highest percentage for Parts 91, 91c and 135 (Figure 1).

Some differences in severity — fatality versus serious injury — were also noted (Figure 2, p. 52). The report says, "If the accident occurred during takeoff or landing, it was more likely to involve a serious injury, but no fatality. Most likely this was because of the lower energies associated with those phases of flight. However, if the accident occurred during the en route phase, it was more likely to involve a fatality. Approach accidents were divided equally, while maneuvering accidents slightly favored fatalities."

Only 10 of the 97 accidents, or slightly more than 10 percent, were not associated with flight crew error.[2] The researchers categorized each of the remaining accidents according to HFACS categories:

Alaska Fatal and Serious Injury Accidents, by Phase of Flight, 2004–2009



Note: Accident aircraft were operating under U.S. Federal Aviation Regulations Part 91 and Part 135. Part 91c is the researchers' term for Part 91 flights with an incidental business purpose.

Source: U.S. Federal Aviation Administration

Figure 1

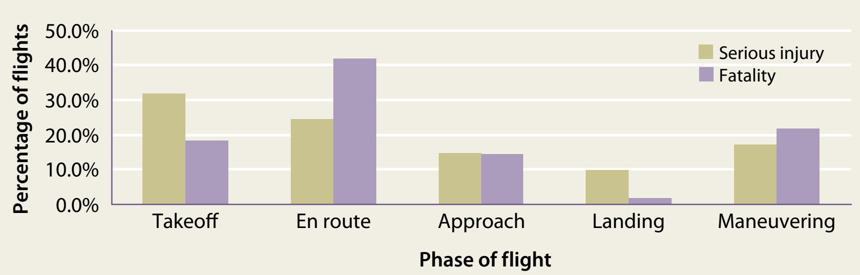
- A *skill-based error* "occurs with little or no conscious thought and is particularly susceptible to attention and/or memory failures."
- A *perceptual error* "occurs when sensory input is degraded or 'unusual,' as is often the case when flying at night, in the weather or in other visually impoverished environments."
- A *decision error* "represents conscious, goal-intended behavior that proceeds as designed, yet the plan proves inadequate or inappropriate for the situation."
- A *routine violation* "tends to be habitual by nature and is often enabled by a system of supervision that tolerates such departures from the rules." An *exceptional violation* is "an isolated departure from authority, neither typical of the individual nor condoned by management." In this study, both types of violations were conflated into a single category, "violations."

Skill-based errors were found to be a causal factor in slightly more than half of the accidents. Decision errors were a causal factor in about one-third of the accidents. A single accident could have more than one HFACS category of causal factor.

"Thirty-two accidents … involved a decision error on the part of the pilot," the report says. "Twenty-five of these decision errors were faulty judgments regarding the weather."

Violation accidents — numbering 24 in the data set — most commonly included overloading the aircraft. Five accidents were associated with illegal drug use, four involved medical certification of the pilot and two involved unreported cases of diabetes.

Alaska Fatal and Serious Injury Accidents, by Severity, 2004–2009

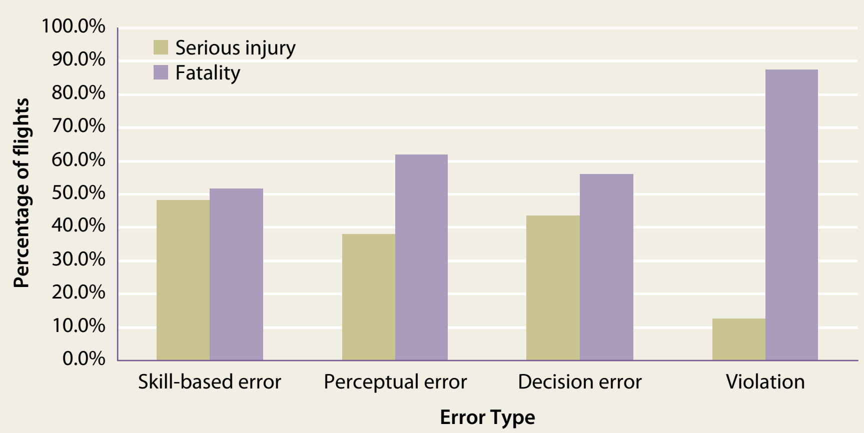


Note: Accident aircraft were operating under U.S. Federal Aviation Regulations Part 91 and Part 135.

Source: U.S. Federal Aviation Administration

Figure 2

Alaska Fatal and Serious Injury Accidents, by HFACS Category, 2004–2009



HFACS = Human Factors Analysis and Classification System

Note: Accident aircraft were operating under U.S. Federal Aviation Regulations Part 91 and Part 135. An accident could be categorized as having more than one error type.

Source: U.S. Federal Aviation Administration

Figure 3

For every HFACS category of error type, fatal accidents outnumbered those with only serious injuries (Figure 3). "This reflects that there are more fatality accidents in the database," the report says. "However, for skill-based error and decision-error accidents, the number of fatal accidents and serious-injury accidents was nearly identical. We see a larger ratio of fatal accidents for those associated with perceptual errors. But the ratio of fatal to serious injury accidents among the violation accidents was seven to one."

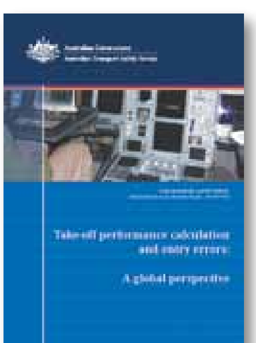
Notes

1. Williams, Kevin W. *A Human Factors Analysis of Fatal and Serious Injury Accidents in Alaska, 2004–2009*. FAA Civil Aerospace Medical Institute. DOT/FAA/AM-11/20. December 2011. <www.faa.gov/library/reports/medical/oamtechreports/2010s/media/201120.pdf>.
2. Several of the 10 accidents not involving flight crew error included errors in maintenance or inspection, but those were not examined for their human factors components.

Safety in Numbers

Correct V speeds rely on valid takeoff performance parameters.

BY RICK DARBY



REPORTS

Tied Up in Knots

Take-off Performance Calculation and Entry Errors: A Global Perspective

Australian Transport Safety Bureau (ATSB). Aviation Research and Analysis Report AR-2009-052. 97 pp. <www.atsb.gov.au/publications/2009/ar2009052.aspx>. 2011.

During takeoff from Montego Bay, Jamaica, the Airbus A330-243 seemed at first to accelerate as expected on an October 2008 flight to London. "After passing 100 kt, the first officer called 'V_1' and 'V_R,'" the report says. "The captain was surprised by the quick succession of these calls. The first officer called 'rotate' and the captain pulled back on the sidestick. When [he did] so, the aircraft did not appear to feel right and the captain immediately applied TO/GA [takeoff/go-around] thrust."

Following completion of the "After Takeoff" checklist, the crew compared the takeoff performance figures against those specified in the flight crew operating manual. They discovered significant discrepancies.

Takeoff weight was given by the dispatcher as 120,000 kg (264,555 lb); the actual takeoff weight was 210,183 kg (463,374 lb). The error led to incorrect V speeds. Instead of the correct 136 kt, V_1 was called at 114 kt. Rotation should have occurred at 140 kt, but took place at 125 kt.

That crew recovered from the error. Not every flight crew is so fortunate in the case of mistaken data calculation or data entry in the cockpit (see, "Absence of Reasonableness," p. 12). The report describes 20 international and 11 Australian accidents and incidents, called occurrences, in which "the calculation and entry of erroneous takeoff parameters, such as aircraft weights and V speeds were involved. … [The report] provides an analysis of the safety factors that contributed to the international occurrences and suggests ways to prevent and detect such errors."[1]

The report is organized as follows:

- Defining takeoff performance parameters, the methods used by airlines for calculating and entering the parameters, typical errors that sometimes result and the consequences.
- A brief summary and analysis of occurrences resulting from takeoff calculation and entry errors involving Australian

aircraft from 1989 to June 2009. Another chapter provides detailed descriptions of similar occurrences involving non-Australian aircraft during the same period.[2]

- A safety factor analysis of the non-Australian-aircraft occurrences, using the ATSB's investigation analysis model.
- Discussion of ways to minimize some of the common causal factors.

Takeoff performance parameters include reference speeds, or V speeds. The aircraft's takeoff weight (TOW) and zero fuel weight (ZFW) are critical for determining the V speeds. In addition, the report says, reduced-thrust takeoffs are commonly conducted to save wear and tear on the engines; those takeoffs require that an "assumed" or "flex" air temperature higher than the actual ambient temperature be factored in.

"Different airlines use, and different aircraft types require, different methods for calculating and entering takeoff performance parameters," the report says. "These may be performed manually or be automated; they may be performed by the crew using performance manuals, the flight management system (FMS), the flight management computer (FMC) or a laptop computer; or remotely by the use of the aircraft communications addressing and reporting system (ACARS)."

'Different airlines use, and different aircraft types require, different methods for calculating and entering takeoff performance parameters.'

Typical errors, the report says, include these:

The ZFW is inadvertently used instead of the TOW; the numbers for a weight are transposed — for example, 324,000 kg becomes 234,000 kg; V speeds are incorrectly entered in the system manually; takeoff data are not updated to reflect a change in conditions, such as ambient temperature; the wrong value is selected from the load sheet or takeoff data card. And there are other ways of messing up the takeoff performance parameters.

If such errors are not caught and fixed, dire consequences may result: tail strike; reduced acceleration or climb rate — the aircraft feels "sluggish"; degraded handling; rejected takeoff; runway overrun; overweight takeoff; reduced obstacle clearance; and other dangerous possibilities.

For Australian occurrences, the specific takeoff performance parameter error was identified in 10 of the 11 cases. "Of these 10, half were related to errors involving V speeds," the report says. "This was followed by aircraft weights, accounting for three occurrences. Of this, two were related to the ZFW and one related to the aircraft's TOW. There were two occurrences where an erroneous flex temperature was used."

The action, or inaction, that led to the erroneous takeoff performance parameters was identified in all 11 occurrences. Data entered incorrectly or not updated accounted for three occurrences each. Using the wrong manual or the wrong figure happened in two occurrences each. In one instance, the data were not checked after a change in flight conditions.

The type of device or aircraft system involved was identified in 10 occurrences. "The most prevalent was the FMC, accounting for just over a quarter of the occurrences," the report says.

An operational or environmental change — for example, a switch from a published instrument departure procedure to a visual departure — was associated with six occurrences, requiring the crew to check, change and/or update the parameters previously calculated.

Six of the 11 occurrences had an effect on flight, including reduced performance on takeoff, a rejected takeoff, a tail strike and application of TO/GA thrust.

The data from the 20 non-Australian occurrences offered a counterpoint to those that took place in Australia.

"While half of the Australian occurrences analyzed … involved the incorrect calculation or input of V speeds, they accounted for only four of the 20 international occurrences," the report says. "The incorrect calculation or input of weight parameters accounted for the greatest proportion, with 16 occurrences, of which 14 were related to the aircraft's TOW and two involved the fuel on board weight."

In 11 non-Australian occurrences, or more than half, *wrong data* were entered — for example, entering the ZFW instead of the TOW, or using the TOW from the previous flight. In four cases, the data were correct but the *entry* was wrong.

"The most common devices involved in the calculation or entry of erroneous takeoff performance parameters related to aircraft documentation and the laptop computer, accounting for six and five occurrences respectively," the report says. "Documentation errors included using the wrong weight to determine the V speeds from aircraft performance charts, using the wrong chart or not taking into account certain flight conditions when determining the maximum permitted TOW."

In contrast to the Australian occurrences, all of the international occurrences affected flight. Eleven led to a tail strike, and four resulted in reduced takeoff performance. Five of the occurrences resulted in collision with an obstacle or terrain.[3] Changed operational and environmental conditions were found to have been present in nine occurrences.

The researchers conducted a safety factor analysis of the non-Australian occurrences.[4] "A total of 131 contributing safety factors were identified from the 20 accidents and incidents," the report says. "Of these, 39 percent were related to individual actions." This was followed by risk controls, or "what could have been in place to reduce the likelihood or severity of problems at the operational level," in 31 percent and local conditions in 28 percent.

Under the heading of individual actions, 50 were aircraft operation actions by the flight crew. In order of frequency, the report says, they included "monitoring and checking," "assessing and planning," "using equipment," "communicating and coordinating (internal)," and "communicating and coordinating (external)."

Of the 131 safety factors, 41 were identified as risk controls. "Of these, 46 percent were related to problems with the usability or availability of aircraft equipment, and 37 percent involved problems with the design, delivery or availability of procedures, checklists or work instructions used by operational personnel," the report says.

The most common local condition identified was "task experience or recency, accounting for 31 percent of all local conditions. This refers to situations where an individual did not have a sufficient amount of total or recent experience to conduct the task appropriately. This also includes being unfamiliar with a task or procedure, and negative transfer influences from other aircraft types or flights."

While cautioning that no single solution exists, the report offers suggestions for minimizing the risk.

The report recommends an independent calculation or cross-check of the takeoff performance data by a second crewmember; having procedures for when the primary aircraft system used to calculate parameters is unavailable; and clearly delineating the responsibilities of each crewmember.

"Where more than one system is available for calculating takeoff performance parameters, system manufacturers and airlines should consider provisions for cross-checking the data between both sources," the report says. "For example, the V speeds automatically calculated by the FMC may be entered into the handheld performance or laptop computer and compared with those values calculated by the computer."

Improved design of tools and materials could help avoid miscalculation or mis-entry, the report suggests: "Flight plans and takeoff data cards should be designed so that all of the relevant performance figures have a designated location. … Performance data such as the TOW or ZFW should be presented clearly and unambiguously to reduce the possibility of the wrong figure being selected."

The report recommends an independent calculation or cross-check of the takeoff performance data by a second crewmember.

An airline's crew rostering practices should ensure that every crew includes a captain or first officer who is highly experienced in type, the report says.

If airline and cockpit procedures fail to "trap" erroneous takeoff parameters, it becomes all the more important to detect degraded takeoff performance in time to reject the takeoff safely. The report quotes an investigation by the Transportation Safety Board of Canada, which "recognized that despite over 30 years of industry effort, there is no acceptable 'in cockpit' defense that provides crews with the necessary information to indicate that the aircraft performance is insufficient to safely execute the takeoff."

Although takeoff performance monitoring systems have been the subject of research and experimentation, "solutions put forward have been too complex and demanding on the pilots," the report says. "A simple system that confirms that the takeoff is progressing as required is needed, one that is as easy to read and understand as the fuel gauge in a car."

Runway distance-remaining signs (RDRS), also known as "distance to go" markers, enable pilots to compare actual versus expected acceleration before rotation. Such markers have been in military use for years, but have not been adopted in civil aviation, the report says. It adds that the U.S. Federal Aviation Administration (FAA) currently recommends that the system be installed on runways used by jet aircraft, and the Air Line Pilots Association, International has urged the FAA to make RDRS compulsory at all U.S. airports with public transport aviation. "However, neither the International Civil Aviation Organization nor the Civil Aviation Safety Authority, Australia, require or recommend airport operators to install RDRS at the side of runways," the report says.

In conclusion, the report says, "Despite advanced aircraft systems and robust operating procedures, accidents will continue to occur during the takeoff phase of flight. [During takeoff] there are limited time and options available to the flight crew for managing abnormal situations such as insufficient airspeed. … The results of this study, and those from other related research, have recognized that these types of events occur irrespective of the airline or aircraft type, and that they can happen to anyone; no one is immune. While it is likely that these errors will continue to take place, as humans are fallible, it is imperative that the aviation industry continue to explore solutions, firstly to minimize the opportunities for takeoff performance parameter errors from occurring and secondly, to maximize the chance that any errors that do occur are detected and/or do not lead to negative consequences."

Notes

1. The examples of takeoff performance parameter errors were limited to aircraft with a maximum capacity of more than 38 seats or a maximum payload of 4,200 kg (9,259 lb). Accidents and incidents involving Australian-registered aircraft were sourced from the ATSB's safety database. Sources for data on non-Australian-registered aircraft included the International Civil Aviation Organization, the Ascend World Aircraft Accident Summary and the Transportation Safety Board of Canada.

2. The actual number of erroneous takeoff performance parameter events was probably greater, the report says. The database did not include errors that were discovered and corrected before takeoff, and other occurrences that involved no damage would normally not be reported.

3. The accident at Melbourne, Victoria, in March 2009 — the subject of the cover story on p. 12 — damaged ground equipment. In this report, the consequence of that occurrence is categorized as a tail strike rather than a collision with an obstacle.

4. A safety factor is "an event or condition that increases safety risk. In other words, it is something that, if it occurred in the future, would increase the likelihood of an occurrence, and/or the severity of the adverse consequences associated with an occurrence." Safety factor analysis of the 11 Australian occurrences could not be undertaken because of limitations in the data.

Off Into the Mud

High speed and heavy rain factor in a runway excursion.

BY MARK LACAGNINA

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

JETS

Approach Procedure Faulted

Boeing 727-200. Minor damage. No injuries.

The flight crew's use of a "pilot-flown approach" rather than a "pilot-monitored approach" at night and in heavy rain likely contributed to a higher-than-necessary approach speed, a late touchdown on a runway contaminated with standing water and the 727's overrun into deep mud, said the Transportation Safety Board of Canada (TSB).

The accident occurred about 0300 local time on March 24, 2010, during a scheduled cargo flight from Hamilton, Ontario, to Moncton, New Brunswick. None of the three flight crewmembers was hurt, and damage to the aircraft was minor.

Gusting winds and light rain had been forecast for Greater Moncton International Airport. When the aircraft arrived, the surface winds were from 110 degrees at 8 kt, gusting to 17 kt, visibility was 4 mi (6 km) in heavy rain and mist, and the ceilings were broken at 600 ft and overcast at 1,000 ft. The last runway surface condition report had been issued about eight hours before the 727 arrived.

The TSB report noted that, at the time of the accident, there was no requirement to issue a special weather report when light rain changes to heavy rain. However, the International Civil Aviation Organization adopted an amendment in November 2010 (eight months after the accident) requiring a special report to be issued when moderate or heavy precipitation begins or ends. The Canadian Aviation Regulations (CARs) were revised accordingly.

The pilots previously had conducted several flights to Moncton but usually had landed on Runway 11/29, which is 8,000 ft (2,438 m) long and has two nonprecision approaches. Because of the wind conditions, however, the crew chose to conduct the instrument landing system (ILS) approach to Runway 06, which is 6,150 ft (1,874 m) long and 200 ft (61 m) wide. "Neither runway … has a grooved surface or a runway end safety area, nor are they required by regulations," the report said. The captain, the pilot flying, had landed on the shorter runway only once before. The first officer had not landed on Runway 06 previously.

Questioning the crew's decision to use Runway 06, the report noted the crew's lack of experience in landing on that runway and that "the weather was above the nonprecision approach minima to Runway 11, which was within acceptable crosswind limitations and offered an additional 2,000 ft [610 m] of landing distance."

Using performance information from the aircraft flight manual (AFM), investigators determined that under the existing conditions and aircraft weight and configuration, the 727 would have required 5,990 ft (1,826 m) to land on Runway 06. This calculation was "based on the AFM and [does] not reflect the effect of outside air temperature, reverse thrust usage, or an adjusted V_{REF} [reference landing speed]," the report said.

The crew planned to conduct the ILS approach at 157 kt, based on a V_{REF} of 139 kt with 18 kt added to compensate for the wind conditions. According to the company's operations manual, "the approach speed is to be decreased as the aircraft nears the ground," the report said. "The gust correction is retained until touchdown, while the steady wind correction should be bled off as the aircraft approaches touchdown. In this case, the gust correction was 10 kt, which would make the target touchdown airspeed 149 kt."

The aircraft had entered heavy rain shortly after the crew established visual contact with the runway.

Shortly after the 727 was established on the ILS localizer and glideslope, the captain disengaged the autopilot and hand-flew the aircraft. Nearing the final approach fix (FAF), the aircraft drifted above the glideslope. The first officer and second officer called out the deviation, and the captain took corrective action. The aircraft crossed over the FAF about 50 ft higher than the published altitude. "The aircraft then was re-established on the glideslope and remained on the glideslope until it crossed the runway threshold," the report said.

The aircraft had entered heavy rain shortly after the crew established visual contact with the runway about 2 nm (4 km) from the threshold. It crossed the threshold at 165 kt and touched down at 157 kt — 8 kt above the target touchdown speed — nine seconds later. The touchdown point was between 2,000 and 2,500 ft (610 and 762 m) from the threshold. "From threshold crossing to touchdown, the aircraft's average rate of descent was calculated to be approximately 400 fpm," the report said.

The speed brakes activated automatically on touchdown, and the crew applied maximum manual anti-skid braking and full reverse thrust about three seconds later. Hydroplaning on the standing water, the 727 veered about 8 degrees right of the centerline. The crew responded by reducing reverse thrust until the aircraft was re-established on the runway heading about three seconds later.

With full reverse thrust and maximum manual braking still being applied, the 727 ran off the ends of the runway and the paved 197-ft (60-m) runway end strip at about 50 kt. "The aircraft came to rest in deep mud, the nosewheel approximately 340 ft [104 m] beyond the runway end and 140 ft [43 m] beyond the edge of the paved runway end strip," the report said.

The airport's aircraft rescue and fire fighting (ARFF) operation had closed on schedule at 2345. "There is no requirement for designated airports to provide ARFF for cargo-only flights," the report said. "A local fire department responded and arrived on-scene approximately 20 minutes after the aircraft departed the runway. The flight crew exited the aircraft using a ladder provided by the firefighters."

Neither the CARs nor the company's standard operating procedures required a pilot-monitored approach (PMA) in the conditions that existed at Moncton. During a PMA, the pilot flying keeps the autopilot engaged until reaching the decision height or minimum descent altitude on approach and then transfers control to the pilot monitoring, who completes the approach and landing.

The report said that Transport Canada found that PMAs "improve the transition from instruments to visual conditions, as well as improve the captain's decision-making ability in the high-workload terminal approach and landing environment."

Windshield Fire Prompts Diversion

Airbus A330-203. Minor damage. No injuries.

The A330 was at Flight Level (FL) 390 (approximately 39,000 ft) and 365 nm (676 km) northwest of Cairns, Queensland, Australia, the night of March 22, 2011, when an odor was detected in the cabin and on the flight deck. "The flight crew actioned the aircraft quick reference handbook checklist for 'Smoke/Fumes/Avionics' in an attempt to minimize the smell, and cabin crew confirmed that this was successful," said the report by the Australian Transport Safety Bureau (ATSB).

Shortly thereafter, however, an arc in the electrical circuit for the left windshield heating system produced a small flame that appeared in the bottom left corner of the windshield. The pilots donned their oxygen masks, used a fire extinguisher to douse the flame and engaged the window heat computer reset button in compliance with the "Cockpit Windshield/Window Arcing" checklist.

About 20 minutes later, the electronic centralized aircraft monitor generated a fault message, "L WINDOW HEAT," and displayed the procedure for correcting the fault. "Despite following that procedure, a further four occasions of arcing and flames occurred over the next six minutes, all of which were extinguished," the report said. "The aircraft operator's maintenance watch advised the crew to deselect the probe window heat, although there was no assurance that action would remove power from the windshield."

The crew decided to divert the flight — which was en route with 147 passengers and 11 crewmembers from Manila, Philippines, to Sydney, New South Wales — to Cairns. "The crew also advised ATC [air traffic control] that they had extinguished repeated fires, the result of electrical arcing from an electrical short circuit in the captain's windshield heater," the report said. The A330 subsequently was landed at Cairns without further incident.

The windshield was among those that had been identified by a May 2010 service bulletin as requiring replacement. According to the report, Airbus issued the service bulletin after receiving several reports of overheated windshield heat connectors in A330s. When the incident occurred, the operator's plan was to replace the affected windshields in its A330 fleet by September 2011, which "was well within the Airbus recommended compliance date of May 2012 for this operator," the report said.

On the Brakes During Takeoff

Gulfstream G150. Minor damage. No injuries.

The commander briefed the copilot that he would conduct a static takeoff, applying full power while holding the wheel brakes, because of the relatively short runway at RAF Northolt Airport in London. In addition to the pilots, there were two passengers and a cabin attendant aboard for the intended return flight to Moscow the afternoon of Feb. 6, 2011.

The crew began the takeoff from the approach threshold of Runway 25, which is 5,535 ft (1,687 m) long. As the G150 reached rotation speed, 122 kt, the commander pulled the control column back, but the aircraft did not respond. He then pulled the column fully back, but the aircraft pitched up only about 1 degree, said the report by the U.K. Air Accidents Investigation Branch (AAIB).

The crew rejected the takeoff just before the aircraft reached 129 kt, or V_2, the takeoff safety speed. "Full braking was applied, and the aircraft came to a stop at the end of the paved surface," the report said. "A fire broke out around the left main wheels, which was suppressed quickly by the rescue and fire fighting service."

Investigators found no pre-existing technical faults and were unable to identify the probable cause of the incident. "The most likely explanation for the lack of acceleration and rotation was that the brakes were being applied during the takeoff, probably as a result of inadvertent braking application by the commander, which caused a reduction in acceleration and a nose-down pitching moment sufficient to prevent the aircraft from rotating," the report said.

The commander pulled the control column back, but the aircraft did not respond.

The commander, 32, had 1,750 flight hours, including 490 hours in type. "He had recently completed his qualification to fly as pilot-in-command on type, and this was his first flight as commander," the report said.

Gear Neglected During Approach

Boeing 767-300. No damage. No injuries.

Interruptions and distractions during an approach to Sydney, New South Wales, Australia, led to a breakdown of situational awareness and resulted in the flight crew not realizing until the 767 descended below 500 ft that the landing gear was not extended, according to the ATSB's recent report on the Oct. 26, 2009, occurrence. The pilots conducted a go-around and subsequently landed the aircraft without further incident.

Before beginning the descent to Sydney, the crew had briefed the ILS approach to Runway 16R, using the operator's noise-abatement procedure, which required in part that the landing gear and landing flaps be extended at a radio altitude (RA) of 2,000 ft rather than on intercepting the glideslope.

Based on weather reports, the crew expected to transition from instrument to visual meteorological conditions well before reaching decision height.

The 767 was established on the ILS and descending through 2,500 ft above ground level when ATC instructed the crew to establish radio communication with Sydney Tower. "The pilot flying [the first officer] stated that he considered [the ATC instruction] a late requirement to call the tower, which distracted him from the 2,000 ft RA procedural point in the operator's noise-abatement procedure," the report said.

Among further distractions were a weak outer marker signal, which prompted the captain to perform a mental check of the aircraft's profile, and showers in the vicinity of the runway. Both pilots also told investigators that, after the aircraft descended below 1,000 ft, they focused their attention on potential conflicts with an aircraft ahead on the approach and with another aircraft that had been cleared for takeoff on Runway 16R. The first officer said that, in response, he mentally rehearsed the go-around procedure a number of times during final approach.

"As the aircraft was approaching 500 ft RA, clearance to land was given by ATC and, almost simultaneously, both pilots identified that the aircraft was incorrectly configured," the report said, noting that the enhanced ground-proximity warning system generated a "TOO LOW GEAR" warning about the same time. The crew immediately initiated the go-around.

TURBOPROPS

'Trace of Ice' Induces Stall on Takeoff

Cessna 208B. Substantial damage. No injuries.

Statements obtained from the seven passengers indicated that there was ice on the Caravan's wings when the aircraft departed in freezing rain from Kwigillingok, on the west coast of Alaska, U.S., for an air taxi flight to Kipnuk the evening of Feb. 17, 2010.

The airplane was about 200 ft above the ground shortly after takeoff when engine power began to fluctuate. The NTSB report said that although the pilot was able to restore power by moving the emergency fuel control lever forward, the Caravan stalled, struck the surface of a frozen lake and became airborne again.

"For safety reasons, the pilot chose to fly straight ahead for 8 mi [13 km] to Kongiganak, Alaska, where the flight landed without further difficulty," the report said. Examination of the Caravan revealed that the right wing had been substantially damaged when the airplane bounced off the frozen lake.

When interviewed by an investigator, the pilot said that there was a "trace of ice" on the wings when the airplane departed from Kwigillingok. The report noted that takeoff with any ice on the wings is prohibited and that the Caravan AFM contains the following warning: "Even small amounts of frost, ice, snow or slush on the wing may adversely change lift and drag. Failure to remove these contaminants will degrade airplane performance and may prevent a safe takeoff and climbout."

Faulty Valve Causes Depressurization

Bombardier Q400. No damage. No injuries.

The aircraft was nearing its assigned flight level, 230, during a scheduled flight from Southampton, England, to Dublin, Ireland, the morning of Jan. 5, 2010, when the copilot, the pilot monitoring, noticed an excessive climb rate (1,500 fpm) on the cabin altimeter — an indication of a pressurization system malfunction.

Shortly thereafter, the pressurization fault annunciator illuminated, the AAIB report said. The commander changed pressurization system control to manual, then back to automatic, but the fault indication persisted.

The pilots donned their oxygen masks, declared an emergency and conducted an emergency descent to 10,000 ft, where they changed their flight status to an urgency. The crew then returned to Southampton and landed without further incident.

When the pressurization problem occurred, both cabin crewmembers were completing snack service to the 23 passengers and noticed that the "sandwich packets and coffee cup foils were beginning to burst," the report said. "One cabin crewmember stated, 'As I was walking to the rear of the galley, my ears were popping and I felt short of breath, my legs felt weak.' Both cabin crew utilized oxygen bottles to regain composure and to refocus."

One cabin crewmember told investigators that after an unsuccessful attempt to contact the flight crew on the interphone, "I was worried that they were OK." Shortly thereafter, the commander used the public-address system to inform the passengers and cabin crew that the "emergency descent is now complete."

The cabin crewmembers said that several passengers complained of sore ears. However, after the aircraft landed, the "cabin crew and passengers were checked and found to be fit and well," the report said. "Post-incident investigation indicated that a faulty aft pressure outflow valve was the probable cause of the pressurization failure."

Loose Bolts Cause Aileron Separation

Beech E90 King Air. Substantial damage. No injuries.

The airplane had undergone maintenance that included an inspection of the ailerons requiring their removal and reinstallation. The pilot ensured that the ailerons were moving freely and correctly before departing from Des Moines, Iowa, U.S., to conduct a post-maintenance functional check flight the morning of Feb. 15, 2011.

The pilot and a maintenance technician performed a variety of checks of the engines and flight instruments at FL 180. "After completing the checks, the pilot requested a left, 180-degree turn back to [Des Moines]," the NTSB report said. "ATC approved the turn, and the pilot selected the autopilot heading switch for a left turn [to the airport]. Approximately 140 degrees into the turn, the autopilot jerked, stabilized and jerked again during the turn to level off."

The pilot noticed that the right aileron had separated from the King Air but was able to land the airplane without further incident.

The aileron was not found, but examination of the hinge brackets on the aft spar revealed that the attachment bolts had not been aligned properly in the nut plates when the aileron was reinstalled. As a result, the bolts "fell out" during the functional check flight, the report said.

PISTON AIRPLANES

Detached Boot Causes 'Violent Roll'

Piper Chieftain. Minor damage. No injuries.

During a cargo flight the morning of Feb. 9, 2011, the pilot felt a "slight shudder" when he activated the wing deicing boots on initial descent to Weston Aerodrome in Dublin, Ireland. "About 10 minutes later, the aircraft suddenly experienced a violent rolling motion but had no adverse pitch movements," said the report by the Irish Air Accident Investigation Unit. "The pilot scanned outside the aircraft and noted that the starboard deicing boot had partially detached and was flailing against the wing and aileron."

The pilot had difficulty controlling the aircraft and declared an urgency. "Dublin ATC immediately offered the pilot the option to land at Dublin [International Airport]," the report said. The pilot accepted this offer due to the fact that the Dublin runway was longer and wider than those available at [Weston]."

During approach, however, the control problems ceased, and the pilot noticed that the detached portion of the deicing boot had separated from the aircraft. The pilot requested and received clearance to proceed to Weston, where he landed the Chieftain without further event.

Examination of the aircraft revealed that a 1.6-m (5.2-ft) section of the inboard deicing boot, which had been installed in 2007, had "peeled away" from the wing leading edge, the report said, noting that further detachment was prevented by the stall warning vane bracket. The flailing section of boot had damaged the wing, flap and aileron.

"Inspection of the aircraft and examination of the maintenance records indicated that the aircraft was well maintained and offered no likely reason for the separation of the deicing boot," the report said.

Snow Was Deeper Than It Looked

Cessna 340A. Substantial damage. Three minor injuries.

The airport in Grove City, Pennsylvania, U.S., was unattended, and no notices to airmen about runway condition had been posted the morning of Feb. 27, 2010. "The pilot overflew the airport and noted what he believed to be a light coating of snow on the runway," the NTSB report said.

The pilot told investigators that the surface winds were from 260 degrees at 10 to 15 kt when he landed on Runway 28, which was 4,500 ft (1,372 m) long and 75 ft (23 m) wide. "After landing on Runway 28, the pilot realized that approximately 1 to 1 1/2 in [3 to 3 3/4 cm] of snow was present on the surface of the runway," the report said.

The 340 slid off the right side of the runway, struck a snowbank and spun 180 degrees. The pilot and his two passengers sustained minor injuries, and the aircraft's horizontal stabilizer was substantially damaged.

Control Lost in Severe Turbulence

Piper Twin Comanche. No damage. No injuries.

The aircraft entered an uncommanded dive when it encountered severe turbulence while cruising at 9,000 ft in instrument meteorological conditions (IMC) near Albury, New South Wales, Australia, the morning of Feb. 16, 2011. The pilot disengaged the autopilot and attempted to raise the nose of the aircraft, but the rapid descent continued.

"At about 6,000 ft and after a number of uncontrollable steep descents and climbs in dark cloud and rain, the pilot eventually regained control of the aircraft," the ATSB report said. The pilot told ATC that he was experiencing navigation and control difficulties due to severe turbulence and requested radar vectors to avoid high terrain.

The Twin Comanche then entered strong drafts, and the gyro instruments tumbled. "The pilot reported that after recovering from another uncommanded descent, the aircraft was thrust upward through 10,000 ft, where it started to shake violently and entered a stall," the report said. "On recovering from the stall, [the aircraft] entered another downdraft and descended uncontrollably again. It was reported that [the aircraft] climbed and descended continually for nearly 35 minutes, at times becoming inverted."

Eventually, the pilot saw terrain through a break in the clouds, flew the aircraft out of the IMC and landed without further event at Albury. According to the report, the pilot and his passenger were not hurt, and the Twin Comanche was not damaged.

HELICOPTERS

Low Contrast, NVGs Factor in CFIT

Aerospatiale AS 350-B2. Substantial damage. Three fatalities.

The mission was a practice emergency medical services flight to a remote desert area near El Paso, Texas, U.S., on a moonless night on Feb. 5, 2010. The pilot was making his first unsupervised flight with night vision goggles (NVGs) after receiving company NVG training that consisted of flights in populated areas with plentiful lighting providing high contrast among objects.

"Ground personnel observed the helicopter orbit [the landing zone] one or two times," the NTSB report said. The AS 350 then entered a steep bank and nose-down pitch attitude, and struck the ground, killing the pilot and the two paramedics.

"The lack of attempted recovery prior to ground impact suggests that the pilot did not recognize the helicopter's descent rate and bank angle," the report said.

NTSB determined that the probable cause of the accident was "the pilot's loss of situational awareness" and that a contributing factor in the controlled flight into terrain (CFIT) accident was "the pilot's unfamiliarity with the hazards of a low-contrast area while using NVGs."

Preliminary Reports, December 2011

Date	Location	Aircraft Type	Loss Type	Injuries
Dec. 1	near Baton Rouge, Louisiana, U.S.	Bell 407	total	1 none
The helicopter lost power and rolled inverted after an autorotative landing in the Gulf of Mexico.				
Dec. 2	Midland, Texas, U.S.	Beech King Air C90	total	1 minor
The King Air struck a house on short final approach after the pilot reported an engine problem. The occupant of the house escaped injury.				
Dec. 3	Larat, Indonesia	Indonesian Aerospace 212	minor	1 serious, 21 minor/none
One passenger was seriously injured when the aircraft veered off the left side of the runway on landing.				
Dec. 4	Pointe-Noire, Congo	Beech King Air 100	major	2 minor/none
The landing gear collapsed when the King Air veered off the runway while landing.				
Dec. 5	Oranjestad, Aruba, Netherlands Antilles	Shorts 360	minor	33 minor/none
The right main landing gear, which had struck a donkey on takeoff from Venezuela, partially collapsed on landing.				
Dec. 7	near Las Vegas, Nevada, U.S.	Eurocopter AS 350	total	5 fatal
The helicopter struck high terrain near Lake Mead during a sightseeing flight at sunset.				
Dec. 8	Antarctica	Kamov 32	major	1 minor, 1 none
After transporting supplies to the Zhongshan research station, the helicopter was involved in a forced landing for unknown reasons while returning to a research vessel.				
Dec. 13	Tikokino, New Zealand	Bell 206B	major	1 minor/none
The main rotor pitch links were damaged during a wire strike on final approach. The subsequent forced landing caused further damage to the JetRanger's skids, tail boom and stabilizers.				
Dec. 15	Val-d'Or, Quebec, Canada	Beech King Air 100	major	2 minor/none
The fuselage, landing gear and right propeller were damaged when the landing gear, rather than the flaps, was inadvertently retracted after touchdown.				
Dec. 15	Puerto Ordaz, Venezuela	Eurocopter BO-105	total	1 fatal, 1 minor/none
The helicopter crashed shortly after the pilot reported a technical problem during a post-maintenance functional check flight.				
Dec. 17	Abmisbil, Papua, Indonesia	Pacific Aerospace 750XL	total	2 fatal, 3 serious
The pilot and a passenger were killed when the aircraft veered off the runway on landing and entered a ravine.				
Dec. 17	Ko Samui, Thailand	ATR 72	major	42 minor/none
While being taxied for a night departure, the aircraft ran off the taxiway into a ditch and struck a wall.				
Dec. 17	Mesquite, Nevada, U.S.	Cessna 208 Caravan	major	2 minor
The landing gear collapsed when the Caravan overran the runway on landing.				
Dec. 20	Yogyakarta, Indonesia	Boeing 737	major	131 minor/none
The nose landing gear collapsed when the 737 overran the 2,200-m (7,218-ft) runway while landing in heavy rain.				
Dec. 20	Harding, New Jersey, U.S.	Socata TBM 700	total	5 fatal
The airplane crashed on a highway shortly after taking off from Teterboro Airport.				
Dec. 22	York, Pennsylvania, U.S.	Cessna 441 Conquest II	total	1 fatal
The airplane crashed in a wooded area 2 nm (4 km) from the airport during a night approach.				
Dec. 25	Karachi, Pakistan	McDonnell Douglas MD-80	minor	72 minor/none
The flight crew was unable to extend the nose landing gear on approach to Quetta and diverted to Karachi, where the MD-80 was landed with the gear still retracted.				
Dec. 26	Dalatka, Florida, U.S.	Bell 206	total	3 fatal
The pilot, a physician and a medical technician were killed when the helicopter crashed in a wooded area during a night emergency medical services flight.				
Dec. 28	Osh, Kyrgyzstan	Tupolev 134	total	1 serious, 80 minor/none
The right wing separated, and the Tu-134 rolled inverted during a hard landing in dense fog.				
Dec. 28	Fort Lauderdale, Florida, U.S.	Cessna Citation VII	major	6 minor/none
The nose landing gear collapsed when the Citation overran the runway on landing and struck the airport perimeter fence.				

This information is subject to change as the investigations of the accidents and incidents are completed.

Source: Ascend

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