# Aero Safety WO R LD

AIGLE

THE LONG RUN Avoiding landing overruns

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### CRASH IN THE ANTARCTIC HOSTILE ENVIRONMENT



THE JOURNAL OF FLIGHT SAFETY FOUNDATION

**NOVEMBER 2012** 

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#### PRESIDENT'S **MESSAGE**

## evidence-based Training

n a breakthrough that I would not have expected for years, the International Civil Aviation Organization (ICAO) has approved provisions for evidence-based training (EBT) in ICAO Standards and Recommended Practices. Credit goes to some extraordinary work done by a range of people and organizations that came together faster and better than anyone expected. The Royal Aeronautical Society led a massive working group that included ICAO, the International Air Transport Association (IATA), airlines, manufacturers, regulators and training providers.

For those of you not familiar with EBT, let me emphasize what a big deal this is. I have been a long and vocal critic of training standards around the world. Our training has been trapped in the 1960s and is dangerously out of date. EBT solves that once and for all. It is a process that will allow operators to restructure their training programs to target the real risks in the operation instead of spending all of their training time addressing the threats that existed in the 1960s. It builds on programs like the U.S. advanced qualification program (AQP) and the ICAO advanced training and qualification programme (ATQP).

As the name would suggest, this is a system built on evidence. The industry has pulled together and developed an extraordinary set of baseline data, which will be published by IATA in a document called the *Evidence-Based Training Data Report*. This report synthesizes information from 3 million flight data records, 9,000-plus line operations safety audit observations, more than 1,000 pilot surveys, and several thousand reports from AQP and ATQP programs. In this baseline, you will find the data you need to overhaul your training program whether you are operating older turboprops or the latest fly-by-wire jets. The implementation process for EBT will be addressed by guidance material from ICAO and a new *Evidence-Based Training Implementation Guide* produced jointly by IATA, the International Federation of Airline Pilots' Associations (IFALPA) and ICAO. Together, these guides will help operators build relevant and effective training programs that start with the baseline data and grow to reflect each operator's operational data and experience. This type of approach will keep training relevant now and in the future.

As I said, a lot of progress has been made very quickly, but now comes the difficult part. It doesn't do any good to develop new training strategies if you are not allowed to let go of the old ones. Regulators across the world have to buy in to the approach and will have to develop new ways to oversee training. Evaluating an operator's training program against a 50-year-old checklist was a pretty simple regulatory task. Evaluating how well an operator builds its program based on operational data will require a regulator that is insightful and sophisticated, and able to devote a lot of time to the task. That may not be a realistic expectation given that many regulators have been decimated by austerity measures or overrun by extraordinary growth.

Government and industry can be proud of the way they have responded to this challenge. I hope that, five years from now, we can be as proud of the way we implemented the changes.

Willow Car

William R. Voss President and CEO Flight Safety Foundation



# AeroSafetyworld CONTENTS

November 2012 Vol 7 Issue 10

### features

- 8 SeminarsIASS | Boeing Analyzes Overruns
- 18 CoverStory | AS350 Crash in Antarctica
- 23 InSight | Breakdowns in Employee Trust
- 28 SafetyManagement | Updating Voluntary Reporting
- 32 AvWeather | Low-Level Jet Streams
- 37 Strategiclssues Calculating Safety ROI
- 43 HumanFactors | Pilot Flight Hours Study
- 47 In Appreciation | Bob Helmreich and Bryan Wyness



### departments

- 1 President's Message | Evidence-Based Training
- 5 EditorialPage | CFIT Resurgence
- 6 SafetyCalendar | Industry Events
- 7 Executive's Message | FSF More Than Just a Magazine
- 13 InBrief | Safety News



- 51 DataLink | Analysis of EGPWS Alerts
- 55 InfoScan | Blue Water Ditching
- 58 On Record | Unexpected Contamination



About the Cover This AS350 later crashed in Antarctica. © Romain Baheu/Pictaero

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If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about aviation safety, we will be glad to consider it. Send it to Director of Publications Frank Jackman, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA or jackman@flightsafety.org. The publications staff reserves the right to edit all submissions for publication. Copyright must be transferred to the Foundation for a contribution to be published, and payment is made to the author upon publication.

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# cfit Resurgence

ontrolled flight into terrain (CFIT) is making a strong comeback as a major killer in commercial aviation accidents, particularly when it comes to turboprop aircraft, according to Jim Burin's Year in Review presentation at Flight Safety Foundation's 65th annual International Air Safety Seminar (IASS) held in October in Santiago, Chile.

Jim, the Foundation's director-technical programs, is writing a detailed 2012-in-review article that will appear in an early 2013 issue of *AeroSafety World*, so I don't want to steal his thunder, but his presentation piqued my interest on a number of levels.

According to Jim's presentation, which draws on data, some of it preliminary, from Ascend and other sources, four of the 14 major, large commercial jet accidents in 2011 were CFIT. The number of major commercial jet accidents this year is down to four (through Oct. 22), but two are CFIT. Through Oct. 22, there have been 13 major accidents in 2012 involving commercial turboprops with more than 14 seats. Of those, four are CFIT. Over the last six years, 23 of 82 turboprop accidents have been CFITs, which works out to 28 percent, or more than one in every four. The majority of the CFIT accident airplanes, according to Jim, were not equipped with terrain awareness and warning systems (TAWS). In fact, none of the turboprop aircraft involved had a functional TAWS, he said.

Aside from the Sukhoi Superjet 100 crash in May in Indonesia, CFIT accidents have not gotten a lot of press lately, and you could argue that the Superjet crash got as much attention for what the accident meant for the Russian aviation industry as it did for the tragedy itself.

Conversely, aircraft upset accidents and training pilots to better handle upset situations have gotten a fair amount of press — and, more importantly, industry focus — over the past few years. In 2007 and 2008, there were 11 total aircraft upset major accidents involving commercial jets. That number dipped to four in 2009, two in 2010 and zero in 2011. Through the first 10-plus months of this year, there have been no commercial jet aircraft upset major accidents.

While we were in Santiago, someone (and I wish I could remember who) offered an analogy to the Whac-A-Mole arcade game, where the object is to pound "moles" on the head with a mallet as they pop up out of their holes. Of course the moles pop up rapidly, and knocking one back down its hole usually means it or a relative will pop up somewhere else. In aviation, an issue is identified, a strategy is developed and implemented, results are achieved and analyzed, and we all move on to the next issue. But there is no guarantee that an issue that has been dealt with and brought under control won't reappear somewhere else sometime in the future. Mitigating the risk requires some combination of technology, training and vigilance, and the passing on of learning to future generations.

As I said earlier, look for Jim's yearin-review article in an upcoming issue. In this issue, we have articles based on IASS presentations beginning on p. 8 and on p. 51. For those of you who attended IASS, the seminar presentations are scheduled to be available online by early December.

Frank Jackman Editor-in-Chief AeroSafety World

#### ► SAFETY**CALENDAR**

NOV. 14-16 ➤ ALTA Airline Leaders Forum 2012. Latin American and Caribbean Air Transport Association. Panama City, Panama. <www.alta.aero/airlineleaders/2012>, +1 786.388.0222

NOV. 19–23 (PART 1), NOV. 26–28 (PART 2) Airworthiness. CAA International. Selangor, Malaysia. <training@caainternational.com>, <www.caainternational.com>, +44 (0)1293 768700.

#### NOV. 19–30 > 12th Air Navigation

**Conference.** International Civil Aviation Organization. Montreal. <www.icao.int/Meetings/ anconf12/Pages/default.aspx>.

NOV. 26 ➤ SMS Overview for Managers. CAA International. Manchester, England. <training@ caainternational.com>, <bit.ly/NTqGhW>, +44 (0)1293 768700.

NOV. 26–30 ➤ Safety Assessment of Aircraft Systems. Cranfield University. Cranfield, Bedfordshire, England. <chloe.doyle@ cranfield.ac.uk>, <www.cranfield.ac.uk/soe/ shortcourses/training/safety-assessmentaircraft-systems.html>, +44 (0)1234 758552. (Also JUNE 24–28, NOV. 25–29.)

NOV. 29–30 ➤ Fatigue Risk Management Systems. CAA International. Manchester, England. <training@caainternational.com>, <bit. Iy/S2yIHG>, +44 (0)1293 768700.

DEC. 13-14 ➤ SMS Workshop. ATC Vantage. Tampa, Florida, U.S. <info@atcvantage.com>, <bit. Iy/QP3EKa>, +1 727.410.4759.

DEC. 14 ➤ Dangerous Goods Training Course for Safety Assessment of Foreign Aircraft Programme Inspectors. Joint Aviation Authorities Training Organisation. Hoofddorp, Netherlands. <a href="https://jaato.com/courses/106/#">https://jaato.com/courses/106/#</a>. (Also JUNE 21, DECEMBER 13.)

DEC. 19-20 ➤ HFACS/HFIX Workshop. HFACS Inc. Las Vegas. <dnlmccnn@gmail.com>, <www. hfacs.com>, 800.320.0833.

JAN. 8-17 ➤ SMS Training Certificate Course. U.S. Transportation Safety Institute. Oklahoma City, Oklahoma, U.S. D. Smith, <d.smith@dot.gov>, <www.tsi.dot.gov>, +1 405.954.2913. (Also MAY 14–23, JULY 30–AUG. 8.)

JAN. 9–11 ➤ Risk Management Conference. Airports Council International–North America. Las Vegas, Nevada, U.S. meetings@aci-na.org, http://www.aci-na.org/event/2406, +1 202.293.8500. JAN. 13–15 ➤ SMS/QA Genesis Symposium. DTI Training Consortium. Orlando, Florida, U.S. <www.dtiatlanta.com/Events.html#>, +1 866.870.5490.

JAN. 14-FEB. 22 ➤ Aircraft Accident Investigation. Cranfield University. Cranfield, Bedfordshire, England. <chloe.doyle@cranfield. ac.uk>, <www.cranfield.ac.uk/soe/shortcourses/ training/aircraft-accident-investigation.html>, +44 (0)1234 758552. (Also MAY 13–JUNE 21.)

JAN. 16-17 ➤ Non-Destructive Testing Audit Oversight Course. CAA International. London Gatwick Airport. <training@caainternational. com>, <www.caainternational.com>, +44 (0)1293 768700.

JAN. 21–23 > MRO Middle East. Aviation Week. Dubai, United Arab Emirates. <events. aviationweek.com/current/mme/index.htm>.

JAN. 23-25 ➤ Airport Wildlife Hazard Management Workshop. Embry-Riddle Aeronautical University and Burbank Bob Hope Airport. Burbank, California, U.S. <training@erau. edu>, <br/>bit.ly/OUYFlq>, +1 386.226.7694.

JAN. 28-FEB. 1 ➤ SMS Principles. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Beth Wigger, <maimail@mitre.org>, <mai.mitrecaasd.org/ sms\_course/sms\_principles.cfm>, +1703.983.5617. (Also MARCH 11–15, MAY 13–17, JULY 15–19.)

JAN. 28-FEB. 6 ➤ SMS Theory and Application. MITRE Aviation Institute. McLean, Virginia, U.S. Mary Beth Wigger, <maimail@mitre. org>, <mai.mitrecaasd.org/sms\_course/sms\_ application.cfm>, +1 703.983.5617. (Also MARCH 11–20, MAY 13–22, JULY 15–24.)

**FEB. 4-5 → Human Factors in Aviation/CRM.** Vortex. Denver. <info@vortexfsm.com>, <www. vortexfsm.com/seminars>, +1 303.800.5526.

FEB. 4-8 ➤ Accident Investigation. ScandiAvia. Stockholm. <morten@scandiavia. net>, <bit.ly/WsvNcL>, +4791184182.

APRIL 29-MAY 3 ➤ Aircraft Accident Investigation. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, case@erau.edu, <bit.ly/wtWHln>, +1 386.226.6000.

MARCH 12-13 ➤ Safety Across High-Consequence Industries Conference. Parks College of Engineering, Aviation and Technology, Saint Louis University. St. Louis, Missouri, U.S. Damon Lercel, <dlercel@slu.edu>, <www.slu. edu>, +1 314.977.8527. MARCH 12-13 > Risk Management.

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MARCH 18-20 > CHC Helicopter Safety and Quality Summit. Vancouver, British Columbia, Canada. <summit@chc.ca>, <bit.ly/tmyQll>, +1 604.232.7424.

APRIL 10-11 ➤ 58th annual Business Aviation Safety Seminar. Flight Safety Foundation and National Business Aviation Association. Montreal. Namratha Apparao, <Apparao@flightsafety.org>, <flightsafety.org/ aviation-safety-seminars/business-aviationsafety-seminar>, +1 703.739.6700, ext. 101.

APRIL 11-13 ➤ Internal Evaluation Program Theory and Application. U.S. Transportation Safety Institute. Oklahoma City, Oklahoma, U.S. Troy Jackson, <troy.jackson@ dot.gov>, <www.tsi.dot.gov>, +1 405.954.2602. (Also SEPT. 17-19.)

APRIL 15-19 ➤ OSHA/Aviation Ground Safety. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, case@ erau.edu, <br/>bit.ly/wtWHln>, +1 386.226.6000.

**APRIL 16-18 → MRO Americas.** Aviation Week. Atlanta. <events.aviationweek.com/ current/mro/index.htm#>.

APRIL 22-26 ➤ Aviation Safety Program Management. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, case@erau.edu, <bit.ly/wtWHln>, +1 386.226.6000.

MAY 6-10 ➤ Advanced Aircraft Accident Investigation. Embry-Riddle Aeronautical University. Prescott, Arizona, U.S. Sarah Ochs, case@erau.edu, <br/>bit.ly/wtWHln>, +1 386.226.6000.

#### 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.

#### EXECUTIVE'S **MESSAGE**

### FLIGHT SAFETY FOUNDATION — More Than "Just a Magazine"

ately, in conversations with Foundation members and prospective members, the topic has turned to "what else do I get for my membership in the Foundation other than a magazine?" The short answer is "a whole lot." The long answer is that we at the Foundation need to be better at letting you know what we are doing for you and what you get for your dues.

Since 1947, we have been one of the leading advocates of aviation safety. If the safety of flight is involved, the Foundation has been there and will continue to be there. So how does that affect you? Anyone who makes a living in aviation, or just uses aviation as a mode of transportation, can look back at how much the Foundation has contributed through studies, working groups, information and programs to keep our way of life safe. If a serious event or accident occurs today, we all feel the impact. In turn, we all currently are enjoying a safety record that never has been achieved before.

How does a record of 0.7 accidents per 1 million commercial airline departures happen? Because of hard work that is done behind the scenes before — even when there hasn't been an accident. The Foundation has had an integral and international role in bringing groups together and/ or working with those groups, to resolve common issues and to look ahead for the next ones. We are uniquely independent and impartial, working with industry, government, consultants, associations, societies, businesses and other foundations. Because of work done in the past in such areas as radar, controlled flight into terrain, approach charts, runway excursions, stabilized approach and landing, corporate flight operational quality

assurance, upset recovery and many others, the aviation safety of business and commercial operations involves less risk than ever.

The Foundation intends to continue to look ahead at the next generation of issues, such as fatigue, automation technology and training, safety management systems application, and evidence-based information sharing. We also intend to work more closely with you, our members. Whether you are a large corporate entity, airline, business aviation operator, government, association or individual, you benefit directly and indirectly as a member.

I know many of you are familiar with the term corporate social responsibility. Basically, entities are now contributing resources to others in their community for the common greater good — the greater good being the ability for all to enjoy a better quality of life. Resources can be things like shirts for the children's sports team, community centers, green initiatives and medical research. The Foundation is a form of social responsibility in the aviation safety world.

Contributing to the Foundation is a form of social responsibility — of continuing to keep aviation safe. *AeroSafety World* is a part of that, but not the only part!

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



BY WAYNE ROSENKRANS

## Overrun Breakdown

Overshooting the touchdown zone and improperly using thrust reversers cause off-end excursions, says a new Boeing analysis.

10-year moving average of fatal runway-overrun accidents involving global large commercial jets during 1992-2011 shows a worsening trend, say Boeing safety specialists. Their findings about a subset of 29 Boeing airliner events from 2003 to the present — accidents, incidents and other events with less serious outcomes - reinforce runway safety solutions already being considered or adopted, however. They also could guide future safety initiatives pending new technological solutions, the Boeing experts reported in October at Flight Safety Foundation's 65th annual International Air Safety Seminar in Santiago, Chile.

By crossing the runway threshold at the correct height and airspeed,

landing within the touchdown zone, and promptly and completely using the thrust reversers and other deceleration devices, the pilots involved would have prevented the most serious of the studied events, said A. Thomas Stephens, lead, aero accident/incident analysis, and Mark H. Smith, senior accident investigator, The Boeing Co. Recognizing and correctly responding in time to each circumstance — such as by conducting a go-around — would have prevented all of them, they added.

"Looking at ... all [29] of the landings ... the airplane was capable of doing a full stop," Smith said. "The airplane crossed the [runway] threshold with margin available to stop. In the top 18 [events cited in the resulting table], in the first two categories [landed long and landed fast], by the time the airplane touched down, that margin was gone or was negative. It all happened between threshold and touchdown. [For] the ones that didn't touch down correctly, their margin was [eliminated] by the mismanagement, if you will, of the deceleration devices combined with the poor runway conditions. ... The overruns did not have to happen."

About a third of the events in Boeing's runway track analysis had official reports available, and two-thirds came from aircraft in-service events reported by operators but not required to be investigated by government authorities.

"Only three primary factors ... govern the stopping point of any airplane," Stephens said: "The touchdown point, which defines the runway remaining in order to dissipate the energy you bring to the runway; the touchdown speed, which - when combined with the mass of the airplane — defines the energy that is brought to the runway [and] that has to be dissipated; and then, finally, the deceleration after touchdown, which defines the effectiveness of your deceleration devices in order to bring the airplane to a stop. ... Once you touch down, the touchdown point and the touchdown speed can no longer change, and deceleration is all [the pilot has left to use]."

Stephens and Smith presented several versions of their primary table (including Table 1, p. 10) that categorizes the 29 events as landed long, meaning the airplane was landed beyond the touchdown zone;1 landed fast, meaning that the flight crew landed with excessive airspeed; or deficient deceleration, meaning that the crew had a problem in correctly using the deceleration devices. The table also indicates whether, at any point before touchdown, the crew exceeded any of the Foundation's criteria for a stabilized approach (ASW, 11/07, p. 13). Among other factors highlighted were knots of airspeed that exceeded the target reference landing speed  $(V_{REF})$  and whether the sum of this value and any calculated tailwind present exceeded 14 kt.

The table versions also show any delay deploying speedbrakes; any delay 4 seconds or greater after touchdown before commanding reverse thrust; whether early reduction or stowage of the thrust reversers occurred; and the runway remaining when the pilot began to reduce the reverse thrust. "If you're in an overrun event, we would hope that [thrust reversers] are kept out until runway departure," Stephens noted. The table versions have an equivalent runway braking action factor (Mu), calculated after the events, with black representing braking action equivalent to a dry runway condition, green as good condition, yellow as medium condition and red as poor condition. Results of each event were highlighted in terms of overrun speed — the groundspeed in knots at which the airplane departed the runway end — and also by recording whether the event resulted in a hull loss.

The airplanes in 13 landed-long events landed anywhere from 3,000 ft to 7,000 ft (914 m to 2,134 m) down the runway. "The vast majority of the events that were determined to be unstable by the stabilized approach criteria wind up being in this category," Stephens said. "Landed Long' contains all of the high-speed overrun events that we had [that is, exit speed of 50 kt or greater and] all of the events that were determined to be hull loss events. ... [We tell pilots,] 'Touch down in the [touchdown] zone or go around, because the consequences are pretty severe." The window of time for decision making also is extremely small, he noted.

About half of the landed-long events studied revealed a flight path– control issue. "[Pilots] were high when they came across the threshold — significantly high on some of them, upwards of 300 or 400 ft above the threshold," Stephens said. Others maintained an advanced, non-idle setting rather than idle. The data also showed that, contrary to non-overrun landings with touchdown 4 to 8 seconds after threshold crossing, the events in the study's landed-long category had touchdowns 10 seconds or more after threshold crossing.

In the landed-fast category, the events were remarkable in that they all began with a stable approach and a touchdown very close to the pilot's aim point within the touchdown zone. The excess speed was found to be a combination of knots above  $V_{REF}$  and unknown/incorrectly reported tailwind components.

In some cases, nonstandard flight maneuvers shortly before the landing phase adversely affected the crews' ability to stop the airplane. One such maneuver (Figure 1, p. 11) was called the *duck-under maneuver* by airline pilots consulted. "The intent of this maneuver is to go down below the glide slope to change your aim point, to move it [farther] up the runway and touch down sooner so that you have additional runway in which to touch down," Stephens said. However, in the example cited, the flying pilots touched down at  $V_{REF}$  plus 30 kt.

The study also assigned some of the overrun events to a category in which the leading factor involved deficient deceleration. Whether the approach was stabilized — nearly all were — was not a factor, and these aircraft did not have excessive airspeed. The most significant subcategory of deficient deceleration chronicled examples — 69 percent of



A. Thomas Stephens, top; Mark H. Smith

Factor	Factors in 29 Runway Overruns Analyzed by Boeing, 2003–2012												
									Decel	eration			
ILS and /	Autopilot			Touchdo	own Point	Touchdo	wn Speed	Speedbrake	Thrust F	Reversers	Runway	Res	ult
ILS Tuned?	AP Disc Altitude (feet)		Approach	Point (feet)	Runway Used (% LDA)	Airspeed >V <sub>REF</sub> (knots)	Tailwind (knots)	When SB Deployed (sec)	When TR Deployed (sec)	When TR Reduced (feet)	Braking Action	Overrun Speed (knots)	Hull Loss
Yes	1,800		Unstable	7,000	72%	23	0	TD	TD +3	departure	Good	81	Yes
Yes	500		Unstable	6,200	70%	12	5	TD	never	—	Dry	50	No
Yes	500		Unstable	5,300	60%	16	3	TD	TD +4	departure	Good	35	No
No	2,000		Unstable	5,150	48%	20	0	TD +5	TD +7	900	Medium	70	No
_	_		Unstable	4,700	52%	30	-1	TD	TD +2	1,000	_	100	Yes
No	900	ng	Unstable	4,500	60%	-3	1	TD	TD +2	departure	Good	47	Yes
Yes	2,300	ol b	Unstable	4,500	56%	6	3	TD	TD +3	400	Dry	90	Yes
Yes	700	jde	Stable	3,950	44%	0	14	TD	TD +3	departure	Medium	63	Yes
Yes	_	Lar	Stable	3,260	41%	20	-1	TD	TD +3	2,000	Medium	40	No
Yes	210		Stable	3,200	48%	-7	4	with TR	TD +2	departure	Good	30	No
Yes	400		Stable	3,120	42%	10	10	TD	TD +2	departure	Good	50	No
Yes	700		Stable	3,000	37%	-5	6	TD	TD +2	departure	Medium	30	No
Yes	300		Stable	3,000	34%	3	5	TD	TD +3	departure	Medium	5	No
				1	13								
Yes	500		Stable	1,600	20%	12	10	TD	TD +27	departure	Good	25	No
Yes	600	ast	Stable	1,500	20%	20	10	TD	TD +3	600	Medium	5	No
Yes	500	ed fa	Stable	1,450	20%	11	15	TD	TD +3	1,250	Medium	20	No
Yes	500	pde	Stable	1,450	20%	6	9	TD	TD +3	departure	Medium	0	No
Yes	300	La	Stable	1,250	18%	4	11	TD	TD +2	departure	Poor	45	No
						1	5						
Yes	—		Stable	2,700	30%	0	0	never	never	—	Medium	45	No
Yes	400		Stable	400	6%	2	-6	never	TD +22	departure	Medium	48	No
Yes	1,000	~	Stable	500	8%	3	4	with TR	TD +20	departure	Medum	32	No
Yes	—	tior	Stable	1,250	21%	0	9	TD	TD +16	departure	Poor	42	No
Yes	_	lera	Unstable	1,720	27%	6	5	TD +9	TD +13	departure	Good	20	No
Yes	1,100	ece	Unstable	1,800	23%	10	2	with TR	TD + 11	departure	Poor	28	No
Yes	250	nt d	Stable	1,900	26%	6	-2	TD	TD +8	departure	Medium	20	No
Yes	—	icie	Stable	1,150	24%	5	-5	TD	TD +6	100	Medium	12	No
Yes	>1,500	Def	Stable	2,900	28%	0	-6	TD +3	TD +5	2,800	Poor	10	No
Yes	360		Stable	2,500	31%	0	2	TD	TD +2	2,250	Good	25	No
Yes	300		Stable	2,200	27%	5	7	TD	TD +2	2,000	Medium	45	No
									1	1			

AP Disc = autopilot disconnect; ILS = instrument landing system; LDA = landing distance available; SB = speedbrake; sec = seconds; TD = touchdown; TR = thrust reverser

Note: Each line contains one landing overrun event involving a Boeing large commercial jet. The first two columns, in this table version, add secondary data about ILS and autopilot use to the primary table of factors. Blue text denotes contributing causal factors.

Source: Mark H. Smith and A. Thomas Stephens, The Boeing Co.

#### Table 1

the overall total — involving pilots' sub-optimal use of thrust reversers, specifically, too slowly commanding reverse thrust and mistiming reduction and thrust reverser stowage.

Thrust reverser deployments ranged from none to delays of 5 seconds to

22 seconds (Figure 2), and premature stowage occurred 100 ft [30 m] to 2,000 ft [610 m] before the end of the runway. Smith elaborated on the heightened risks involved not only in delayed command or no command of reverse thrust, but also in early reverser reduction with a significant amount of runway remaining.

He said that their data analysis also found that 75 percent of the overrun events occurred during winter months in the Northern Hemisphere, including all slippery runway cases; this was consistent with expectations. Overall, 94 percent occurred on non-dry runways. Data from flight data recorders showed that in all but two events, the instrument landing system (ILS) was tuned and displayed to the pilots.

"[In] some of the ... unstable-approach cases ... the ILS was tuned and the autopilot was connected all the way down to 500 ft, and [the event] still became unstable and long," Smith said. "Our recommendation is, 'Reduce reverse thrust at about 60 kt, but ... do not reduce reverse thrust until you are sure you can make the full stop.""

The significance of the different levels of braking action also can be greater than pilots recognize, Smith noted. "If you are on a medium runway, you have 25 percent ... of the brakes you are used to having on a dry runway — that's significant," he said. "If you get on a poor runway — you're [at] one-eighth [relative braking action] — you're down in the 12 to 15 percent range. ... On the medium runway, [thrust] reversers will double the deceleration that you can get out of the airplane — they are critical." On a medium runway, the decision to use no reversers adds 1,200, 1,300 or 1,400 more ft (366, 396 or 427 m) of stopping distance; on a poor runway, the penalty exceeds 3,000 ft.

In response to questions about differences in the use of autobrakes versus pilot-applied wheel braking, Smith and Stephens said relevant data were collected and analyzed, but were not deemed significant for the initial safety recommendations.

"For the most part, the maximum brake seemed to be ... applied for most of these, be it the autobrakes or manual, so we did not see that as a big factor," Smith said. They also noted that the work of the U.S. Federal Aviation Administration's Takeoff and Landing Performance Assessment Aviation Rulemaking Committee — which submitted proposed recommendations in 2010 — includes significant changes to regulations, guidance and training designed to mitigate overrun risks based on this data analysis and data from other sources.

#### Touchdown in a Landed-Fast Overrun Event



ILS = instrument landing system; kt = knot

**Notes:** In this overrun event, the pilot intentionally deviated from the ILS glide slope in a *duck-under maneuver* intended to assure a short touchdown. The result was a 20-kt airspeed increase plus a further 10-kt increase from an unreported tailwind.

Source: Mark H. Smith and A. Thomas Stephens, The Boeing Co.

#### Figure 1



**Notes:** The average time spent on the runway was about 30 seconds in 29 runway-overrun events analyzed by Boeing researchers. This comparison of prompt vs. excessive delay in commanding reverse thrust shows the effect on time to stop.

Source: Mark H. Smith and A. Thomas Stephens, The Boeing Co.

#### Figure 2

#### Note

 In this study, the touchdown zone for each event was the first 3,000 ft of the runway for U.S. events, the first 900 m of the runway (if International Civil Aviation Organization standards applied), or the first one-third of the runway — whichever was less.



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## Safety News

#### **Friction-Reporting Caveats**

he U.S. Federal Aviation Administration (FAA) has stopped recommending that airports provide runway friction measurement values (Mu) to pilots when snow or ice is on the runways. The FAA's action does not prohibit issuance of runway friction measurements, however.

"If an airport chooses to report friction measurement values, the FAA requires airports to report Mu values below 40 as actual values, or any values above 40 as 40," the agency said in an email to Flight Safety Foundation. The email was written in answer to questions asked during the Air Line Pilots Association, International Air Safety Forum 2012, held in August.

"The FAA no longer recommends reporting for three reasons," the email said. "First, friction measurements can vary significantly, even when reporting on the same contaminated surface conditions. Second, reported readings can differ depending on the measuring device being used. Finally, the friction measurements only apply to the portion of the runway where friction measurements are conducted. All these considerations led to the [FAA Takeoff and Landing Performance Assessment (TALPA)] project to develop a consistent method of reporting."

The FAA said it is exploring other methods of evaluating runway slipperiness.

"The FAA has a multi-year research program to evaluate the feasibility of determining runway slipperiness from data recorded by an airplane during landing in a time scale that would let that information be relayed to subsequent landing airplanes," the agency said. "There are a number of technical, logistical and other issues that must be addressed before such a system can be implemented on a broad scale. ... The safety and economic benefits to both airplane and airport operators could potentially be significant."

The FAA also is monitoring several privately funded and directed efforts, each using a different method but with similar goals.

"Several [U.S.] airlines are participating in prototyping exercises to evaluate their accuracy, repeatability and usability," the FAA said. "We hope to gain valuable experience and data over the [U.S. 2012–2013] winter by evaluating these systems in various environmental conditions. If this winter's efforts are successful, it will likely be a number of years before we know if any of these systems can provide accurate and timely runwayslipperiness information that would be broadly applicable across airplane types — and usable by pilots, airport personnel and air traffic controllers without unacceptable changes in workload or procedures."

*— Wayne Rosenkrans* 



#### **Regulatory Overhaul**

he Australian Civil Aviation Safety Authority (CASA) has begun overhauling the nation's Civil Aviation Safety Regulations in hopes of enhancing aviation safety.

"Modernised, logically organized, internationally aligned and technologically relevant rules will help everyone in aviation to operate to the highest possible safety standards," Aviation Safety Director John McCormick said.

McCormick noted that many of the existing rules are more than 30 years old and "do not properly fit with a modern aviation system and latest technologies.

"To make them work, CASA has been issuing exemptions to allow the aviation industry to meet ongoing operational needs. Right now, there are more than 1,700 exemptions on the books, meaning the regulation of aviation activities is not necessarily a level playing field, and some of the rules are not fit for purpose."

In addition, McCormick said, Australia's regulations "have not kept pace with international developments in aviation safety."

He added that the new regulations would be more understandable, better organized and easier to use than existing rules. They will also be easier to update, he said. "CASA's intention is for the rules to be part of a living set of aviation safety standards that evolve as the aviation industry further matures and grows," he said. "Our goal is an aviation safety system that performs even better, with risks identified and managed to minimise accidents and incidents."



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#### **Flight Test Guidelines**

he U.S. Federal Aviation Administration (FAA) and a key aviation industry organization should work together to develop flight test operating guidance for aircraft manufacturers, the U.S. National Transportation Safety Board (NTSB) says.

The NTSB — citing the April 2, 2011, crash of an experimental Gulfstream G650 on takeoff from Roswell, New Mexico, U.S. — issued 10 related safety recommendations, including the call for the FAA and the industry's Flight Test Safety Committee to develop the flight test operating guidance. Five of the recommendations were issued to the FAA, three to the safety committee and two to Gulfstream Aerospace.

The two flight crewmembers and two technical crewmembers were killed and the airplane was substantially damaged in the crash, which the NTSB said followed an aerodynamic stall and uncommanded roll during a test flight that was conducted with one engine operating.

The NTSB said the probable cause of the accident was Gulfstream's "failure to properly develop and validate takeoff speeds and recognize and correct errors in the takeoff safety speed that manifested during previous G650 tests, the flight test team's persistent and aggressive attempts to achieve a takeoff speed that was erroneously low and Gulfstream's inadequate investigation of uncommanded roll events that occurred during previous flight tests."

As a result of its accident investigation, the NTSB recommended that the FAA tell domestic and foreign manufacturers of airplanes certified under Federal Aviation Regulations Part 23 and Part 25 about key elements of the accident and "advise them to consider, when estimating an airplane's stall angle-of-attack in ground effect, the possibility that the airplane's maximum lift coefficient in ground effect could be lower than its maximum lift coefficient in free air."

The NTSB also called on the FAA and the Flight Test Safety Committee to develop flight test safety program guidelines "based on best practices in aviation safety management." The FAA should include those guidelines in its next revision of FAA Order 4040.26, *Aircraft Certification Service Flight Test Risk Management Program*, the NTSB said.

In addition, the NTSB recommended that the FAA tell Part 139 airports that are the scene of flight test activity to be aware of "the importance of advance coordination of high-risk flight tests with flight test operators to ensure that adequate aircraft rescue and fire fighting resources are available."

A related recommendation to Gulfstream said the company should commission a safety audit of its flight test safety management system and should provide other manufacturers, flight test industry groups and others with information about the lessons learned from the implementation of that system.

"In all areas of aircraft manufacturing, and particularly in flight testing, where the risks are greater, leadership must require processes that are complete, clear and include well-defined criteria," NTSB Chairman Deborah A.P. Hersman said.

#### In Other News ...

he Civil Air Navigation Services Organisation (CAN-SO) has named as its next director general Jeff Poole, who has been the International Air Transport Association's director of government and industry affairs since May 2011. Poole will take over in January from Interim Director General Samantha Sharif. ... The U.S. Federal Aviation Administration has proposed a \$354,000 civil penalty against US Airways, which the agency says operated a Boeing 757 on 916 revenue flights while the airplane was not in compliance with Federal Aviation Regulations. The airline did not conduct required tests before returning the airplane to revenue service after replacing a leaking engine fuel pump in August 2010, the FAA said. ... The European Aviation Safety Agency has published new rules for air operations designed to harmonize requirements for commercial air transport operations throughout Europe.

#### **Doubts About UAS**

nmanned aircraft systems (UAS) are "not capable of replacing human capabilities in complex and safety-critical situations" and should not replace manned aircraft, the International Federation of Airline Pilots' Associations (IFALPA) says.

In a position paper issued in October, IFALPA said that UAS must be required to comply with the same rules that apply to other aircraft.

"It is not acceptable for such rules and regulations to be changed for manned aviation in order to integrate UAS and their operations," the position paper said.

UAS that do not comply with existing regulations will require "segregated airspace or mitigation by special authorizations," the paper said.

IFALPA said UAS and manned aircraft should be subject to the same design standards and certification regulations and the same target levels of safety. The organization also called for regulatory authorities to establish criteria for the selection, licensing, instruction



and training of UAS operators, as well as appropriate duty time limits for UAS pilots and crewmembers that are based on existing pilot regulations and scientific data.

Compiled and edited by Linda Werfelman.

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### An AS350 B3 probably encountered a whiteout before its fatal crash into Antarctic pack ice, the BEA says. ENVIRONMENT



he pilot of a Eurocopter AS350 B3 had never operated from a helideck at sea when he took off from an Antarctic supply ship and descended below a low cloud layer to fly as low as 30 ft above the Antarctic. The helicopter crashed into pack ice, killing all four people aboard, the French Bureau d'Enquêtes et d'Analyses (BEA) says.

1985

In its final report on the Oct. 28, 2010, accident, the BEA said that the probable cause was "the decision to undertake the flight and to continue it in unfavourable meteorological conditions in a hostile environment that offered few alternatives to the plan of action."

The decision "probably resulted in the loss of visual references in whiteout conditions," the report added.

Three contributing factors were cited:

- The "context of the campaign" the pilot's awareness of the urgency of the delivery of personnel and equipment to an Antarctic research base — which "gave particular importance to achieving the mission's goals."
- The "absence of operational documentation" with specific instructions for flights in an area of the Antarctic known by the French as Adélie Land, where the French Dumont d'Urville scientific research base is located.
- The failure of the operator, SAF Helicopteres, to submit to the regulatory authority the section of its operations manual dealing with instructions for Adélie Land flights.

In addition, the report said that the pilot's use of anti-seasickness medication, which had a sedative effect, "may have contributed to the accident."

#### **Propeller Damage**

The AS350 and a second helicopter were on the ship l'Astrolabe, along with replacement personnel and materials destined for the Dumont d'Urville base. The original plan called for l'Astrolabe to proceed to a point about 43nm (80 km) from the base, where supplies and personnel would be transferred to the two helicopters for the remainder of the journey.<sup>1</sup>

However, the ship's propeller was damaged on Oct. 27, when it was 207 nm (129 km) from the Dumont d'Urville base. The vessel was unable to proceed. "For maintenance purposes, the ship had to turn back no later than the morning of 31 October," the report said.

"On 28 October, the pilots of the two helicopters on board the ship agreed to transport the passengers and any equipment that could fit into the cabin to the Dumont d'Urville base," the report said. "The flights would relieve the personnel from the base for the first time after nine months' winter residence."

The first helicopter took off from the ship's helideck about 1630 local time, carrying supplies and three passengers. About 1645, the accident helicopter departed with three passengers, including a maintenance technician, and additional supplies.

Soon after 1750, the accident pilot made a 360-degree turn, descending from 2,500 ft to about 800 ft and telling the other pilot that the maneuver was intended to allow him to fly the helicopter below the cloud layer. About 1800, he made a second 360-degree turn, flying between 300 ft and 50 ft and reducing the helicopter's speed from 130 kt to 40 kt.

At 1809, the first helicopter landed at Dumont d'Urville.

At 1815, the last data point was recorded for the accident helicopter, showing it at 30 ft. Two minutes earlier, the report said, "two speeds recorded 30 seconds apart were less than 8 kt."

At 1828, the alarm from the helicopter's emergency locator beacon was detected. Because of adverse weather, the wreckage was not found until two days later, when the crew of an Australian search and rescue Lockheed P-3 Orion located the crash site. The bodies of the pilot and his three passengers were recovered by helicopter.

Because of risks associated with the breakup of the pack ice, a close examination of the wreckage was not possible. An aerial observation by the pilot of the other SAF helicopter, however, indicated that it had been moving at a low vertical speed and a high horizontal speed when it struck the ice, the report said.

#### **Pilot Experience**

The pilot, 36, had accumulated 3,122 flight hours, including 1,664 hours in type. In 1998, he received a commercial pilot license, which was converted to a flight crew license in 2009. He also had a flight instructor rating and type ratings in the AS350, AS355 SP and SA316/319/315. He had a Class 1 medical certificate and, at one time, had held an instrument flight rules rating, obtained in Canada, but it expired in 2000. Before the accident, he had flown two hours in the previous 30 days and 130 hours in the previous six months.

The pilot of the first helicopter told investigators the accident pilot had "expressed his concerns ... regarding taking off from and landing on the helideck," the report said. "He had never previously performed these maneuvers."

The accident pilot was hired in 2004 by SAF Helicopteres, which operates worldwide, including in "hostile environments," the report said. SAF was awarded a contract in August 2010 by the Paul-Émile Victor French Polar Institute (IPEV), operator of the Dumont d'Urville base and a second Antarctic scientific research base, to provide helicopter transportation of personnel and supplies several times over the coming year and to station one AS350 B3, a pilot and a mechanic at Dumont d'Urville for short flights throughout the year.

SAF had planned to amend its operations manual — as required for renewal of its aircraft operator certificate — to include "instructions specific to missions conducted in Adélie Land," the report said. When the accident occurred, the changes had not been made, and the new operations base at Dumont d'Urville had not been reported.

The report noted two points from the SAF Helicopteres operations manual: that pilots "will fly at 500 ft above the ground or above water" and that "since no flight is to be performed at altitudes of less than 500 ft AGL [above ground level] during the day and 1,000 ft AGL at night, the low-altitude index [on the radio altimeter] is to be set to one or [the] other of these values during the cruise flight phase."

The helicopter had accumulated 1,857 hours since entering service in 2007. It was equipped for day or night flight under visual flight rules. The helicopter had been flown 245 hours since its last 600-hour inspection in February 2010 and one hour since a 100-hour inspection in August 2010.

The Turbomeca Arriel 2B1 engine had accumulated 245 hours (and 301 cycles) since its installation in March 2010 and had recorded 735 hours total time.

The only weight-and-balance documents were kept in the helicopter and could not be recovered after the accident. The pilot of the other helicopter said that the loads carried by both aircraft were similar and that his helicopter's weight-and-balance documents showed that it was within the manufacturer's limits.

The accident helicopter was equipped with a radio altimeter, but investigators were unable to determine what alert height had been selected by the pilot before the accident. The pilot of the first helicopter said that, as the clouds lowered, he had set his radio altimeter index to 30 ft.

#### Low Clouds, Low Visibility

According to weather observations from Météo France personnel and Dumont d'Urville equipment, visibility early on the day of the accident was about 40 km (25 mi), but by late afternoon, high clouds developed. In the evening, weather conditions deteriorated, with visibility falling to 8 km (5 mi) and then to 3 km (2 mi), lowering clouds and strong winds; ultimately, a storm reduced visibility to 40 m (131 ft).

A Météo France satellite map about seven hours before the accident indicated that there was "very low cloud" — which can include stratus and fog banks — between the ship and the Dumont d'Urville base.

As the pilots prepared for the flight, however, neither they nor anyone at the Dumont d'Urville base had access to the satellite images

Several minutes after takeoff, a passenger in the accident helicopter photographed the cloudy sky and the icy sea.



or data describing weather conditions between the ship and the base. The pilots knew only that an Oct. 27 forecast had called for "a little cloud, with the sky clouding over in the afternoon" on the 28th and "unsettled weather" on Oct. 29, and that a 1530 observation at Dumont d'Urville had noted visibility of 40 km, with the sky "covering slowly" and "confirmation of an expected deterioration," the accident report said.

The pilot of the first helicopter, who had flown the previous year for the company that held the IPEV contract, said that actual weather conditions after departure were good and that the forecasts were accurate for about the first 150 nm (278 km) of his flight.

Then, "53 nm [98 km] from Dumont d'Urville, he encountered difficult conditions associated with a cloud ceiling of about 200 ft and visibility of 1,500 m [slightly less than 1 mi] for about 15 nm [28 km]," the report said, describing the conditions as "whiteout-type."

The pilot said that he did not consider landing on the pack ice, which would have been too weak to be safe, and that, although fuel reserves would have been sufficient for him to reverse course, he did not turn back because he was "not sure that he could locate the ship again quickly," the report said.

After about 15 nm, weather conditions improved, and the weather was good for the remainder of his flight. He said that he suggested to the accident pilot that he keep the helicopter at 3,000 ft to remain above the low clouds, but the accident pilot said he preferred to fly beneath the cloud layer.

At 1925, when he left the base to search for the second helicopter, he found "very poor" weather conditions which "forced him to turn back when approximately 18 nm [33 km] from the accident site," the report said.

Adélie Land has no radio-navigation aids, so pilots use the global positioning system (GPS). A GPS unit was installed in the accident helicopter, and the pilot also carried a portable unit.

Pilots of the two SAF helicopters communicated throughout their flights using aircraft very high frequency (VHF) radios; the pilot of



the first helicopter said, however, that transmission quality was poor for the last 30 nm (56 km) of his flight. The radio transmissions were not recorded.

The accident helicopter was not equipped with flight recorders, which were not required by regulations. Investigators were unable to recover the memory card from the helicopter's data tracking system from the crash scene; instead, they used flight-following data that had been transmitted by satellite to the operator to determine the helicopter's flight path.

#### Seasickness Drug

While on the ship, the pilot had taken medication to fight seasickness, according to one witness and a laboratory analysis of the pilot's blood samples. One side effect is the drug's "significant sedative effect," the report said, noting that the packaging includes a warning that, because the medication can cause drowsiness, users should "be very careful" about driving or using other heavy machinery.

"Certain side effects, notably the sedative effect, reduce a pilot's ability to adapt to flying conditions when there are few visual references," the report added.

The report said it was unclear if the pilot had taken the medication on the day of the accident,

The ocean off the Adélie Land coast is impassable for much of the year because of ice. and the lab analysis could not determine how much of the medication was in the pilot's bloodstream during the flight.

#### **Oversight**

A February 2010 audit of SAF by the Direction de la Sécurité de l'Aviation Civile (DSAC) "identified several deficiencies" in the quality assurance system and flight safety that "constituted a major deviation," the report said, noting that the DSAC also found that the operator had not responded to previous agency requests for action on minor deviations, including deviations associated with the operations manual, initial training and practice sessions for the flight crew and operation of the accident prevention and flight safety program.

Some items were discussed orally with no written record of the comments, the report said.

The DSAC was informed of SAF's activities in Adélie Land only after the accident, and as a result, the agency suspended the passenger transport flights, "pending the necessary amendments by the operator to its operations manual," the report said. The manual was amended in December 2010, prompting the DSAC to rescind its suspension and renew the company's aircraft operator certificate.

#### 'Powerful Incentive'

The report noted several reasons for the pilots' "powerful incentive to undertake the flight" — including the damage to the ship and the need for repairs, the poor weather forecast for the following day and the "expectations of the over-wintered personnel on the Dumont d'Urville base."

If the pilots had known about the area of clouds visible on the satellite map, they could have planned for the weather or canceled their flight, the report said.

Instead, they took off from the ship, and as weather conditions deteriorated, the accident pilot "changed direction several times, on one occasion in order to fly under the cloud layer," the report said. "These actions may have been motivated by his fear of not being able to land at his destination or by it being impossible to fly above the cloud layer. ... His frequent changes of direction appear to be indicative of his search for visual reference points or better meteorological conditions."

The report said that the pilot might have been reluctant to turn back to the ship because of "his concerns regarding landing on a helideck at sea."

The report added, "In addition, the fact that the first pilot had managed to negotiate the area of bad weather by flying at low altitude was a strong but effective incentive to continue with the flight."

His search for visual references may have delayed his responses to radio messages from the other pilot, the report said, adding that, because there was no indication of a technical problem, "it is likely that ... the pilot had to fly in whiteout conditions and as a result was disorientated by losing all his visual references. ... Since the pilot was flying at a very low altitude, the helicopter probably hit the pack ice during a descent that the pilot failed to notice due to his preoccupation with searching for visual reference points."

The report said that the operations manual did not prescribe objective criteria to help pilots decide whether to accept Adélie Land flights, and that SAF had not told DSAC about the new base in Adélie Land or requested an exemption from the agency to permit flights from a helideck at sea.

"The relationship between the authority and the operator was not sufficient to ensure that SAF Helicopteres operated flights safely," the report said.

This article is based on the English translation of the BEA report, "Accident on 28 October 2010 off Adélie Land (Antarctica) to the AS 350 B3 Squirrel, Registered F-GJFJ, Operated by SAF Helicopteres." September 2012. The report is available at <www.bea.aero/docspa/2010/ffj101028.en/pdf/f-fj101028.en.pdf>.

The report noted several reasons for the pilots' 'powerful incentive to undertake the flight.'

# DISTRUST FUND

Employees who distrust their managers are less willing to share information about themselves and safety concerns.

BY SIMON BENNETT

iven the centrality of trust in current safety management ideas, it follows that industries with trust breakdowns may not be as safe as they could be. Working on behalf of the British Air Line Pilots' Association (BALPA), the author used a questionnaire to investigate the pilot lifestyle, including this aspect of the work environment. Four hundred and thirty-three responses were received. Three questions explored levels of trust between pilots and managers.

Before discussing the results, it is useful to look at some of the research that suggests trust is the forgotten ingredient in the safety mix.

Leaving aside the tension between normalaccident theory (which posits that accidents are inevitable) and high-reliability theory (which claims that the risk of an accident can be significantly reduced), it is clear that both theories have something to contribute to risk management. For example, Geoffrey R. McIntyre summarizes the main features of high-reliability theory in his book *Patterns in Safety Thinking*:<sup>1</sup>

- Accidents can be prevented through good organizational design and management.
- Safety is the priority organizational objective.
- Redundancy enhances safety: Duplication and overlap can make "a reliable system out of unreliable parts."
- Decentralized decision making is needed to permit prompt and flexible field-level responses to surprises.

#### **INSIGHT**

- A "culture of reliability" will enhance safety by encouraging uniform and appropriate responses by field-level operators.
- Continuous operations, training and simulations can create and maintain high-reliability operations.
- Trial-and-error learning from accidents can be effective, and can be supplemented by anticipation and simulations.

What is most interesting about this list is not so much what it says, but what it does not say. Organizational learning requires that information is communicated up and down hierarchies in an uninhibited and timely manner. But risk communication will only happen

#### "If You Felt Stressed And/Or Fatigued, Who Would You Talk To?"

Who would you consult?	Number of Pilots
Family doctor	97
Aviation medical examiner	59
Partner	336
Offspring	13
Trusted (non-work) friend	162
Trusted colleague	219
Chief executive officer	1
Personnel director	1
Operations director	2
Chief pilot	23
Fleet manager	62
Rostering manager	8
Crewing officer	14
Other (please specify)	52

**Note:** Some pilot respondents consulted people in more than one category.

Source: Simon Bennett

Table 1

if employees trust managers and vice versa. Despite the primacy of trust in the risk communication process, trust is not explicitly mentioned by McIntyre. He merely alludes to it when he talks about the need for "good organisational design and management."

Several studies have established a link between trust and safety. For example, in their paper "The Impact of Safety Organising, Trusted Leadership and Care Pathways on Reported Medication Errors in Hospital Nursing Units,"2 Timothy Vogus and Kathleen Sutcliffe observed: "Recent studies ... suggest trusted leaders ... create a context likely to bolster the effects of safety organising on patient safety. When registered nurses (RNs) trust their manager they are more likely to fully engage in the behaviours of safety organising (e.g., discussing errors and ways to learn from them, questioning assumptions and current modes of operating) because they think it is interpersonally safe ... to do so."

"Blamism" — a blame-oriented management attitude — can have a corrosive effect on employees' willingness to report incidents and accidents and share information and ideas with colleagues. Blamism, which may be perceived as victimization, undermines trust. As Andrew Weyman, Nick Pidgeon, Shelly Jeffcott and John Walls observe in their 2006 report Organisational Dynamics and Safety Culture in UK Train Operating Companies:3 "The attribution of blame and culpability is a dominant characteristic of the rail sector ... . The strong focus on blame found within ... rail sector businesses has the potential to reduce employee preparedness to report near-miss

incidents, and to lead to a focus on immediate rather than underlying causes in incident investigations. This is likely to be to the detriment of corporate and sector-wide learning in risk management."

In Just Culture: Balancing Safety and Accountability<sup>4</sup> (ASW 10/12, p. 55), Sidney Dekker points out that employees' trust may also be undermined by the positions taken by management on matters unrelated to safety, such as pay negotiations: "Trust that was lost in management because of their positions on industrial or social issues ... can ... spill over into safety issues. So even if management has not acted negatively in relation to an incident ... its behaviour elsewhere (or perception thereof) can affect the trust that practitioners will have in management handling of safety matters."

In *Pre-Accident Investigations: An Introduction to Organizational Safety*,<sup>5</sup> Todd Conklin, a senior adviser at Los Alamos National Laboratory, New Mexico, U.S., says that where trust is deficient, both workers and managers withdraw. Energies that could be devoted to risk communication are spent instead on defensive strategies. Management becomes more prescriptive. Workers become more defensive. Information is guarded lest it be used against the originator. Working relationships ossify. Suspicion grows. Organizational risks multiply.

#### **Trust Within Aviation**

The first of the three relevant questions in the author's research asked the pilots who they would consult if they felt stressed and/or fatigued (Table 1). The second asked those pilots who had sought advice or help with a domestic relationship issue who they had consulted (Table 2). The third asked those pilots who had sought advice or help about a relationship issue with a work colleague who they had consulted (Table 3, p. 27).

What is striking about these pilots' responses to the three questions is their reluctance to confide in airline authority figures (e.g., rostering managers, fleet managers or chief pilots) and health professionals (concerning safety issues of stress and fatigue). Generally, pilots sought advice and support from partners, colleagues or friends. The aviation medical examiner (AME) was a less popular source of advice and support than partners, colleagues, friends and the family doctor. Pilots' near-total shutting out of the personnel director is noteworthy, especially when one considers that one of the personnel director's tasks is employee support.

#### **Talking to the AME**

It is reasonable to infer from these statements that some pilots have trust issues with airline authority figures. Pilots' relationships with their AMEs were probed in a series of interviews. Comments included:

- "I'd be a little wary [to confide in my AME] because he has the capacity to take my flying licence away. So when I reported sick for stress I actually went to my G.P. [general practitioner]."
- "Because our livelihood depends so much on our medical [certificate], you are very loath to bring anything up that isn't really necessary. If I were to have a minor health issue I was unsure about, I would much rather go and confide in my G.P. first, to see what happens, then take it to my AME, rather than the other way around ... because the AME has a duty of care to do things immediately if they hear something."
- "Yes, I could confide in my old one. I could probably confide in my new AME. However, if something in my life was affecting my work I would probably look

elsewhere. I'd be worried that he might write something down that might leak to the CAA [U.K. Civil Aviation Authority]. If, say, I had a marital problem, I would probably chat to my close friends. If things escalated, I would probably talk to someone for cash, someone like a psychologist."

While such anecdotal comments do not prove that there is wide distrust among pilots toward independent medical and airline authority figures, the BALPA data suggest all is not well. A 2011 Populus survey of U.K. AMEs noted: "Most AMEs agreed that pilots had told them that they are reluctant to report fatigue within their company."

#### **Content and Tone**

Levels of interpersonal trust are influenced by several factors, including the tone and content

of verbal and written transactions. Put simply, *what* we say, and *how* we say it, influence perceptions and emotional responses. These in turn influence willingness to contribute ideas and disclose safety-related personal information. The following case study suggests that managers sometimes fail to strike the right tone in communications with pilots (with possible impacts on perceptions and levels of trust):

A captain was waiting at a city center bus stop for her connection to the airport. She was in full uniform and carrying a case for a long trip. As she prepared to board the airport bus she heard a child screaming behind her. A man (presumably related to the child) had collapsed. The captain attended the man. His

#### "Have You Ever Sought Advice/ Help for a Domestic Relationship Issue?"

#### Yes: 19.9% (86 pilots) No: 80.1% (347 pilots)

Who did you consult?	Number of Pilots
Family doctor	19
Aviation medical examiner	5
Partner	14
Offspring	1
Trusted (non-work) friend	37
Trusted colleague	30
Chief executive officer	0
Personnel director	0
Operations director	0
Chief pilot	1
Fleet manager	7
Rostering manager	1
Crewing officer	0
Other (please specify)	43

**Note:** Some pilot respondents consulted people in more than one category.

Source: Simon Bennett

Table 2

eyes were closing. Fearing he was passing away, the captain administered cardiopulmonary resuscitation (CPR) while talking to paramedics on a mobile telephone.

After some time the paramedics arrived and relieved the captain. They said that without her intervention the man would have died. After dispatching the man to hospital, the paramedics told the captain to declare herself unfit to fly. Next day, the captain visited the hospital to be told that the man had died in the night. Later that day, the captain's doctor declared her unfit to fly for four days.

Subsequently the captain received the following written communication from her manager: "Please provide details of your absence last week. I understand that you were on your way to work when you had to administer CPR to somebody in distress. I was therefore

The questionnaire invited respondents to describe their relationship with managers. There was a good deal of negative comment. For example:

"I cannot talk to anyone connected to the airline, as they will ground me. I will then lose pay, [and] that will make me more stressed."

"I could not possibly contemplate talking to anyone in authority within my employer: I have utterly no confidence that the matter would be dealt with properly. My poor wife bears the brunt of things. Her support is sometimes all that keeps me going."

"I would never talk to a manager or anyone in work about it, as they have an unbelievable skill of not being able to listen, and point out that it's all my fault, and that not performing properly in work is a disciplinary offence."

"If I got to talking to the chief pilot about it, it would have to be really serious (i.e., at the point where I felt I could be on the verge of endangering myself and others by flying), because I wouldn't really expect him to be able to effect an outcome suitable for me."

"I would certainly use BALPA's [peer] support [arrangement] rather than company support, which I would not trust."

"I came to the conclusion that solutions are possible but they cost time and involvement from the company and they do not want to look at it. My airline is a money-making machine in the first place and nothing else. They are simply not interested in how the same work can be done in a way that would be more relaxing and less stressful. They simply do not want to consider anything that could/would make our lives better or easier. Every two or three years another manager takes over who wants the same horses to continue to run as fast as possible." very surprised to see that you had subsequently called in sick as I assume that you were fit to come to work. Additionally, your absence very neatly joins two periods of Off/Leave — always something that I find highly suspicious. Please explain and, if able, provide a doctor's note and any information regarding your 'good Samaritan' episode." The captain described these comments as "disgusting."<sup>6</sup>

The airline business is highly competitive. With profits being squeezed by rising costs, managers are under pressure to get the maximum return from resources (aircraft and flight crew). Such pressures can skew managers' perceptions and influence the tone of their verbal and written communications. As this case illustrates, a skeptical or accusatory communication can alienate employees. Having provided a full account in good faith, the captain was disappointed by her manager's reaction. She left the airline. The 2012 Kenexa High Performance Institute report Trust Matters notes: "Those who distrust their leaders are about nine times more likely to seriously consider leaving their organization."7

#### **A Fragile Commodity**

Writing for the United Kingdom's Chartered Institute for Personnel Development, Veronica Hope-Hailey observes: "Trust is known to be a fundamental enabler of ... workplace benefits. If trust levels are high, organisations experience more, and superior, problem solving and co-operation ... and increased information sharing ... . Fundamentally, research has shown that a sense of high trust between different levels creates a climate of well-being ... with better job satisfaction and greater motivation as beneficial outcomes."8 Company culture consultancy Meridian Group says, "High morale ... is closely connected to trust ... . The keys to safety are trusting, open relationships. In a safe work culture, people speak up openly about unsafe situations ....." Trust is an important but fragile commodity. Taking a long time to build, trust can be destroyed in an instant (as demonstrated by the case study, above).

#### **INSIGHT**

#### "Have You Ever Sought Advice/Help for a Relationship Issue With a Work Colleague?"

Yes: 13.2% (57 pilots) No: 86.8% (376 pilots)	
Who did you consult?	Number of Pilots
Family doctor	0
Aviation medical examiner	0
Partner	17
Offspring	0
Trusted (non-work) friend	15
Trusted colleague	42
Chief executive officer	0
Personnel director	0
Operations director	0
Chief pilot	5
Fleet manager	12
Rostering manager	0
Crewing officer	0
Other (please specify)	6
Note: Some pilot respondents consulte than one category.	d people in more

Source: Simon Bennett

#### Table 3

In today's organizations, inter-grade trust is in short supply. According to Kenexa: "In 2011 ... 28 percent [of employees] actively distrusted their leaders and 24 percent were undecided." The erosion of trust represents an organizational pathogen, says Kenexa: "Such significant levels of distrust demand attention by HR [human resources] professionals as they have clear implications for ... organizational performance." The consequences of an erosion of trust between pilots and managers are potentially a serious risk. There also is wide agreement that fluid risk communication improves safety performance.

Without comprehensive and timely feedback from the line, airline managers may find themselves working blind. Ill-informed decisions create latent errors that may, under certain hardto-foresee conditions, generate active errors (leading perhaps to injury, death and damage to aircraft and company reputation). High-reliability theory must be embellished to reflect the *centrality* of trust to safe operation. In his efforts to improve the safety of complex socio-technical systems, the Los Alamos National Laboratory's Conklin called for a new open, respectful and trust-based relationship between managers and employees. If aviation is not to be left behind, the industry needs to recognize it has a problem with employee trust. Then it needs to do something about it.

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

- McIntyre, G. *Patterns in Safety Thinking*. Aldershot, Hampshire, England, and Burlington, Vermont, U.S.: Ashgate, 2000.
- Vogus T.J.; Sutcliffe K.M. "The impact of safety organizing, trusted leadership, and care pathways on reported medication errors in hospital nursing units." *Journal of Nursing Administration*, July–Aug. 2011; 41 (7-8 Suppl.): S25–30.
- Weyman, A.; Pidgeon, N.; Jeffcott, S.; Walls, J. Organisational Dynamics and Safety Culture in UK Train Operating Companies. London: HSE Books, 2006.
- Dekker, S. Just Culture: Balancing Safety and Accountability. Second edition. Aldershot, Hampshire, England, and Burlington, Vermont, U.S.: Ashgate, 2012.
- Conklin, T. Pre-Accident Investigations: An Introduction to Organisational Safety. Aldershot, Hampshire, England: Ashgate, 2012.
- 6. Personal communication to the author.
- Kenexa High Performance Institute. "Trust Matters: New Links to Employee Retention and Well-Being." Wayne, Pennsylvania, U.S.: Kenexa, 2012.
- Hope-Hailey, V. "High Trust Creates a Climate of Workplace Well-Being — With Better Job Satisfaction and Greater Motivation as Beneficial Outcomes." <www.cipd.co.uk/comment-insight/ comment/importance-trust.aspx>.

InSight is a forum for expressing personal opinions about issues of importance to aviation safety and for stimulating constructive discussion, pro and con, about the expressed opinions. Send your comments to Frank Jackman, director of publications, Flight Safety Foundation, 801 N. Fairfax St., Suite 400, Alexandria VA 22314-1774 USA or jackman@flightsafety.org.

#### **SAFETYMANAGEMENT**

uture error-tolerant system improvements to airline operations will require a fresh appraisal of voluntary safety programs to ensure they match advances in safety culture and technology, says Timothy Logan, director of safety, Southwest Airlines. He urges the industry and government to come to grips with legacy philosophical errors that today affect how well these programs support safety management systems (SMSs). He presented his paper and answered questions in August during the ISASI 2012 seminar in Baltimore organized by the International Society of Air Safety Investigators (ISASI).

"It's really important to talk about the state of these programs," Logan said. "[There've] been a lot of things underlying these programs that need to be fixed, [that] need to be rectified for us to have a really good SMS. ... For those of us in the safety offices of large operations, our focus is no longer on reacting to hull losses or even serious incidents. Our focus has moved toward preventing incidents through the identification of hazards and threats for which we previously had little to no information."

SMS rests on four pillars: safety policy, safety risk management, safety assurance and safety promotion. He called safety risk management and safety assurance "the engines of SMS" in everyday airline operations because they drive decision making. Yet today's voluntary safety programs are not structured to

## SHORTSIGHTED RULEBOOK BY WAYNE ROSENKRANS

The data-exchange firewalls between voluntary safety programs inhibit SMS effectiveness, says a U.S. airline's director of safety.

support the system safety process of SMS, he said.

In the Southwest Airlines SMS, these programs are a subset of all information sources used in system safety analysis and decisions. Among other sources are irregularity-reporting programs, occupational injury reports, internal evaluation program audits, maintenance reliability programs, aircraft damage reports and internal investigation reports.

The voluntary safety programs he discussed were aviation safety action programs (ASAPs) for specific employee groups; flight operational quality assurance (FOQA, also called flight data monitoring of routine operations); voluntary disclosure reporting programs to the U.S. Federal Aviation Administration (FAA) by the airline and its maintenance, repair and overhaul facilities; line operations safety audits (LOSAs); and FAA-sanctioned internal evaluation programs. Other airlines also rely on their FAA-airline advanced qualification programs (AQPs), Logan said.

"We have lots of data, and the problem is [that] it comes in waves, very unorganized, and we are sitting at the bottom [of the figurative waterfall] with the pail trying to figure out what are those issues to go look at," Logan said. "What's interesting is that, in a lot of cases, those [sources of safety data] aren't shared outside of the airline. But ... we have to merge that data with our ongoing data ... from our maintenance programs through reliability [studies]. We have damage reports, we have injury reports."

Injury reports, for example, don't include a flight number or a date. "We don't even necessarily know how to relate [an injury report] to the flight or a facility," he said. "It is so frustrating sometimes to have a report that has good information in it, but we can't use it to be able to [relate] it back to a flight or a maintenance facility."

#### **Origins of Problems**

From Logan's perspective, airlines are inhibited by the independence of these programs from each other, the conflict of FAA regulatory enforcement and company disciplinary action with the safety purposes of these programs leading to deviations from the memorandum of understanding (MOU) and reduced effectiveness — and what today seem to be excessive levels of data protection given the priority of system safety analysis.

"All these programs were created independently," he said. "We have different analysis. We have different taxonomies, meaning [that] one ASAP program might be running on a different software with different taxonomies than the other. So, to mix a flight attendant ASAP report and a pilot ASAP report, it can be challenging and doesn't necessarily equate very easily."

Different governance documents for each voluntary safety program also complicate efforts by airlines to build holistic views of problems. "The flight attendants, the mechanics, the dispatchers and the pilots all have a separate MOU," he said. "They don't have to coordinate, and they don't have to talk. … None of that guidance has ever been coordinated with regard to how we are going to use [these programs] systemically from a safety management standpoint."

The practical, efficiency-related consequences have included duplication of staff and resources — people doing the same job with a silo mentality in operational departments and employee work groups. During safety data analysis, the airline often cannot "take one report and overlay it, [we] can't take the FOQA data and mix it with the other data also," Logan said.

Another complication has been disparate treatment of some airline employees — such as ramp operations staff — because they are not covered by an ASAP program. Moreover, the defensive, adversarial mindset from the time when voluntary safety programs were designed has become an anachronism, he added.

"All of the guidance that we used ... was created [or] came out of the existing FAA enforcement handbooks and enforcement guidance," Logan said. "There was a need for these [provisions] to be put in place at the time they were implemented ... We had no strategic vision [of] what we wanted to do with this data once we had it, and how we were going to fit it in [to SMS]. ...This is just the reality of how we got these programs going."

#### **New Imperatives**

People who helped to develop these programs — Logan included — especially did not have today's prevailing concept of how to use safety information that inherently would identify human errors, he now believes. "[Safety] is a human process; humans make errors," Logan said. "A lot of those errors are built into the system, and they're caused by the system or facilitated by the system. We do not deal with that well. We still look at the violation aspect of [events] first, and deal with that without really understanding it's an error, it's human, we need to figure out how we are going to fix it."

Part of the core issue is the mindset of people who dismiss voluntary safety programs as merely a way to "get out of jail free," that is, avoid disciplinary action.

#### **SAFETYMANAGEMENT**

Current U.S. voluntary safety programs typically exclude some airline employee groups, such as ramp staff.



He added, "I will passionately disagree; in the majority of the cases, that is not the case. We do much more proactive work with our employees who report into the program than is ever evident. ... We make sure that [the reporting] employee understands what they should have been doing, gets trained on those issues they didn't understand even up to going into the simulator or going out and demonstrating [competence]. That is the best proactive safety you can do, and it does fix things."

#### 'Rogue Employee' Myth

During the design of FOQA and ASAP programs, participants sometimes voiced a need to find rogue employees, those whose unsafe acts would be considered intentional. Some participants would say, "We all know they're out there," he recalled. "At the time, the lack of trust and history probably made these possibilities believable."

The past and present workplace cultures of voluntary safety programs differ, however. "We have to understand that these were created in an environment where there was little or no trust," Logan said. "We were back in the days [in the 1980s and 1990s] where it was 'Catch me if you can'... The value of the information [now] has largely overcome the lack of trust between the parties." As a result, in almost 20 years, U.S. airlines typically have not identified rogue employees. "At the [U.S. Federal Aviation Regulations Part] 121 carrier level, our data does not identify rogue employees [abusing the reporting incentives]," he said. "It really identifies system safety issues that we have to deal with — whether it's a training issue, whether it's just information to the crews, or whether … we didn't do a good job when we set up our process in the airlines, whether it's a procedure, a checklist or any [other] items."

Similar concerns shaped the original relationship between the government and airlines, he said. "What was going to happen if [airlines showed] this information to the FAA or to the [U.S. National Transportation Safety Board (NTSB)] or to the Congress?" Logan recalled. "Would we be [identified publicly] as a rogue carrier or a rogue operation? That never happened, but we were concerned about it, so we operated as if it was going to happen."

#### **Questionable Barriers**

In today's airline SMSs, the legacy of suspicion about voluntary safety programs has been detrimental, impeding full SMS effectiveness — in his experience. "What happened is we have a limited ability to cross-pollinate the

[ASAP] information because of the data protections that have been put in place," Logan said. "We lose pertinent [FOQA] information because some of the information goes away after a certain amount of time. ... [We've] put controls into the software that delete the flight number and the date, so we may not necessarily know that information [that is, identification of individual flight segments is kept secret, allowing only aggregate analysis of multiple flights]. There is a barrier to systematic safety analysis. And those barriers prevent us from smoothly evolving an accident [or] an incident investigation."

Limitations on how Southwest Airlines can analyze runway excursions versus near-excursions illustrate the point. "If I have an airplane that slides off a runway, and I know about it, I can pull a flight [data] recorder; I can grab the [cockpit voice recorder data]," Logan said. "I can work with the NTSB on those issues [see "NTSB Seeks Data for Safety Recommendations"]. I can pull all the information I want — immediately — off of the airplane. … I can bring the crew in and do an interview. I can do everything I want to do."

Conversely, if he receives a report from a captain or other party who reports - through one of the voluntary safety programs - that an aircraft "almost" ran off a runway, the analysis runs into the barriers. "If [the report] comes in through one of the programs, the ability to do that same investigation is limited, and I'm not sure that's in our best interest, especially when we look [from] an SMS standpoint," Logan said. "The idea [in SMS] is we are supposed to be using those near-miss events to be able to get ahead of those events. If we can get at the data [yet] we can't use the data, we're not going to be able to do that. ... In a perfect world, we could use the same techniques we

have developed for accident investigations, such as flight data information [FOQA], crew interviews [ASAPs] and review of associated data in the investigation to identify hazards."

Another example cited is monitoring system safety whenever Southwest Airlines begins flying into an airport that is new for the company. "We're going to [need to] get information that's going to tell us something that we may not have known," he said. "We have to be able to react to that."

Airline LOSA programs and the FAA's Aviation Safety Information Analysis and Sharing (ASIAS) program encounter similar aggregated-data access/use limitations and missing context.

Worldwide fleet data collected by airplane manufacturers also have been a missing source of information in airline SMSs, Logan said. "We need to have that part of it if we are going to do [SMS] systems analysis on our issues," he said. "There are fleet-specific or national airspace issues that we, in the carriers, can't alone really move or push. We're trying to do that through ASIAS, [and] through the [U.S. Commercial Aviation Safety Team] process, but it's not as easy."

#### **Call for Reassessment**

Recommendations in the presentation aim to resolve the SMS impediments described. "The FAA administrator needs to establish an aviation rulemaking committee ... to get the industry, [government, academia,] labor and other folks together to really review all of the guidance that's out there on these voluntary safety programs and integrate them with SMS," Logan said. "When you look at the SMS guidance, you'll see references to the voluntary safety program[s] but there is no tie [from SMS] across to those programs. ... Let's

#### NTSB Seeks Data for Safety Recommendations

Uring ISASI 2012, Deborah A.P. Hersman, chairman of the U.S. National Transportation Safety Board (NTSB), acknowledged the need to better educate the U.S. Congress and the flying public about how airlines today carry out their safety responsibilities using safety management systems (SMSs) and voluntary safety programs. Tapping into the safety data used in SMSs also may help the NTSB to bolster its arguments for adopting safety recommendations, she said.

"There are going to be things that are uncomfortable ... that are not the operating norm [for airlines communicating about SMS-related results]," Hersman said. "But changes are going to have to be made if we want to take it to the next level of safety. If we want to gain the next benefit ... we are happy to tell the good-news stories and share the data — if we have access to it. ... I think our team [in 2011 and 2012 discussions with ASIAS (Aviation Safety Information Analysis and Sharing) leaders and during InfoShare meetings] found very much that if we can provide the data to support our [safety] recommendations, they are much more likely to be implemented. ... We want to continue that dialogue, and we do appreciate the risks that people [involved in InfoShare and ASIAS] are taking and the opportunity to build some confidence there."

As aviation safety technology and culture have evolved, the NTSB has had to adapt through a commensurate modification of practices. "NTSB is not the only one," she said. "I think the industry, the regulator and others do need to stand outside the [SMS] process sometimes and take a look at it to see if the process itself is working."

– WR

write [new] guidance to match up to what we need from SMS; let's not do it from the bottom up. We [also] need to make sure that the Part 193 [U.S. Freedom of Information Act] protections are embedded [explicitly within FAA-accepted SMS programs and apply to] any of the information [an analyst in] SMS comes across ... that's the best way to make sure that the information will be available."

New educational programs about SMS could remove some secrecy surrounding airline safety activities, which prevents elected officials and the public from understanding the nature and results of SMS. "The problem is nobody outside of our group really knows how much we're doing, and nobody has really studied it," he said. "I think the only way to do it is to start the conversation. I would really like to see us come together, and maybe ISASI is the perfect place to do that, or maybe Flight Safety Foundation is the perfect place to do that. ... [We] have to lift the veil a little bit and say [publicly] 'Know what? We do have [safety] events out there, but we deal with them very well.' We usually come up with corrective actions very [quickly and methodically] and put implementation [of solutions] in place. ... Barriers to data usage and data correlation should be eliminated."

In the question-and-answer session, Mont Smith, director, safety, Airlines for America, said that twice-a-year, government-industry Aviation Safety InfoShare meetings perhaps should provide educational content for selected observers who could communicate about safety accomplishments of ASIAS and the airlines. Logan agreed. 🤝

#### BY ED BROTAK

t seemed that airplanes arriving and departing from Will Rogers World Airport in Oklahoma City, Oklahoma, United States, on the morning of Aug. 3, 2012, would have few problems with wind conditions. The air was dry, and the surface weather map was devoid of any significant systems, typical of summer in the Southern Great Plains. Winds were light at the surface, running about 5 kt. And winds well aloft also were weak, less than 25 kt to 40,000 ft. So imagine the surprise when pilots ran into winds in excess of 40 kt just 1,600 ft above the ground. This was an example of what meteorologists call a "low-level jet stream" or a "low-level jet."

Jet streams are fast-moving currents of air that have been likened to rivers in the sky. For many years, meteorologists only theorized about their existence. Driven by the inherent temperature contrasts on Earth and the effects of the planet's rotation — the Coriolis effect — the air never is still. In the meteorologists' view, fluid mechanics theory indicated that the air's movement should be concentrated in some regions — these areas eventually were called jet streams.

Later, aviation provided the absolute proof. When airplanes started flying higher, particularly by World War II, pilots encountered the strong winds of the jet stream. These are the now-familiar high altitude jet streams that normally occur from 30,000 to 35,000 ft.

As the science of meteorology progressed, and the atmosphere was probed more thoroughly on a regular basis, other jet streams were discovered. Some were many miles up, on the threshold of space, but others were close to the surface. These are the low-level jets, and they are a particular concern for aviation given the potential for loss of control of an aircraft so near the ground.

Unseen lets

Low-level jet streams increase the potential for loss of aircraft control near the ground.

A low-level jet stream is a wind speed maximum found within the lower part of the atmosphere. Its height can vary from 5,000 ft down to a few hundred feet above the surface. Wind speeds typically range from 20 to 50 kt, but have exceeded 80 kt in extreme cases. To be officially classified as a jet, the wind speeds above this low-level maximum must be relatively slower. However, operational meteorologists and aviation interests would be more concerned with any rapid increase in wind speed with height near the surface, regardless of the wind profile above it. Low-level jets can be several hundred miles long and tens of miles across.

For example, for a low-level wind of 50 kt at 5,000 ft to be officially called a low-level jet, winds would have to decrease to, say, 30 kt at 10,000 ft. But if the winds at 10,000 ft were 70 kt, the 50-kt wind at the lower height would not be a low-level jet. You would still have 50-kt winds at 5,000 ft, however, and that could cause problems for aviators.

Low-level jets are a result of dynamic processes in the atmosphere. Without going into the mathematics, basic physics shows that when strong temperature contrasts exist, winds increase. Fronts, which separate warmer from cooler air masses, are, by definition, regions where strong temperature contrasts exist. So low-level jets tend to be found near various fronts. Topographic barriers such as mountain ranges also affect airflow and can intensify lowlevel winds into jets.

Low-level jets pose a number of problems for aviation. These potentially dangerous conditions just above the surface can occur during the critical times of takeoff or approach to landing. As with upper-level jet streams, low-level jets produce turbulence and there also are rapid

#### **AVWEATHER**

 UTC = Coordinated Universal Time

 Source: U.S. National Oceanic and Atmospheric Administration

Surface Weather Map at 0000 UTC January 23, 2012

#### Figure 1

#### 850 Millibar Wind Chart at 0000 UTC January 23, 2012



#### UTC = Coordinated Universal Time

Note: Shown are standard wind barbs indicating wind speed and direction; lines are isotachs of equal wind speed done every 10 knots.

Source: Plymouth State University

Figure 2

changes in wind speed (i.e., low-level wind shear) that can affect the handling of an aircraft. Head winds or tail winds, which affect the lift generated by the wings, can change suddenly. Strong, rapidly changing crosswinds can pose a major hazard for planes attempting to land. Even if the jet stream itself is located some distance above the surface, strong wind gusts can occur near the ground.

Whether strong winds from a low-level jet reach the surface depends on the structure of the lower atmosphere. Meteorologists call the layer of air in contact with Earth's surface the *boundary layer*. If this layer is well mixed, then strong winds well above the surface can mix downward, at least in strong gusts.

Sometimes the boundary layer is separated from the atmosphere above it by a stable layer, usually an atmospheric inversion. This happens when there is dense, colder air near the surface and warmer air aloft. If a low-level jet is above the stable layer or inversion, strong winds will not make it down to the ground, but pilots will note a sharp increase in wind speed when they approach the jet stream.

Low-level jets can be detected by radiosondes, balloon-borne instrument packs that are launched twice a day from more than 80 sites in the United States and 900 stations around the world. As the instrument packs rise, they move with the air currents. By tracking the radiosondes, meteorologists can determine the direction and speed of the wind at various levels of the atmosphere. On some occasions, Doppler radar (*ASW*, 9/12, p. 24) also can detect lowlevel wind maxima.

Low-level jet streams are fairly common and have been observed on every continent. There are many different types of low-level jets and a variety of situations that produce them. To start with, we'll examine jets that occur with well-defined synoptic situations — the weather features easily seen on standard weather maps.

The 0000 UTC Jan. 23, 2012, surface chart for the United States (Figure 1) shows a developing low pressure area in the middle of the country. The counterclockwise flow is producing strong southerly winds ahead of the cold front and a northwesterly flow of colder air behind it. A look at the wind field at 850 millibars (mb) (Figure 2), approximately 5,000 ft above sea level (ASL), shows two distinct low-level jets. Ahead of the cold front, we have a prefrontal, southerly jet.

The Little Rock, Arkansas, radiosonde sounding showed winds in excess of 40 kt at 1,600 ft, increasing to 60 kt at 6,500 ft. Strong wind gusts exceeding 40 kt were reported at Clinton National Airport in Little Rock, brought down to the surface in thunderstorm downdrafts. Looking further north, although the jet wind speeds were still strong, surface winds only gusted to 20 kt at Lincoln Capital Airport in Springfield, Illinois. Colder air near the surface blocked the stronger winds from making it to the ground.

Strong southerly jets are very common in the Great Plains from the United States northward into Canada. One contributing factor is the topography. The Rocky Mountains border the plains to the west. They provide a physical barrier to the airflow, thus concentrating the southerly winds into jets. Although these jets develop regardless of the moisture content of the air, winds from the south can transport moisture from the Gulf of Mexico well north. In addition to the direct aviation problems associated with these jets, strong-to-severe convection also can accompany them, especially in the spring.

A post-frontal, northerly low-level jet also can be seen in the Western Plains. Winds exceeding 50 kt were recorded for Dodge City, Kansas, in a sounding at a height of 1,600 ft. Although the air was cold, it was well mixed, and wind gusts of 33 kt were reported at the Dodge City Regional Airport.

An even stronger northerly low-level jet was recorded during the major cyclone in the western Great Lakes on Oct. 27, 2010 (*ASW*, 2/12, p. 47). Bismarck, North Dakota, was well behind the surface cold front and into the cold air. A low-level jet of 70 kt from the northwest was noted at 2,300 ft above the ground. Surface winds gusted to nearly 50 kt. Above the jet, winds calmed. The wind speed at 30,000 ft, standard jet stream height, was only 39 kt.

Looking again at the surface weather map (Figure 1) of the United States, meteorologists saw a ridge of high pressure wedging down the east side of the Appalachian Mountains. The clockwise flow around the center of high pressure was producing northeast winds along the East Coast. The Moorehead City, North Carolina, sounding showed a wind maximum of 24 kt about 820 ft above the surface. Winds above this were much lighter. This type of low-level jet in a cold, northeast flow is even stronger when there is a major low pressure area to the south.

At 0000 UTC Dec. 27, 2010, a major winter storm was affecting the New York metropolitan area (*ASW*, 2/12, p 47). The sounding taken at Upton, New York, showed northeast winds of 51 kt just 1,000 ft above the surface. Wind speeds peaked 4,000 ft up, at 77 knots. Winds lessened considerably above this. Wind gusts of 50 kt at the ground were measured at John F. Kennedy International Airport.

In addition to intensifying any preexisting jets, mountain ranges can produce their own low-level jet streams. *Barrier jets* are formed when at least part of the overall wind flow is perpendicular to a mountain range. In particular, cold air masses — which are very dense are blocked by higher terrain.

With warmer air above, this lid of stability blocks the air from flowing over the mountaintops. Instead, the airflow becomes parallel to the mountain chain and accelerates into a jet. The highest winds are found on the windward side of the mountain range below the ridge peaks. Wind speeds can exceed 50 kt. Barrier jets have been noted in many locations around the world where there is a combination of cold air and mountainous terrain.

Another type of low-level jet stream is the *coastal jet*. Often measured along coastlines, they show strong temperature contrasts. In particular, along the western coasts of continents we usually find cold water due to prevailing cold currents and the process of upwelling, that is, cold bottom waters rising to the ocean surface.

In addition to intensifying any preexisting jets, mountain ranges can produce their own low-level jet streams.

#### 1200 UTC sounding for Peachtree City (Atlanta), Georgia, for 1200 UTC September 12, 2012



#### Figure 3

In the summer, the cool air over the water contrasts greatly with the warmer air over the land. There is also very often a capping inversion found at such locations.

The end result is often a low-level jet just off shore that flows toward the equator. Wind speeds of 20 kt to 40 kt are common, and they can exceed 50 kt. The jet core is often near 1,300 to 1,600 ft. Coastal jets are common along the West Coast of North America from California to Alaska. They also have been observed off the coasts of Chile and Peru, Spain, and southwest Africa.

The low-level jets described above are linked to easily identified weather systems or to various geographic or topographic features. Other low-level jets occur in much more innocuous situations.

The 1200 UTC sounding on Sept. 12, 2012, for Peachtree City, Georgia, (Figure 3) depicts a particularly deceptive phenomenon. In looking at the vertical wind profile, calm winds at the surface change to 21 kt by 1,200 ft above the ground. Then the winds decrease above that height, and remain remarkably light. At the surface, the region is under a high pressure area.

What is causing this low-level wind maximum? A look at the vertical temperature profile shows that the strongest winds correspond to the highest temperature reported. The temperature has, in fact, increased from the surface to this point in a classic example of the *nocturnal inversion*. This means that when the sun goes down, Earth's surface radiates heat into space and cools quickly, more quickly than the air.

The air nearest the surface is cooled from below, from being in contact with the cooler ground. Thus, a surface-based temperature inversion has developed. Usually, the coolest temperatures occur near sunrise, about the time of this sounding. The inversion layer decouples the surface layer of air from the air above it, also removing the frictional drag found at the surface.

Without friction to slow the moving air, wind speeds increase and are maximized right at the top of the inversion layer. This wind aberration is called the *nocturnal jet*. Technically, this is not a "true" jet — without other atmospheric processes being involved, it will dissipate in the morning as the air warms and vertical mixing sets in. However, the decoupling effect itself is important, and the true low-level jets described above tend to be stronger at night and in the early morning.

Finally, aviators may ask, "Can low-level jets be predicted?" Southerly jets — the largest and strongest of the low-level jets — can be forecast by some standard computer models. A number of fine-scale models also have had some success in forecasting the occurrence of less-pronounced low-level jets out to 18 or 24 hours. Today, there are still large errors in height and intensity forecasts, however. Often these jets have to develop first and then be detected before simple continuity forecasts can be made. The Oklahoma City situation above would fall into this category. *⇒* 

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.



The basic math is easy, but thoughtful effort is required to identify the correct data.

he math needed to determine the financial return on investment (ROI) for safety interventions is easy (*ASW*, 10/12, p. 16), but technical expertise is required to calculate the associated benefits and investments.

The key performance indicators discussed by safety executives may differ from those discussed by the corporate finance department. One group may count unstabilized approaches, go-arounds and employee injuries. The other group looks at quarterly financial performance. Safety and profitability are the mutually inclusive, number one priority for most industries, especially transportation.

If you think that safety and finance are not related, then consider how quickly customers flee an airline or a company after a catastrophic event. For example, the 2010 oil spill in the Gulf of Mexico had an extreme impact, not only from clean-up costs but also from the costs associated with public perception. Airline stock prices take a big hit following an accident. Sales are threatened when new model aircraft develop unexpected failures. Offshore helicopter operations suffer the same fate when their safety records are in question.

In most cases, the highly visible catastrophes could have been prevented with safety interventions that seem inexpensive, especially after the fact. The operator could have had more training, the extra safety mechanism should have been installed, the vessel or aircraft could have had one extra safety-oriented design feature, and the company should have tracked the event precursors more closely.

The examples above refer to major events, which seldom occur. This article focuses on the hundreds, if not thousands, of small hazards or errors that add up and ultimately injure employees, impact production and service, and contribute to financial losses. The costs of such errors should not be considered "the cost of doing business" but rather the cost of not doing business as well as possible. These incidents are indicators of organizational safety and potential predictors of aviation accidents.

#### **STRATEGIC**ISSUES

This article describes an approach to predicting and/or measuring the cost and safety return, or benefit, on safety interventions. It helps technical and safety personnel make a business case for their programs by offering the fundamental vocabulary and procedures for discussing and calculating ROI. It helps finance personnel to see the direct correlation between safety and profit.

#### **Easy Formula**

The ROI formula is the easy part. Economists who reviewed the approach say that the procedures and math of the simplified calculations are reasonable and correct. It is a matter of addition, subtraction and division. Anyone can calculate ROI.

But the catch comes with the work involved in identifying the benefits and the investments that must be added up, subtracted and divided. Writings and speeches about ROI have not sufficiently emphasized the technical effort of deriving investment and benefit data.

Some technical personnel have not yet adopted the ROI mindset, perhaps because they have not been convinced of the value of their ROI efforts. Typically, they fix problems rather than assign costs and calculate ROI, and they do not always know the entire cost of an error because their priority is production and schedules. Other factors are that financial personnel are the ones who typically perform cost and investment analyses, that executives do not demand ROI calculations for many technical interventions and that corporate culture usually does not expect ROI data from technical personnel.

#### Now Is the Time

The many recent papers<sup>1-7</sup> and speeches discussing the benefits of calculating safety ROI have not changed aviation corporate behavior. However, the

increasing worldwide emphasis on safety data may encourage the use of this tool. Safety management systems (SMSs) demand a process and a culture to analyze key performance indicators, to formally identify hazards, to establish management interventions and to measure impact. These activities provide the data and the motivation to increase efforts to calculate ROI. The simplified ROI model has not changed, but the corporate culture *has*.

You must thoroughly understand your safety challenges before you can calculate ROI, and an SMS can be the foundation for understanding these organizational challenges and determining the procedures and associated costs necessary to manage the risk. An SMS, supported by the right safety culture, can help identify the hazards that contribute to risk. SMS and ROI go hand in hand.

After you conduct a reasonable risk assessment, you know the possible negative outcomes as well as the probability that they could happen. You also know how to address the individual hazards contributing to risk. For example, you know that you have a problem of communication during shift turnover in aircraft maintenance. The afternoon shift has limited overlap with the graveyard shift. As a result, there have been many task handovers when critical information was not conveyed. This communication has resulted in missed steps in maintenance or a repeat of work that has already been completed.

Your SMS data help you know the consequences of that challenge. You can also count the number of times that an issue may have affected airworthiness and/or safety. You can put a value on the cost of the resulting rework, the associated delay of delivery, flight delays and other related costs. Finally, you can determine a remedy — for example, new documentation procedures

or increasing the time of shift overlap. In threat and error management terms, you know how to manage the threat to reduce or eliminate the error. You know the costs of the hazard and the costs and timetable of the intervention. Your field experience may help you to assign some level of confidence to your planned solution. This prepares you for an accurate ROI estimation. With the ROI information, you can decide how to proceed. The SMS data can not only identify threats but also help you show, in terms of safety and cost, how your intervention affected the number of subsequent events.

#### **ROI Calculator**

What follows is one example of an ROI calculation that demonstrates the safety and financial payback on a fatigue awareness program implemented by a large maintenance and repair organization (MRO). The six-quarter ROI was more than 3-to-1 on a \$200,000 investment.

The ROI calculator, developed in cooperation with Booz Allen Hamilton, is available at the U.S. Federal Aviation Administration's (FAA's) website on fatigue management for maintenance personnel - <mxfatigue.com>. The software comprises a sophisticated set of connected Excel worksheets and includes extensive user documentation and guidance. The ROI calculation is based on a straightforward formula that subtracts the total cost from the net return (expected benefit times the probability of success) and divides that number by the total cost (Figure 1). However, the calculation can only be as accurate as the data you input, so you must commit a reasonable amount of effort up front to establish the expected net investment (cost) and the expected net return (benefit).

In this example, a large maintenance organization acknowledged human fatigue as a safety risk. The company began collecting data on the contribution of fatigue to company incidents and accidents. Questions from FAA fatigue management documents were used to identify events in which fatigue was a contributing factor, and the company instituted scheduling limits in 2009. In 2011, the company instituted fatigue countermeasure training as a safety intervention for all maintenance technicians and management. The training was implemented from January 2011 to January 2012.

The training, developed by the FAA–Industry Maintenance Fatigue Workgroup, comprised 90 minutes of interactive training and testing, and viewing of a video titled "Grounded" (available free at <mxfatigue.com>). The computer-based training was delivered at multiple locations throughout the company.

#### **Estimated Investments**

This section demonstrates the ROI calculations, using the FAA's calculator.

Figure 2 shows the company's personnel cost estimates for implementing the training. An additional section of the worksheet, not shown in the figure, lists non-labor costs like hardware, facilities, supplies and other expenses. To identify these costs, the company answered about a dozen questions devised to help first-time users collect the necessary data and complete the

#### **ROI Basic Formula**



Notes: ROI = Return on Investment

Source: U.S. Federal Aviation Administration

#### Figure 1

Iser Guide Navigation Panel							
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#### Figure 2

#### **STRATEGIC**ISSUES

investment form — for example, "How many personnel were trained?" "Did you have to buy special hardware?" and "Over how many quarters did the training occur?" Other questions may be added as needed.

In the example, the responses to the questions showed that the investment

costs were limited to personnel time, and that personnel expenses were limited to the time of the trainees and some of the management and administrative support. The employees completed the training via the FAA safety website <faasafety.gov>. Company training personnel logged completions for corporate tracking. Forty percent of the employees completed the training away from the worksite, so there were no lost production costs. The others trained instead of working, so the cost was associated with their unavailability. As previously mentioned, there was no cost to the company to develop the training.

User Guide Navigation Panel					
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PART A: Select Financial Indicators and how much imp	provement is estimated to benefit your company		_	-	Industry Info
PART A: Select Financial Indicators and how much imp	provement is estimated to benefit your company Notes about Financial Indicators	Average Cost per Event*	# of Current issues per year	# of Current Issues per year to be addressed	Total Estimated Returns
PART A: Select Financial Indicators and how much imp Financial Indicators that your Intervention will improve Aircraft Damage OSHA Reportables	Notes about Financial Indicators 89 expected in 2011 @ average of 105,000 189 expected in 2011 @ average of 6307	Average Cost per Event* \$ 105,000 \$ 6,307	# of Current issues, per year 89 189	# of Current Issues per year to be addressed 9 19	Total Estimated Returns \$ 934,500 \$ 119,202

#### Source: U.S. Federal Aviation Administration

#### Figure 3

#### **Probability of Success** User Guide Probability of Success - "How likely will the Returns be realized?" BACK 5 NEXT Part A: Enter a score based on your best assessment of how the project will be managed. Select Score 1-5: Success Categories Prior Experience At least one person on the project team has a working knowledge and experience with Project Management processes At least half of the project team has successfully completed more than two projects of similar size and function The project sponsor has successfully led to completion more than two projects of similar size and function The customer has signed off acceptance of more than two successfully delivered projects of similar size and function The customer, leadership, and the project team have worked on a successful project of similar size and function in the past 23 4 5 Sub-section average score 3.8 Leadership and Customer 6 The project has defined roles and responsibilities for customer, leadership, and project team members The project has a sponsor with budget authority The customer and project team have agreed to readily identifiable deliverables and success criteria Leadership and the customer agree to participate in all missione project review meetings Leadership and the customer agree to sign-off deliverables according to the predefined success criteria 4 2 9 10 3.8 Sub-section average score Leadership and the project team agree there are sufficient resources available until the end of the project. The project team has matched the skills and abilities of the team members to the needs of the project All materials required for the project are available, or have a committed delivery date in line with the project plan The sponsor commits to support a request for additional resources, if required The Safety and Quality departments are involved in the project planning, development and implementation 12 13 14 15 5 Sub-section average score Planning 16 17 18 Leadership and the project team have developed and approved a business case that aligns to organizational objectives Leadership and the project team agree the project plan is SMART (Specific, Measurable, Achievable, Relevant, and Time-bound) Leadership and the project team agree that appropriate milestones have been built into the project plan Leadership and the project team have developed and approved a risk (bg with contingencies A communications plan has been developed and will be implemented to inform stakeholders of progress 19 20 Sub-section average score Probable returns - "How much of the estimated Returns will be realized?"

Source: U.S. Federal Aviation Administration

Data on investments and returns do not show the quarterly cash flow, or the timeline for financial and safety returns. The next steps required the company to assign estimated spending and return rates by quarter. These data are not presented here.

#### **Estimated Return**

To estimate the return on the training, the company answered a series of questions regarding financial and safety returns, such as "How many safety incidents do you expect the intervention will resolve?" "What key performance indicators will be influenced by this intervention?" "What are the metrics you will use to measure these changes (e.g., aircraft damage, rework delivery delay, employee injuries, lost time job injuries)?" and "What are the costs associated with each metric you selected?"

The company expected to see a reduction in aircraft damage and injuries<sup>8</sup> compared with 2010 performance (Figure 3). The company believed the training could target 10 percent of the predicted aircraft damage events (10 percent of 89 events in 2011, at an average cost of \$105,000) and 10 percent of the predicted on-the-job injuries (10 percent of 189 injuries in 2011, at an average cost of \$6,307).

#### **Probability**

Most ROI is calculated based on predictions of expected costs and returns, derived from estimates that likely are not completely accurate. Therefore, the probability of success is part of the calculation. It is used in the formula to compute net return and is a function of prior experience, the level of corporate support, the availability of resources and the amount of planning that is committed to the development of the safety intervention. Figure 4 shows 20 questions, rated by the company using a 5-point scale to assign a probability of success. The software automatically assigns a plus or minus 10 percent confidence level around the probability in the output. In this example, the probability of the training intervention successfully resolving the target safety and investment returns was 80 percent.

#### **ROI Analysis**

Figure 5 p. 42 shows the ROI output chart in the project analysis summary. In this example, the ROI over six quarters is 312 percent. The original investment of personnel time is paid back within the first quarter. The extraordinarily high ROI is partially attributable to the extremely low training costs. Even if the company had made a large investment in training materials, however, there still would have been a high payback.

The company estimated, conservatively, that adherence to the fatigue training could improve worker efficiency by an additional 1 percent. In 2011, 1 percent of all hours worked would have meant a benefit of \$900,000 in efficiency (an amount not included in ROI calculation). When the investment is low and the benefits are high, the ROI can be impressive.

ROI calculations can inform decisions about safety interventions. Following implementation of safety interventions, a straightforward comparison of performance can be made from one year to the next. In this company, the cost of aircraft damages was reduced by nearly 30 percent in 2011, compared with 2010. That is \$3.04 million in savings. The number of injuries was unchanged in 2011, but the average cost of an incident was reduced by nearly 15 percent, resulting in savings of \$183,534. These performance improvements were achieved by a variety of programs, including the fatigue countermeasure training.

#### **More ROI Examples**

During 2012, the authors worked with airlines, manufacturers and MROs to implement the ROI procedure, as outlined in the FAA website. It became obvious that every safety intervention was not conducive to a reasonable ROI. For example, one airline reported a series of incidents in which a company procedure resulted in a certain part of the landing gear not being properly torqued when the task was transferred from one shop to another. An employee noticed the procedural error and reported it through a corporate voluntary reporting system. Neither the airline nor the manufacturer saw a safety issue. The company adjusted the procedure to correct the hazard. There was a fine imposed by the regulator because of a lengthy non-compliance period. Obviously, the authors did not use avoidance of a regulatory penalty as an exemplary numerator for an ROI calculation.

#### **ROI Cautions**

You must be careful to be accurate in your estimates and measures and to remember that conservative, relatively low estimates are often best. Also, it is important to be aware of relevant developments when you attribute savings and safety improvements solely to your intervention. For example, a few years ago, a researcher claimed that his intervention reduced personal injury by nearly 90 percent at an airline maintenance facility. He was unaware that, when he made the final measures, the facility had reduced staff by nearly 75 percent.

Sometimes your safety intervention may have unexpected positive

#### **STRATEGIC**ISSUES



#### Figure 5

or negative results. For example, in one instance, an airline did not plan to calculate the additional benefit of improved employee safety but then determined that numerous incidents were being prevented because of the intervention.

Should the investment or benefits change, the worksheet makes it easy to alter the values and immediately recompute the ROI value.

#### **Bottom Line**

Some say that calculating ROI focuses too much on money and not enough on safety. Nevertheless, money and safety are inseparably linked. While ROI is a financial concept, the monetary returns are largely driven by the safety returns. Safety interventions make a difference. It will take executive attention and ROI calculations to make these interventions a priority. Safety interventions like the ones shown above can be the gateway to a competitive advantage, instead of being the first thing cut when budgets are tightened. Although the FAA ROI Calculator provides step-by-step instructions and guidance, the software cannot check the quality of your input. The hard work is up to you.

William B. Johnson, Ph.D., is the FAA chief scientist and technical adviser for human factors in aircraft maintenance systems. Katrina Avers, Ph.D., is a research scientist at the FAA Civil Aerospace Medical Institute.

This work was supported by the Civil Aerospace Medical Institute, the Human Factors Research and Engineering Group, the FAA Flight Standards Directorate, Office of Aviation Safety Chief Scientific and Technical Advisor Program and industry partners that provided critical data to test the ROI process. This article was developed from a presentation by Johnson and Avers to the Shell Aviation Safety Seminar in October in The Hague, Netherlands.

#### Notes

- Johnson, W.B.; Sian, I.B.; Watson, J. (2000). "Measuring the Impact of Human Factors Interventions." SAE Meeting on Advances in Aviation Safety. Daytona Beach, Florida, U.S. April 11–13, 2000.
- Hastings, P.A.; Merriken, M.; Johnson, W.B. (2000). "An Analysis of the Costs

and Benefits of a System for FAA Safety Inspectors." *International Journal of Industrial Ergonomics*, 26, 231–248.

- Johnson, W.B.; Avers, K. (2012).
   "Calculating Payback for Safety and Training Programs." The Journal for Civil Aviation Training. Issue 2/2012.
- Johnson, W.B. (2006). "Return on Investment in Human Factors." *The Journal for Civil Aviation Training*. Issue 4/2006.
- Krois, P.; Farrow, D.; Johnson, W.; Blair, D. (2007). "Advancing the Human Factors Business Case." In *Proceedings of the* 14th Annual Symposium on Aviation Psychology. Dayton, Ohio, U.S.: Wright State University. April 25, 2007.
- Johnson, W.B. (2012). "Looking for the Big ASAP Success Story." *Aircraft Maintenance Technology Magazine*. July 2012, 24–28.
- FAA (2005). The Operator's Manual for Human Factors in Aviation Maintenance. <www.hf.faa.gov/opsmanual>.
- 8. In this instance, "injuries" are those that must be reported under U.S. Occupational Safety and Health Administration (OSHA) guidelines, including injuries that result in fatalities, lost workdays, job transfers or termination of employment, or that require medical treatment.

# A Measure of Linda Werfelman

More flight time doesn't necessarily lead to improved performance, a new study says.

ow-time airline pilots are just as capable during normal flight operations as their more experienced colleagues, according to the findings of an Australian study designed to measure the relationship between total flight time and job performance.

The study, by researchers from the University of South Australia, was based on evaluations of data collected by trained observers during 287 normal sectors by pilots engaged in short-haul jet flights for a high-capacity regular public transport operator in Australia. A report on the study was published in the August issue of The Aerospace Medical Association's *Aviation, Space, and Environmental Medicine.*<sup>1</sup>

In the study's examination of pilots' technical proficiency, the report said, "There were no statistically significant differences between experience groups for first officers or captains. ... However, there were minor differences with regard to nontechnical measures as a function of crew composition. There was also a difference in automation use."

The report noted that issues involving pilot experience are especially relevant in the aftermath of the approval in the United States of a law that will require airline first officers to have accumulated at least 1,500 flight hours and of the consideration of a similar requirement for airline pilots in Australia. 'The focus on hours ... appears to give little regard to individual skill development and learning requirements.'



"The importance of flight training is widely recognized by airlines, regulators, safety investigators and the aviation industry as a primary tool in maintaining the ultra-safe system of commercial aviation," the report said. "However, the focus on hours attained at the time of license issue appears to give little regard to individual skill development and learning requirements, which may have been somewhat overlooked in the syllabus. There is an implicit suggestion in the legislation that, if an individual has attained the required hours to be issued with a pilot license, they also possess the requisite skill. In many debates and discussions that have been held regarding low-hour pilots, the one thing that remains constant is the view that hours [equal] experience."

The report noted that previous studies of the relationship between a pilot's experience and his or her performance have yielded differing results, with some concluding that experience had a significant effect on performance and others finding little connection between the two. Many of these studies, however, have included general aviation pilots, some of whom had fewer than 100 flight hours, or pilots for non-major airlines, and the results do not necessarily apply to airline pilots.

The issue of pilot experience gained renewed attention in the aftermath of the fatal Feb. 12, 2009, crash of a Colgan Air Bombardier Q400 on approach to Buffalo Niagara (New York, U.S.) International Airport. The crash killed all 49 people in the airplane and one person on the ground and destroyed the airplane. The U.S. National Transportation Safety Board said the probable cause was the captain's "inappropriate response" to the activation of the stick shaker and the airplane's subsequent stall.

The first officer's flight time — 2,244 hours at the time of the accident but less than 1,500 hours when she was hired by Colgan in January 2008 — was cited by members of Congress who voted into law a requirement that pilots in U.S. Federal Aviation Regulations Part 121 operations have an airline transport pilot certificate, which is issued only to pilots with at least 1,500 hours. The requirement is scheduled to take effect in 2013.

#### **Methods**

In developing the framework for the study, the researchers classified both the first officers and the captains into two groups of low-hour and high-hour pilots. Of the first officers, 17 percent were low-hour first officers, who had 1,500 or fewer flight hours; 83 percent were high-hour first officers, with more than 1,500 hours. Of the captains, 15 percent were low-hour captains, with 5,000 or fewer flight hours, and 85 percent were high-hour captains with more than 5,000 flight hours.

"These thresholds were chosen as they are used by the industry as a standard for promotion to captain and often for entry of first officers," the report said, "and yet ... there is little or no scientific evidence behind their use."

Data for the study were gathered over six weeks during a line operations safety audit (LOSA), with trained jump-seat observers recording information on a variety of metrics, including the operational environment, crew performance and threats from weather and other sources. Some pilots may have been observed more than once, but that could not be determined because of the anonymous nature of data collection, the report said.

The observers took detailed notes throughout the flight, beginning with preflight preparations, and at the end of each flight, they completed forms that called for an analysis of all external threats and crew errors that had been observed.

The observers looked at both individual performance and, in considering non-technical performance, at the entire flight crew.

In assessing individual performance, the primary markers were stabilized approach criteria based on the parameters identified in Flight Safety Foundation's *Approach-and-Landing Accident Reduction (ALAR) Tool Kit.* 

"The six criteria outlined by [the Foundation] at both 1,000 ft AFE [above field elevation] and 500 ft AFE were used to benchmark crew performance," the report said. "These [criteria] were airspeed, vertical speed, appropriate thrust set, approved landing configuration, on proper flight path and briefings and checklists completed.

"The pilot flying was assessed on whether [he or she] met each stabilized approach [criterion] at the 1,000-ft or 500-ft AFE target. In addition to this, information was collected on the altitude at which the autopilot was disconnected on approach by the pilot flying."

The crew's non-technical skills (NTS) were evaluated on the four primary criteria of communication, situational awareness, task management and decision making, and their subsections — a total of 16 markers. The crew was rated on a scale from 1 (poor) to 4 (outstanding) on each of the NTS performance criteria for each of five phases of flight — predeparture; takeoff; cruise; descent, approach and land; and taxi.

The study evaluated the crews' threat and error management (TEM) abilities according to a University of Texas model that considered the proportion of threats that were managed effectively, the proportion that were inconsequential, the number of errors made and the number that were managed effectively, and the proportion of errors that were inconsequential.

#### Results

During the 287 observed flight sectors, the study identified and analyzed 845 threats and 811 errors. The findings were "in line with typical observations of normal commercial flight operations," the report said.

Among the most frequent threats were those involving adverse weather, air traffic control requirements and ground handling events, the report said. The most common errors involved aircraft handling, management of aircraft systems and instruments, and management of aircraft automation.

Results of the individual performance analysis showed no statistically significant differences among the four pilot groups.

"This is not entirely unexpected, as most airlines have developed stabilized approach criteria and procedures, which all flight crew are regularly assessed against, both as the pilot flying and as the pilot not flying," the report said.

However, in one area — not an element of the stabilized approach criteria — a significant difference was noted. Low-hour first officers disconnected the autopilot "at a significantly lower average altitude of 655 ft, compared with 1,168 ft for high-hour first officers," the report said.

Nevertheless, the report added, "there was no difference observed in the safety of the flight, against the stabilized approach criteria of the low-hour group."

Researchers identified several possible explanations for the increased use of automation among low-hour first officers.

"For instance, the increased reliance on automation flying the aircraft to a lower altitude during approach may be indicative of the lower experience of the group; that is, 'expert' performance has not yet developed," the report said. "As such, these first officers may be relying on automation to manage the flight for a longer period of time, thereby reducing the time spent ... hand-flying, than their more experienced colleagues. This would allow the first officers more time to conduct the other necessary tasks during approach and would also free up their cognitive capacity to do so, which would be a beneficial flight management strategy."

The earlier disconnection of autopilot for high-hour first officers "may be an indication of the automaticity" of their actions during approach, the report said. "It is equally possible that the high-hour first officers are choosing to disconnect at a higher altitude in order to build up hand-flying time as a way of gaining experience in preparation for upgrading to captain. ...

"Both scenarios are equally valid and neither [presents] any detriment to safety of the flight."

#### **Little Variation**

The study found no significant difference in TEM performance, with low-hour and highhour captains receiving similar scores; the scores of low-hour first officers were no different than those of high-hour first officers.

Results of the
individual
performance
analysis showed
no statistically
significant
differences among
the four pilot groups.



In the review of NTS performance, the study found a slight difference between low-hour and high-hour first officers in two areas.

First, crews that paired a low-hour captain with a low-hour first officer scored lower on cooperation than any of the other pairings possibly an indication of "the low-hour first officer's being new to the flight deck and not yet familiar enough to work in close cooperation with the captain," the report said. "It may also be due to the low-hour captains having recently upgraded and may be indicative of them adjusting to the new role."

Second, crews that paired a high-hour captain with a low-hour first officer received low scores in the "monitoring and cross-check" category, possibly an indication that low-hour first officers "are not yet familiar enough with operations to monitor and cross-check as well as their high-hour colleagues," the report said. The document also noted the possibility that high-hour captains were "not completing the monitoring and cross-check functions as thoroughly as their colleagues, which may in part be due to managing the low-hour first officer."

The report said, however, that the "minor differences" between low-hour and highhour first officers in these areas should not be overstated.

"Despite the significance, which may well be from chance, there is very little difference between the hour groups and overall no real difference in performance in the dataset," the report said.

#### **No Less Able**

Overall, the report said that the study found no indication that low-hour pilots were "systematically different or less able in their performance when compared to their more experienced colleagues, despite the arguments often quoted in any discussion of pilot training and selection."

The document noted, however, that there may have been some limitations to the LOSAbased study because some of the observers may have been known to the pilots they were observing and because the pilots may have engaged in "compensatory behavior" by making certain that more difficult flight sectors were flown by the more experienced crewmember.

In addition, because LOSA is designed to assess normal flight operations, the study was limited in scope, the report said.

"While the LOSA snapshot of normal operations is useful, it may be of further benefit to explore the same hypothesis but with tighter experimental control and under non-normal flight conditions," the document added, suggesting that another study using flight operational quality assurance (FOQA) data might provide a more comprehensive view of pilot performance during stabilized approaches.

Flight simulator studies also might be useful in examining pilot performance during non-normal flight conditions that can only be created in simulators, the report said.

"This may go some way to answering the question of whether or not low-hour first officers are performing less well than their more experienced cohort and if they are performing well enough to be operating in an airline environment with minimal total flight hours," the report said.

Nevertheless, the report said that the study provides "concrete evidence to inform legislators, regulators, safety groups, pilots and the industry in the ongoing debate surrounding pilot hours and inferred performance. There is a continued need for scientific rigor, rather than political commentary, to inform the debate on commercial pilot training and licensing, in particular the individual differences that make up the competence of a pilot instead of adherence to an arbitrary threshold that might somehow ensure performance, and, therefore, safety."

#### Note

 Todd, Melanie A.; Thomas, Matthew J.W. "Flight Hours and Flight Crew Performance in Commercial Aviation." *Aviation, Space, and Environmental Medicine* Volume 83 (August 2012): 776–782.

## IN APPRECIATION of Bob Helmreich and Bryan Wyness

Editor's Note: Robert L. Helmreich, Ph.D., 75, and Capt. Bryan S. Wyness, 71, key figures in aviation safety over the last few decades, both died earlier this year (ASW, 7/12). In light of their many contributions to aviation safety, particularly in crew resource management and fatigue risk management systems, respectively, we asked several industry experts for their thoughts on what Helmreich and Wyness meant to aviation. Their comments have been edited for length and clarity.

#### Robert L. "Bob" Helmreich, Ph.D.

n the early '70s, I had the good fortune to work with the likes of Charlie Billings, H.P. Ruffell Smith, George Cooper and others at the U.S. National Aeronautics and Space Administration (NASA) Ames Research Center. In these early days of the human factors program there, we had done several analyses of aircraft accident reports and a limited amount of incident data, and were analyzing the rich data coming from the Ruffell Smith full-mission simulation study. We gradually formed the idea that human error was a critical issue in aviation, and that specifically, it seemed that such error wasn't coming from a lack of technical knowledge or skill, but more from an inability to effectively utilize the vast array of resources available to flight crews — other crewmembers, equipment in the aircraft, air traffic control (ATC), support from airline maintenance and operations centers, and cabin crew. It seemed to be the kind of issue that was being addressed in business management training programs, and from this nascent idea came the term "cockpit resource management," which eventually became "crew resource management" (CRM).

About 1974, I discussed this work and these ideas with another colleague from the Man-Machine Integration Branch at NASA Ames, Trieve Tanner (now deceased). Trieve was



the NASA project leader for a study of socialpsychological issues in long-term manned space flight, and was the contract monitor for a study that used extended underwater habitats as an analog for long-duration space missions. During my discussion with Trieve, he suggested that I might find it worthwhile to have this same discussion with the principal investigator for that study, a guy named Helmreich. We did, and it became immediately clear that Bob was closely tuned to wavelengths similar to those we were exploring, only he was focused on human performance in space, via the depths of the ocean, and we were focused on human performance in airplanes. In the end, it was clear that these were largely overlapping issues, and to my knowledge, it was Bob's first look at aviation human factors.

Bob took a concept and ran with it and is directly responsible for the central place that CRM now occupies in the art and science of human factors, not just in aviation, but in a broad array of systems that depend upon the exquisite and unique capability of humans to work effectively as teams to achieve some desired outcome safe flight, safe navigation of ships, safe surgery, fire fighting, and on and on. I continue to be amazed at how many explicit and implicit references to CRM in its many variations can be found in a very diverse set of human activities. It was largely Bob who made this possible in several ways.

First, as a scholar and scientist, he was a rich source of endless new ideas, new ways of looking at a problem, new solutions. Secondly, and equally importantly, as a teacher and mentor, his enthusiasm for concepts and ideas was infectious. He occupies a unique place in the history of human factors. Our world is safer because of him.

— John K. Lauber, Ph.D.

met Professor Robert Helmreich in April 1990 during the first International Civil Aviation Organization (ICAO) Flight Safety and Human Factors Symposium, held in what was then Leningrad under the auspices of what was then the Soviet Union. I knew of Bob, but I had never really met him until then. Leningrad provided the opportunity and, paraphrasing Bogart in the closing scene of *Casablanca*, it was the beginning of a beautiful friendship that would extend over 20 years, during which we traveled the world teaching aviation human factors under the flag of ICAO.

Bob started his applied research at the bottom of the sea, but his true love was aviation. I believe that, given the opportunity to start all over again, he would probably become an airline pilot, so strong was his fascination with our industry. Be that as it may, it was to aviation that he dedicated his enthusiasm, his competence as a researcher and practitioner, and above all, his ability to unite groups of people from different professional backgrounds and cultures.

His legacy to aviation safety is a matter of record. He took a concept, brittle at the time, and turned it into an aviation industry standard, eventually extending it to other industries that rely on teams to achieve their objectives. He achieved this by becoming "one of us," notwithstanding being a scholar and a scientist. Bob considered himself an aviation safety practitioner whose specialization was psychology, rather than a psychologist involved in aviation. This was the perspective he impressed upon his students, research assistants, associates and colleagues, thus paving the way for the aviation human factors safety practitioner, a figure now firmly entrenched in aviation safety practice.

Professionally, Robert Helmreich lived and died by data. Flight decks all over the world opened to his research. Over more than two decades, from the early days of CRM research to the recent observations of the line operations safety audit (LOSA), the project amassed astronomical quantities of data. The potential for data misuse was tremendous. Yet it is a testimony to Bob's integrity that, as of today, not one airline and not one single crewmember has suffered consequences because of misuse of data.

Bob was my aviation human factors mentor, my teacher, my peer and my friend. He was mentor, teacher, peer and friend to thousands of other aviation professionals who, like me, enjoyed his genuinely warm personality. A fan of sport cars and a world class traveler, he was also an avid reader of history. Although partial to the history of the Civil War, which he relished sharing with infectious enthusiasm, there was no aspect of universal history that would escape his interest. More than once, witnessing his impressive lecturing performances or enjoying war stories over gallons of beer, I thanked the stars for the exceptional fortune that provided me with the opportunity of his professional and intellectual peership.

- Daniel E. Maurino

#### Capt. Bryan S. Wyness, BSc., FRAeS

Bryan was an aviator of global stature. He learned to fly at the Wanganui and Wellington Aero Clubs in New Zealand. In October 1964, after gaining his commercial pilot license, he was accepted by the National Airways Corp. as a pilot trainee with only 150 hours total flying time. (How different to the entry requirements today!)

He became a first officer, first on the Douglas DC-3, then the Fokker Friendship. In 1970, he joined Air New Zealand as a first officer on the Lockheed Electra and subsequently the DC-8 and DC-10.

In 1979, he gained his first command, initially on the DC-10 and then on the DC-8. At that stage, the DC-8 was coming to the end of its time at Air New Zealand. It was an airplane that he very much enjoyed; it operated primarily out of Wellington across the Tasman to Australia, but shortly after he came on the type, one of the fleet was converted to a freighter that operated long haul to the Pacific Islands and Los Angeles, in addition to the Tasman. Loads varied from race horses and lions to fresh ginger from Fiji (a striking contrast in aromas), as well as general cargo.

He then captained the Boeing 767 and 747, while moving rapidly through management ranks and ultimately became vice president for flight operations.

Bryan drove the development of Air New Zealand's world-leading pilot fatigue risk management program in conjunction with NASA in the United States, the Defence Evaluation and Research Agency (DERA) in the U.K. and universities in New Zealand and the U.K. Bryan's work eventually led to an ICAO document of standards and recommended practices. He retired from Air New Zealand in 2003.

He held appointments with the International Advisory Committee of Flight Safety Foundation and the New Zealand Transport Accident Investigation Commission (TAIC) as



a commissioner; with the TAIC, he became involved in maritime and rail occurrences as well as aviation incidents and accidents. In March 2001, he was recognized by Boeing for his leadership. In 2003, he was awarded the Jean Batten Memorial Trophy by the Guild of Air Pilots and Air Navigators (GAPAN) for outstanding contributions to New Zealand aviation. The following year, he received the Aviation Industry Association of New Zealand Individual Award for his outstanding contribution to the enhancement of operational integrity and flight safety.

Since 2003, he had provided specialist flight operations, civil aviation operations, policy development, regulatory compliance and International Air Transport Association Operational Safety Audit (IOSA) certification expertise to the industry in New Zealand, Australia and the U.K., among others.

He was a foundation partner of NZ Safety Management Systems, and in 2007 was made a GAPAN liveryman. He was the regional chairman of GAPAN and guided the Guild in working closely with the Royal New Zealand Air Force in aviation excellence, training, standards and safety management systems.

He was also a former member of the Air New Zealand Board.

> Capt. Fred Douglas and Neil G. Airey

n 1993, Air New Zealand's medical director called to ask if I could meet with Capt. Bryan Wyness and a colleague at the airport as they were passing through Seattle. They had just come from NASA Ames, where they met with Mark Rosekind and the fatigue team to discuss using NASA's flight crew research to develop a scientifically based system to address flight and duty time limitations. As a former NASA scientist, I was both thrilled and intrigued by Bryan's vision of taking a data-driven approach to address the age-old challenge of tired pilots and aviation safety, but we agreed it would not be easy.

I was fortunate to participate in the kickoff meeting a couple of years later. In addition to Mark Rosekind and the Air New Zealand team, Bryan also invited professors Simon Folkard from the U.K. and Keith Petrie from New Zealand. The end result was Air New Zealand's fatigue risk management system (FRMS), which has continued to thrive for more than 15 years. It was Bryan's driving force, vision and commitment to the task that led to its development. He recognized from the beginning that success would depend on maintaining scientific credibility upon which both the pilot community and the regulator could rely. So he converted the original team of outside experts to an independent alertness advisory panel to review policies, processes, data collection and research on an annual basis. Additionally, he sought the help of experts at DERA (later QinetiQ) and universities in New Zealand to assist in the in-flight studies.



He worked with pilot representatives to assemble a crew action study group to review crew fatigue reports on a monthly basis and to offer input to ongoing research.

Bryan joined the steering committee of Flight Safety Foundation's International Ultra-Long-Range Crew Alertness Project in 2001 and guided its use of Air New Zealand's FRMS as the foundation for recommendations now being utilized worldwide. When ICAO formed an FRMS task force in 2009, he offered valuable help because the Air New Zealand FRMS became the starting point for the development of the international standards and guidance that were approved by the ICAO Council in 2011.

One example of his leadership in human factors was his work with the University of Texas to enable Air New Zealand to be the first non-U.S. carrier to conduct LOSA audits. I will never forget when he called to describe a 767's nearmiss on the approach to Apia due to false signals being generated by the instrument landing system (ILS) undergoing maintenance. He offered to provide a DVD describing the incident, the underlying causes of the false ILS guidance, and how the risk could be mitigated. "Would Boeing copy and distribute it to its customers worldwide?" We called Airbus officials immediately, and they, along with the Foundation, agreed to also spread Bryan's message.

Bryan continued his commitment to fatigue risk management and flight safety after his retirement in 2003. He provided expertise on specialist flight operations, civil aviation operations, policy development, regulatory compliance and IOSA certification to the industry in New Zealand, Australia and the U.K.

Bryan tragically passed away following a motorcycle accident on July 20, 2012. He was on the same bike he rode in 2005 on a threemonth journey as one of six "Silk Riders" covering nearly 20,000 km in the footsteps of Marco Polo on the Silk Road from Venice to Beijing. Those who shared his many passions including motorcycles, opera and car racing counted it a privilege, just as in aviation. Through his contagious enthusiasm and total commitment to international safety, he always made a difference.

- Curt Graeber, Ph.D.

BY RICK DARBY

# À la Mode

A new study sheds light on causes of EGPWS alerts in various modes.

f all the alerts the Enhanced Ground Proximity Warning System (EGPWS) can provide, "terrain, pull up" would seem most likely to get a pilot's attention immediately — and the quickest action. Or not.

In fact, responses take place about as fast — most often, in two seconds — regardless of the alert type, according to data prepared for presentation in October at the 65th annual International Air Safety Seminar, presented by Flight Safety Foundation and the Latin American and Caribbean Air Transport Association in Santiago, Chile.

EGPWS is now installed on more than 40,000 turbine-engine and turboprop airplanes worldwide. The system has helped significantly in reducing the risk of controlled flight into terrain (CFIT). But EGPWS, for all its technical sophistication, is an *alerting* device; the response of the flying pilot to the alert is the essential factor in avoiding CFIT.

Yasuo Ishihara of Honeywell Aerospace, which designed and manufactures the EGPWS, presented a paper analyzing flight history data recorded by the EGPWS in more than 18 million flights.<sup>1</sup> Recorded data indicate the number of alerts for each EGPWS function — such as mode 1, "excessive descent rate," mode 2, "excessive terrain closure rate" and mode 4, "unsafe terrain clearance" (Table — and the number of flight segments.
 The database was designed to help investigate the causes of EGPWS alerts.

The data also break out the rate of alerts for various transport category aircraft (Figure 1, p. 52).

"EGPWS records data 20 seconds before and 10 seconds after every EGPWS caution and warning alert in the flight history database," Ishihara said. "Because the EGPWS flight history data stop 10 seconds after an alert, a pilot response had to start within the recorded time period."

Pilots responded to mode 7, "reactive wind shear," alerts at the highest rate, followed by mode 4, "unsafe terrain clearance — gear," meaning landing gear are still retracted when the airplane is near the ground (Figure 2, p. 52). "It is interesting that the rate of pilots' response to most EGPWS alerts was very similar whether the alert was 'terrain, terrain, 'terrain, pull up,' 'too low, terrain' or 'sink rate, pull up,'' Ishihara said. "Our initial assumption was that a pilot responds to a 'pull up' warning at a much higher rate than other alerts."

Ishihara noted, however, that the EGPWS history data do not indicate the date, time or weather when an EGPWS alert occurred. "Many of the recorded EGPWS alerts might have occurred in day VMC [visual

Mode	Criterion for Pilot Response
Mode 1 (descent rate) "sink rate"	More than 4 degrees pitch or 500 fpm increase
Mode 1 (descent rate) "sink rate, pull up"	Initiated go-around
Mode 2 (terrain closure rate)	Initiated go-around
Mode 3 (descent after takeoff)	More than 4 degrees pitch or 500 fpm increase
Mode 4 (unsafe terrain clearance)	Initiated go-around
Mode 5 (below glideslope)	More than 4 degrees pitch or 500 fpm increase
Mode 6 (bank angle)	Not included in this study
Mode 7 (reactive wind shear)	Initiated go-around
Terrain awareness - terrain and obstacle	Initiated go-around
Terrain clearance floor (TCF)	Initiated go-around
EGPWS = enhanced ground proximity warning sys	stem
Source: Yasuo Ishihara, Honeywell Aerospace	

#### **EGPWS Modes and Pilot Response Criteria**



EGPWS = enhanced ground proximity warning system; NG = new generation **Notes**: Mode 6 (bank angle) and Mode 7 (reactive wind shear) are disabled on Airbus fly-by-wire aircraft. Terrain awareness – obstacle is a customer selectable function.

Source: Yasuo Ishihara, Honeywell Aerospace

#### Figure 1



EGPWS = enhanced ground proximity warning system; TCF = terrain clearance floor; TA = terrain alert

**Note:** Because the EGPWS flight history data stops 10 seconds after an alert, a pilot response had to start within the recorded time.

Source: Yasuo Ishihara, Honeywell Aerospace

Figure 2

meteorological conditions], in which pilots did not have to respond to the alerts according to the standard operating procedures," he said.

For modes 1, 2, 4 and 7, pilot response time peaked at two seconds in the database (Figure 3). Response was defined as the time it took for the aircraft pitch to increase more than 1.4 degrees after an alert.

"It is also interesting that pilot's response time was very similar regardless of EGPWS alert types," Ishihara said. "Our initial assumption was that a pilot would react to 'terrain, pull up' and

reactive wind shear warnings much sooner than other alerts."

The analysis looked at aspects of alerts according to the EGPWS mode. Here are some highlights:

#### Mode 1, "Excessive Descent Rate"

Eighty-nine percent of mode 1 alerts occurred below 500 ft radio altitude, and 67 percent below 200 ft.

"The rate of mode 1 alerts was noticeably high on Boeing 747 classic airplanes," Ishihara said. "Based on the data analysis, it is believed that the alerts were mostly due to a noisy barometric altitude rate signal provided by the air data computer (inertial vertical speed is not available on 747 classic installations) below 100 ft, in conjunction with a generally higher final approach speed (which requires a higher rate of descent to fly the same approach path) than other airplane types."

#### Mode 2, "Excessive Terrain Closure Rate"

The odds of receiving a mode 2 alert depend heavily on the EGPWS software version and whether the airplane is equipped with global positioning system (GPS) and geometric altitude.<sup>2</sup>

"Ninety-eight percent of mode 2 alerts occurred on airplanes with an EGPWS software version older than -217 (Boeing P/N 965-1690-050 or Airbus P/N 965-1676-001), without GPS or without geometric altitude," Ishihara said. "In other words, GPS-equipped airplanes with the EGPWS software version newer than -218 and geometric altitude have significantly less risk of activating Mode 2 alerts."

#### Mode 3, "Altitude Loss After Takeoff"

Ishihara said, "Almost all mode 3 alerts were occurring during a flight in a traffic pattern such as a training flight. Depending on the traffic pattern altitude and the length of the downwind leg, EGPWS may not switch from the takeoff mode to the approach mode prior to beginning a descent." Unusual departure procedures, such as the standard instrument departure procedure at one airport in Japan that requires leveling off at 1,000 ft, can cause the alerts if the aircraft overshoots the assigned altitude and must quickly descend.

#### Mode 4, "Unsafe Terrain Clearance"

Aside from false alerts — 57 percent of mode 4 alerts, mainly because of incorrect radio altimetry or failure of the landing gear switch or the landing flaps switch — unstabilized approaches were a frequent cause.

"When the aircraft was flown at excessive speed on final approach, especially above the flap placard speed, the landing flaps could not be set at 245 ft radio altitude, resulting in 'too low, flaps' or 'too low, terrain' alerts,"



EGPWS = enhanced ground proximity warning system; TCF = terrain clearance floor Source: Yasuo Ishihara, Honeywell Aerospace

#### Figure 3

Ishihara said. "There were considerable numbers of 'too low, gear' alerts when the landing gear was not down by 500 ft radio altitude during the final approach." As shown in Figure 2, pilots responded at a higher rate by initiating a go-around for this alert than for other terrain alerts.

#### Mode 5, "Descent Below Glideslope"

"Thirty-four percent of mode 5 glideslope alerts occurred below 100 ft radio altitude," Ishihara said. "There were a large number of cases where pilots were ducking under the glideslope below 100 ft. In some other cases, the glideslope signal appeared to become very unreliable below 50 ft. Glideslope alerts occurring at higher altitudes were often triggered while maneuvering to intercept the localizer below 1,000 ft."

Erroneous mode 5 alerts were identified on some new generation Boeing 737s with integrated approach navigation (IAN) capability.<sup>3</sup> Ishihara said, "At some airports, such as Kos, Greece, or Madeira, Portugal, a large number of unwanted glideslope alerts were occurring on IAN-capable [737s]. In all those cases, the aircraft appeared to be on a correct path to the runway threshold; however, the computed glideslope deviation signal provided by the aircraft system was erroneous."

#### Mode 6, "Bank Angle Protection"

Most maximum bank angles causing alerts in the study period were less than 40 degrees. New generation 737s had the highest rate of alerts, Boeing 777s the lowest rate (Figure 4, p. 54). In addition, 777s had no alerts for bank angles greater than 45 degrees, while 1.10 percent of other types had alerts for bank angles of 50 degrees, 0.20 percent for 55 degrees, 0.05 percent for 60 degrees, and 0.04 percent for more than 60 degrees. EGPWS recording stops 10 seconds after the "bank angle" alert, so the actual rates

#### DATALINK

of maximum angles might be more than are shown in the database.

#### Mode 7, "Reactive Wind Shear"

Sixty percent of wind shear alerts occurred during the approach. As seen in Figure 2, mode 7 alerts resulted in the highest percentage of pilot responses.

#### **Causes of Terrain Awareness and TCF Alerts**

Almost half of terrain awareness and terrain clearance floor (TCF)<sup>4</sup> alerts resulted from not having a destination runway in the EGPWS (Figure 5). "This often meant the latest terrain/ runway database was not installed," Ishihara said.

In conclusion, Ishihara said that for maximum effectiveness of EGPWS, operators should update to the latest software; keep the terrain/ obstacle/runway database current; install GPS; activate geometric altitude; and select at least one side of the display in the TERR (terrain) mode.

#### Notes

- Ishihara, Yasuo. "Reviewing Worldwide EGPWS Alert Statistics, Further Reducing the Risk of CFIT." In Flight Safety Foundation, *Proceedings of the* 65th annual International Air Safety Symposium, Santiago, Chile. 2012.
- 2. Honeywell describes geometric altitude as "a computed aircraft altitude designed to help ensure optimal operation of the EGPWS terrain awareness and display functions through all phases of flight and atmospheric conditions. Geometric altitude uses an improved pressure altitude calculation, GPS altitude, radio altitude, and terrain and runway elevation data to reduce or eliminate errors potentially induced in corrected barometric altitude by temperature extremes, non-standard altitude conditions and altimeter mis-sets."
- IAN is an approach option offered by Boeing, which says it is "designed for airlines that want to use ILS [instrument landing system]-like pilot procedures, display features and autopilot control laws for nonprecision (Category I) approaches."
- 4. A number of CFIT accidents have involved aircraft making final approaches through poor visibility only to strike the ground short of the intended runway. The location of over 30,000 runways at over 12,000 airports is maintained in the EGPWS internal

#### Bank Angle Alert Rate, by Aircraft Type



EGPWS = enhanced ground proximity warning system; NG = new generation

Source: Yasuo Ishihara, Honeywell Aerospace

#### Figure 4



EGPWS = enhanced ground proximity warning system;

FMS = flight management system; GPS = global positioning system; QFE = height above field level; TCF = terrain clearance floor

Source: Yasuo Ishihara, Honeywell Aerospace

#### Figure 5

database. The EGPWS maintains a clearance floor spreading outward from each of these runways. If a descent below this clearance floor is detected, the warning 'too low, terrain' will be given, regardless of aircraft configuration."

# Water World

#### A guide for those who go down to the sea ... in aircraft.

BY RICK DARBY

#### BOOKS

#### **Preparation and Communication**

### Blue Water Ditching: Training Professional Crewmembers for the Unthinkable Disaster

Montgomery, Dave. North Charleston, South Carolina, U.S.: CreateSpace, 2012. 139 pp. Figures, tables, photographs.

*Fly the ocean in a silver plane See the jungle when it's wet with rain ...* 

he idea of flying the ocean in a silver plane sounded romantic when Patsy Cline sang about it; nowadays it's routine for passengers and pilots alike. But sometime, somewhere, it will be anything but routine — in fact, a potential disaster.

"It is a safe bet to predict that there will be a blue-water ditching by an airliner, freighter or large corporate aircraft in the near future," says Montgomery, a former U.S. Air Force command pilot and today a Gulfstream IV captain for NetJets. In 1991, he participated in operational testing of an amphibious aircraft in the Atlantic Ocean. His biographical note says, "He writes about takeoffs and landings on parallel



swells and on mixed sea chop from experience, something very few pilots can do."

Ditchings are rare in proportion to the number of flights transiting large bodies of water, but given the huge number of those flights, ditchings are bound to occur from time to time. Montgomery calculates that some 716,300 flights take place each year across the North Atlantic, North Pacific and polar regions. "Add in to the statistics the number of flights over the South Atlantic, South Pacific, Indian Ocean, Southern Ocean, Arctic Ocean and all of the seas and gulfs and the thousands of inter-island flights that face a ditching possibility, and we can conservatively estimate there are over a million blue-water flights a year," he says. "That is 2,700-plus flights a day."

Flight Safety Foundation (FSF) considered the possibility of ditching significant enough to produce a 664-page guide, *Waterproof Flight Operations*, published in 2004 and available as a compact disc <flightsafety.org/store/flightsafety-digest-september-2003–february-2004>. Montgomery says, "Search-and-rescue forces around the world are certainly aware of these risks. Recently a first mass-rescue drill was held with a scenario of a large passenger aircraft polar ditching."

Airline and corporate crewmembers receive intensive training in briefing passengers for a ditching, evacuation, the use of life rafts and life vests, and other elements of survival in a water landing. Unfortunately, Montgomery says, realistic simulation of the event in all its complexity is impracticable.

"Because a real-time ditching training exercise is so time-intensive (expensive) and not [a regulatory] requirement, very few crews have ever experienced the 45-plus-minute drill in the simulator," he says. "To be effective, the exercise would need actors to portray flight attendants and extra crewmembers. Also needed are actors to portray [pilots of] other aircraft within VHF [very high frequency] radio range, actors for ATC [air traffic control] and a functioning data link system if the operator uses a system. These emergency scenarios require extensive setup (envision a South Pacific crossing with multiple possible divert options). The setup time combined with required actors combined with simulator time equates to significant expenditures of training funds." Nevertheless, he offers examples of possible simulations for two scenarios, a quick ditching and a drift-down ditching.

For crews who do not have the benefit of realistic simulation, Montgomery believes the keys to successful ditching are preparation and communication.

Concerning the former, he says, "I summarize ditching preparation for the front-end [cockpit] crew as having a working knowledge of how to handle the aircraft from power loss to water touchdown; and front-end crew pointing the aircraft in the right direction to either facilitate rescue [or] reach an area of best water conditions (beach, bay or protected side of an island); picking the best ditching heading; and having basic knowledge of how to handle the last 100 ft."

He is impressed with current standards of preparation for "back-end" (cabin) crewmembers: "The 'managers in the back' can be very aggressive when the time comes to put on the emergency game face. After all, they are not [only] on the aircraft to serve drinks or food ... they are there because the governing agency requires them for safety, and when an 'event' occurs they spring into action. ... They are accustomed to dealing with very challenging unknowns."

Communication preparation, Montgomery says, can be categorized as internal — within the aircraft — and external — to and from the rest of the world.

"As important as the internal communication is for the crew and passengers, I cannot stress strongly enough the importance of external communication," he says. "You may have limited electrical power and possibly limited radios. If you are down to VHF only, and the only relay aircraft within VHF radio range does not have an HF radio, or some data link capability, rescue could be delayed by hours ... or days. However, if you are able to relay your location to "Mom" [slang for your company or headquarters], ATC, multiple aircraft via VHF radio and possibly even make a call direct to the correct regional rescue center, you have launched the recovery effort and greatly improved the survivability chances of all occupants."

As in pricing real estate, "location, location, location" is critical to ditching. Sometimes it is beyond the crew's control, but when feasible, they should calculate the most likely direction from which rescue will arrive and head that way. Oceans are vast. Melbourne, Australia, to Mumbai, India, is 5,292 nm (9,801 km). Sydney, Australia, to Los Angeles is 6,509 nm (12,055 km).

Location is so important because "the successful ditching will leave crewmembers drifting, paddling or sailing in either the calm of beautiful seas or in the hell of rough waters. Very few aircraft plying the oceanic airways have equipment to support life more than 12 to 48 hours. A search area for a ditched aircraft can easily be hundreds or thousands of square miles.

"Even in the best scenario of continuous 406 MHz ELT [emergency locator transmitter] hits, rescue may be days away. In the wait for maritime help, most probably a long range [Lockheed] C-130, [Hawker Siddeley] Nimrod

As in pricing real estate, 'location, location, location' is critical to ditching. or [Lockheed] P-3 will find you to drop supplies if capable, but ships moving at a mere 20 kt will take time to reach you and pluck you from your raft or floating fuselage."

Among the book's chapters are those dealing with self-training by individuals or in team settings, preferred water-landing techniques, the search-and-rescue satellite system, aircraft and ship search-and-rescue assets, and on-the-water survival.

#### VIDEO

#### **Overcoming Bad Attitudes**

**Loss of Control: Aircraft Upset Recovery, a User's Guide** U.K. Civil Aviation Authority (CAA), developed with the Guild of Air Pilots and Air Navigators, Safety Operating Systems and Flight Safety Foundation. Compact disc. October 2012.

A ircraft upset is now recognized as the most serious threat to flight safety, and is one of the "significant seven" risks identified by the CAA in a study of more than 1,000 fatal accidents and the findings of its Mandatory Occurrence Reporting Scheme database. This CD training package is "intended as a refresher course for commercial pilots, offering in particular a stepby-step approach to identifying, and dealing with, a stalled aircraft," says Gretchen Haskins, director of the CAA Safety Regulation Group.

The CD contains a Microsoft PowerPoint presentation, "Upset Recovery: By Pilots for Pilots," and three papers in Adobe PDF format: "Aeroplane Upset Recovery Training: History, Core Concepts and Mitigation," from an original paper by Safety Operating Systems' John M. Cox, developed by the Royal Aeronautical Society Flight Operations Group; "High-Altitude Operations," a supplement to the FAA *Airplane Upset Recovery Training Aid* developed by an FSF-led industry working group in 2008; and "Stall Recovery Technique," a CAA Safety Notice (SN-2011/08).

The PowerPoint quotes a 2011 Boeing study that says that between 2001 and 2010, 1,756 onboard fatalities and 85 ground fatalities resulted from loss of control accidents, so that a 50 percent reduction in the rate of loss of control accidents would be rewarded by 920 fewer fatalities over a 10-year period. The largest part of the presentation falls under the headings of "Avoid," "Recognise" and "Recover" from loss of control. A refresher in the fundamentals of aerodynamics supplements the training.

The Royal Aeronautical Society document says it is designed "to use in preparation for the day you face an impending or actual loss of control during flight. It is a brief reference manual to be read and remembered. It gathers advice offered elsewhere and is intended to give pilots more background to add to their

experiences in abnormal flight conditions and recovery, whether from impending stalls or fully developed upsets."

The paper examines how serious the threat of loss of control is and cites "upset" accidents, many of which could have been avoided or recovered from (though not those caused by mechanical or automation malfunctions such as

a locked rudder "hardover"). A second section looks at the aerodynamic factors involved in controlled flight and loss of control. A third offers detailed descriptions of recovery techniques in various unusual attitudes, such as "nose high, wings level," "low airspeed, pitch attitude below minus 10 degrees and airspeed decreasing," "high bank angles," and "nose high, bank angle beyond 45 degrees; pitch attitude above 25 degrees and airspeed decreasing."

The paper adds, "Monitor your instruments at all times and remain focused on the operation, without becoming distracted with peripheral activities that have nothing to do with the flight. Know your power settings and the aircraft attitude you need for the various phases of flight you encounter. Trust your instruments, not your physical reactions to what you think is happening, when you find yourself in an unusual condition."

The CD is to be distributed to all U.K. commercial airplane pilots.



## **Unexpected** Contamination

Overrun prompts call for more accurate assessments of runway surface condition.

#### 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

Late Touchdown Faulted Boeing 737–800. No damage. No injuries.

he investigation of a runway-overrun inci-

dent has prompted the U.K. Air Accidents Investigation Branch (AAIB) to recommend the establishment of a single definition of what constitutes a *contaminated runway* and the development of an accurate and timely method of measuring the depth of runway contaminants, so that pilots can obtain the information they need to determine required landing distances.

A significant difference between the reported and the actual surface condition of the runway at Newcastle (England) Airport the night of Nov. 25, 2010, was a likely factor that led to an encounter with braking action that was less than the flight crew anticipated and to the 737 coming to a stop with its nosewheel 3 m (10 ft) beyond the end of the runway, said the AAIB in its final report on the incident.

Other factors included "touchdown of the aircraft beyond the normal touchdown zone and selection of idle reverse thrust before the aircraft was at taxi speed," the report said.

The 737 was inbound from Lanzarote, Canary Islands. Snow showers had been forecast for Newcastle, so the flight crew had decided to carry an additional 1,100 kg (2,425 lb) of fuel for a possible diversion to Edinburgh, Scotland. The crew conducted a landing performance calculation with the "C-Land" application for a laptop computer, which showed that "at their expected landing weight, they would be able to accept a wet runway and a slight tailwind" at Newcastle, which has a single 2,329-m (7,641-ft) runway, the report said. "They also decided that if the runway had more than 3 mm [0.12 in] of contaminant, this would mean that it was contaminated, which was not acceptable for their operation."

However, the report noted that guidance on what constitutes a contaminated runway varies among U.K. aviation publications. The crew's conception that a runway meets their company's designation as contaminated when it has more than 3 mm of slush or wet snow was in keeping with guidance provided by U.K. Civil Aviation Authority (CAA) Aeronautical Information Circular 86/2007, Risks and Factors Associated With Operations on Runways Affected by Snow, Slush or Water. It contradicted the definition contained in Civil Aviation Publication 683, The Assessment of Runway Surface Friction Characteristics, which "considers a runway as contaminated when any depth of slush or wet snow is present," the report said.

"The CAA stated that material contained across CAA documentation relating to contaminated runway operations is targeted at different audiences, and, therefore, there are necessary differences in style and content," the report said. "However, the inconsistencies concerning the definition of a contaminated runway surface ... could cause pilots to assess incorrectly the contamination state of a runway."

During the flight from Lanzarote, the pilots received several reports indicating that the

weather conditions at Newcastle were changing rapidly. However, runway condition was consistently reported as wet. "Using the C-Land application, the pilots calculated that the landing distance required for a wet runway was approximately 300 m [984 ft] less than the landing distance available," the report said.

The crew planned to conduct the instrument landing system (ILS) approach to Runway 07. While briefing the approach, the copilot, the pilot flying, said that he would use full flaps and the highest autobrake setting below maximum, and apply full reverse thrust after touchdown. "The crew briefly discussed the possibility of

using maximum autobrake for the landing but decided this was unnecessary," the report said.

A weather report issued while the 737 was on the ILS approach indicated that surface winds were from 310 degrees at 13 kt, visibility was 4,500 m (2.8 mi) in wet snow, and there were scattered clouds at 400 ft and a broken ceiling at 800 ft. The crew of a preceding aircraft reported "medium to good" braking action on the runway.

However, the 737 crew initiated a missed approach when the airport traffic controller relayed a runway inspection report indicating that there was 3 to 4 mm (0.16 in) of snow on the runway. They entered a holding pattern, "intending to hold there until either the runway had been cleared sufficiently for them to make a second approach or it became necessary to divert to Edinburgh," the report said.

About 10 minutes later, the controller told the crew that sweeper vehicles had completed one pass over the runway and that 2 mm (0.08 in) of wet snow remained on the surface. "Judging that the runway was no longer contaminated, the pilots updated the landing data for a wet runway ... and carried out a second approach," the report said.

The 737 touched down at 140 kt about 450 m (1,476 ft) from the approach threshold — or about 150 m (492 ft) from the normal touch-down point, the report said. The spoilers deployed automatically, the autobrakes activated, and reverse thrust was applied. Groundspeed was about 97 kt when the copilot disengaged the autobrakes and reduced reverse thrust to idle.

"After the reduction in reverse thrust, there was a notable decrease in the aircraft deceleration," the report said. "Application of full manual braking appeared not to change the deceleration, [which was] not consistent with the 'good' braking action anticipated by the crew."

The commander assumed control as the 737 neared the end of the runway at a groundspeed of about 50 kt. With both pilots applying manual wheel braking, the aircraft came to a stop near the runway centerline but with its nosewheel beyond the runway end lights. None of the 189 passengers and eight crewmembers was injured, and there was no damage. The pilots shut down the engines, and the passengers and cabin crewmembers were transported to the terminal by airport vehicles before the aircraft was towed to the ramp.

"Both pilots independently walked on the runway back towards the Runway 25 displaced threshold and assessed the surface as very icy," the report said.

In addition to recommending elimination of inconsistencies among the definitions of a contaminated runway, the report discussed research currently being conducted by the CAA, the European Aviation Safety Agency and the U.S. Federal Aviation Administration on accurate and timely methods of measuring runway contamination and providing the information to pilots for use in calculating required landing distances (see "Friction-Reporting Caveats," p. 13).

#### **Aileron Servo Bracket Fails**

Airbus A330-301. Minor damage. No injuries.

Because of a large cloud of ash streaming south from a volcano in Iceland, the flight crew planned to take a more northerly route than normal for the scheduled flight with 227 passengers and 11 crewmembers from Dublin, Ireland, to Chicago on the afternoon of May 11, 2010.

"Due to the funneling of aircraft tracks in the Icelandic area arising from the presence of the ash cloud to the southwest, there was considerable congestion in the airspace over Iceland," said the report by the Irish Air Accident Investigation Unit (AAIU). [was] not consistent with the "good" braking action anticipated by the crew.'

'The deceleration,

#### **ONRECORD**

The A330 was cruising at Flight Level (FL) 330 (approximately 33,000 ft) over Iceland when it encountered moderate turbulence, which the crew believed was caused by the wake of another aircraft. "The turbulence resulted in some aircraft roll and yaw," the report said. "The autopilot, which remained engaged during the turbulence encounter, quickly returned the aircraft to level flight."

Shortly thereafter, air traffic control cleared the crew to climb to FL 380. During the climb, the crew noticed that the vertical velocity was lower than expected and that fuel consumption was higher than expected. They found that the anomalies were being caused by the abnormal deflection of all four ailerons. The electronic centralized aircraft monitor (ECAM) showed that the inboard aileron on the right wing was deflected 15 degrees up and that the outboard aileron on the right wing and both ailerons on the left wing were deflected about 10 degrees down.

"The flight crew for this particular flight consisted of three pilots, so the captain was able to leave the flight deck and go to the cabin, where he obtained visual confirmation that the physical configuration of the ailerons corresponded with the indications on the ECAM," the report said.

No warnings or cautions were displayed on the ECAM. While troubleshooting the problem in consultation with company maintenance personnel, the flight crew found no difficulty in maneuvering the A330 with the autopilot either engaged or disengaged. They decided to continue the flight to Chicago O'Hare International Airport, where the aircraft was landed without further incident.

Investigators determined that while the autopilot was correcting the turbulence-induced roll over Iceland, the outer mounting bracket on a servo controller for the right inboard aileron had fractured, causing the aileron initially to oscillate and then to settle in the upward deflection. The corresponding bracket in the left wing also was found cracked.

Examination of the broken bracket by Airbus revealed that fatigue cracking had originated from a 50-micron pit that had formed during manufacture. Previous incidents involving failed or cracked servo controller brackets on A330s and A340s had prompted a service bulletin to be issued in 2009, calling for eddy current inspections. Although the incident aircraft had been inspected according to the service bulletin, AAIU investigators determined that the testing probe used during the inspection had provided false indications that the brackets were sound.

#### **Driver's Foot Slips Off Brake**

Boeing 737-700. Substantial damage. No injuries.

he 737 was parked at a gate at Fort Lauderdale/Hollywood (Florida, U.S.) International Airport, and about half of the passengers had deplaned the afternoon of Oct. 29, 2010, when a driver began moving a lavatory-service vehicle backward toward the airplane.

"A guide man signaled the driver to stop the vehicle for a brake check, which he did," the U.S. National Transportation Safety Board (NTSB) report said. "The guide man then signaled the driver to resume reversing the vehicle and subsequently signaled the driver to stop in the service position, located about 3 ft [1 m] from the airplane's fuselage."

The driver stopped the vehicle but did not place the transmission in the park position; his foot then slipped off the brake pedal and onto the accelerator. The vehicle backed into the airplane, tearing a 12- by 6-in (30- by 15-cm) hole in the fuselage and damaging some stringers.

The report said that the driver, who was "twisted around" in his seat to see the guide man when the accident occurred, was not wearing required work boots and that a rubber cover was missing from the brake pedal.

#### **TURBOPROPS**

#### 'Beyond Their Performance Limit'

Dornier 328–100. Substantial damage. Five minor injuries.

nvestigators concluded that among the factors leading to a runway overrun at Mannheim City Airfield on March 19, 2008, was that the flight crew deviated from standard operating procedures, "reached their performance limit and, at the end, went beyond it." Other factors included



the crew's "non-initiation of a balked landing" and their inability to deploy the thrust reversers after a bounced landing and touchdown near the end of the runway, according to the German Federal Bureau of Aircraft Accident Investigation (BFU).

The accident occurred during a scheduled evening flight with 24 passengers and three crewmembers from Berlin. The pilots, who had not flown together previously before completing a flight from Mannheim to Berlin earlier that day, were returning to Mannheim with the first officer flying from the right seat, said the final report, issued by the BFU in August.

The airport had surface winds from 330 degrees at 12 kt, gusting to 18 kt, 4,000 m (2 1/2 mi) visibility in snow showers and a broken ceiling at 1,400 ft. The 1,066-m (3,498-ft) runway was clear and dry.

Before initiating the localizer/distance-measuring equipment approach to Runway 27, the first officer expressed reservations about conducting the landing. The pilot-in-command (PIC), who was far more experienced and much older than the first officer, replied, "It will all work out."

The report indicated that the approach was not stabilized and neither pilot called for a goaround. The first officer did not respond when the PIC told him to reduce power to flight idle after the airplane crossed the runway threshold. The Dornier floated about 10 ft above the runway after the first officer initiated a flare and was about 200 m (656 ft) beyond the runway threshold when he abruptly transferred control to the PIC, which was "not a reaction appropriate to the situation," the report said.

The aircraft touched down beyond the midpoint of the runway, bounced and touched down again about 480 m (1,575 ft) from the end. The power levers were still forward of the flight idle position, and the PIC was unable to engage the thrust-reverse system.

The report said that recorded flight data showed no significant deceleration. The PIC engaged the parking brake, and the locked main wheels left tire skid marks for about 150 m (492 ft) before the Dornier overran the runway at about 30 kt. The left main landing gear collapsed, and the nose and left wing struck an embankment before the aircraft came to a stop.

#### **Distraction Leads to Stall**

Beech King Air 100. Substantial damage. One fatality, four serious injuries, five minor injuries.

The departure for a scheduled flight from Edmonton to Kirby Lake, both in Alberta, Canada, the morning of Oct. 25, 2010, was delayed about one hour because the weather conditions were below minimums at the destination. When the flight got under way, Kirby Lake had surface winds from 170 degrees at 8 kt, gusting to 16 kt, 4 mi (6 km) visibility in light snow and a 600-ft overcast.

"During the descent and approach to Kirby Lake, the crew engaged in nonessential conversation that was not related to the operation of the aircraft," said the report by the Transportation Safety Board of Canada.

The crew conducted the area navigation approach to Runway 08, with the first officer as the pilot flying (PF). His workload was affected by the need to include the captain's horizontal situation indicator (HSI) in his instrument scan because global positioning system track information was fed only to the captain's HSI. The King Air encountered icing conditions, and the crew cycled the deicing boots six times during the approach.

Required altitude callouts were not made, and the captain saw the runway after the aircraft descended below the published minimum descent altitude. "The PF was not able to identify the runway," the report said. "Throughout the remainder of the approach, both pilots were predominantly looking outside the aircraft."

The captain pointed out a road and a radio tower, and their locations in relationship to the airport. However, the first officer did not see the runway until the King Air was less than 1 nm (2 km) from the approach threshold. The aircraft stalled shortly thereafter, with no aural warning. "Maximum power was required, but recovery was not achieved prior to the aircraft hitting the ground" 174 ft (53 m) from the runway, the report said. The first officer expressed reservations about conducting the landing. The captain was killed, three passengers and the first officer were seriously injured, and the other five passengers sustained minor injuries.

#### Tail Strike on No-Flap Landing

Bombardier Q400. Minor damage. No injuries.

uring a nonprecision approach to Southampton (England) Airport in icing conditions the evening of Nov. 30, 2010, the "FLAP POWER" caution light illuminated when the flight crew attempted to extend the flaps to the approach position.

"The crew calculated that the runway at Southampton Airport was not long enough for a flap zero approach in icing conditions and decided to carry out an ILS approach to Runway 08 at Bournemouth Airport," the AAIB report said.

The approach was stabilized, and the commander disengaged the autopilot at 1,000 ft, in accordance with the emergency checklist (ECL) for a no-flap landing. As he reduced power while nearing the runway, he perceived a high rate of descent and increased the aircraft's pitch attitude. The copilot called, "Pitch 8 degrees, don't pitch any more." As the Q400 touched down, the "TOUCHED RUNWAY" caution light illuminated.

The crew taxied to the stand, where the 69 passengers disembarked normally. Inspection of the aircraft revealed that the frangible touch-runway-detection switch was broken.

"The commander commented that, although he was aware of the ECL requirement to avoid pitch attitudes in excess of 6 degrees at touchdown, he found the temptation to flare the aircraft to reduce the rate of descent overwhelming," the report said. "He also thought that the advice in the ECL to gradually reduce power to achieve flight idle at touchdown might have contributed to the aircraft's high rate of descent."

#### **PISTON AIRPLANES**

#### Incorrect Crossfeed Configuration

Beech C55 Baron. Destroyed. Four serious injuries.

efore departing from Wilmington, Delaware, U.S., for a flight to Buffalo, New York, the afternoon of Nov. 17, 2011, the pilot requested that both main fuel tanks be topped off. However, investigators determined that the left main tank likely was only partially filled.

The pilot told investigators that he was distracted by passengers during his preflight inspection of the Baron and did not visually check the left main tank. The fuel gauge for that tank was known to be inaccurate, according to the NTSB report.

The pilot said that during cruise, he used the auxiliary tanks until they were "empty." When he repositioned the fuel selectors to the main tanks, the left engine lost power. The pilot then attempted to configure the fuel system to crossfeed fuel from the right main tank so that he could restart the left engine. However, he did not configure the system properly, and the right engine lost power due to fuel starvation. Further attempts to start the engines were unsuccessful.

During the forced landing, the airplane crashed into a garage in Ulysses, Pennsylvania. The pilot and his three passengers were able to exit the Baron before it was consumed by fire.

#### **Turbulence Triggers Breakup**

Cessna M337B Skymaster. Destroyed. Three fatalities.

The pilot and two crewmembers were conducting a public use flight, providing aerial support for a military training exercise near MacDill Air Force Base Auxiliary Field in Avon Park, Florida, U.S., the night of Nov. 17, 2010. Forecast weather conditions had been covered during the mission briefing, but there was no indication that hazardous weather would be encountered in the military operations area, according to the NTSB report.

However, unexpected frontal movement caused weather conditions to deteriorate rapidly during the mission, with the formation of cumulus congestus clouds, the report said. The pilot decided to discontinue the flight and return to MacDill.

The Skymaster, which was not equipped with a weather radar system, entered an area of intense rain showers and severe turbulence on approach to the base. "The right wing separated in flight, and the airplane crashed inverted in a farm pasture," the report said.



#### **Collision in a Mountain Pass**

Piper Chieftain, Cessna U206. Substantial damage. No injuries.

he Chieftain was eastbound on a visual flight rules charter flight with eight passengers from Kokhanok, Alaska, U.S., to Anchorage the afternoon of July 10, 2011. The float-equipped Cessna was westbound on a private flight with three passengers from Anchorage to Brooks Camp.

Visual meteorological conditions prevailed when the airplanes entered the opposite ends of Lake Clark Pass, about 37 nm (69 km) northeast of Port Alsworth. At an elevation of about 1,000 ft, the pass is in a river valley about 0.5 nm (0.9 km) wide and flanked by 5,000-ft mountains.

The NTSB report said that the Cessna pilot was broadcasting his position on a common traffic advisory frequency, but the Chieftain pilot was not monitoring the frequency. Neither pilot saw the other airplane or took evasive action before the top of the Chieftain's vertical stabilizer struck the forward float spreader bar on the U206.

The collision, which occurred at 2,300 ft, caused minor damage to the Cessna's left float and separation of the upper 18 in (46 cm) of the Chieftain's vertical stabilizer. However, "the rudder remained attached and functional," the report said. "Both airplanes landed safely after the collision."

#### HELICOPTERS

#### **Simulation Leads to Control Loss**

Eurocopter AS350-BA. Substantial damage. Two serious injuries.

commercial pilot was receiving instruction in night vision goggle (NVG) operations the evening of Nov. 4, 2009, when the flight instructor initiated a simulated hydraulic failure while on the downwind leg to land at Globe, Arizona, U.S.

The instructor said that the pilot did not properly adjust the trim or maintain sufficient airspeed, which decreased to about 20 kt, and the low-rotor-speed horn sounded. Both pilots were attempting to arrest the subsequent uncontrolled descent when the helicopter struck the ground, the NTSB report said. "The pilot reported that the last time he had performed a simulated hydraulic failure was almost one year before the accident and that he had never performed such a procedure or had one demonstrated while operating with NVGs," the report said.

#### **Control Inputs Cause Mast Bumping**

Bell 206B JetRanger. Destroyed. One fatality.

uring a traffic-observation flight the morning of Oct. 15, 2010, the pilot told the two policemen aboard the helicopter that they would not be able to patrol as long as usual because he needed to obtain fuel. The pilot subsequently returned to the police department helipad in Arnold, Missouri, U.S., deplaned the passengers and departed to refuel in St. Louis.

About 20 minutes later, the engine flamed out due to fuel exhaustion, and the pilot abruptly pushed the cyclic control forward while attempting to initiate autorotative flight. "Pushing the cyclic forward abruptly is contrary to the appropriate actions for entering an autorotation, which are lowering the collective pitch control to the full-down position, adding anti-torque pedal as needed to maintain heading and applying cyclic as needed to maintain proper airspeed," the NTSB report said.

The improper control inputs caused the main rotor hub to contact the rotor mast, a phenomenon called mast bumping. The main rotor separated, and the helicopter struck terrain near Clarkson Valley, Missouri.

"Review of the pilot's medical records indicated that he had a history of depression, anxiety and obstructive sleep apnea," the report said. "Each of these conditions had been documented and treated since 2007, and none were reported to the Federal Aviation Administration on the pilot's airman medical applications."

Toxicological testing revealed a high level of venlafaxine, an anti-depressant, in the pilot's bloodstream, which likely had caused dizziness and impaired the pilot's performance, the report said.



Preliminary Re	ports, September 2012			
Date	Location	Aircraft Type	Aircraft Damage	Injuries
Sept. 4	Al Ain, United Arab Emirates	Agusta-Bell 206-3B	destroyed	2 minor
The helicopter broke	e up in flight after the transmission separated	d during a training mission.		
Sept. 5	Soldotna, Alaska, U.S.	de Havilland DHC-8-103	none	15 none
The Dash 8 was clim	bing through 12,000 ft when it entered an u	ncommanded left roll and desce	nt. The flight crew regain	ed control at about 7,000 ft.
Sept. 5	Fort Worth, Texas, U.S.	Cessna 421B	destroyed	2 serious
The 421 stalled and	crashed as the pilots attempted to return to	the airport after the cabin door o	pened on takeoff.	
Sept. 6	Manville, New Jersey, U.S.	Beech 76 Duchess	substantial	1 serious, 1 minor
Witnesses said that to came to a stop invert	the airplane "porpoised" after touching dowr 'ted.	n, veered left and ran off the side	of the runway. The Duch	ess then struck a fence and
Sept. 7	Lohegaon, India	Beech King Air C90B	destroyed	3 none
The King Air struck t	errain on final approach during a training flig	ght.		
Sept. 7	Rome, Italy	Cessna 402B	destroyed	2 fatal
The 402 crashed out	of control in a junkyard while departing on	an aerial photography flight.		
Sept. 9	Grand Canyon, Arizona, U.S.	Bell 206L-1 LongRanger	substantial	2 none
The engine flamed of severed the tail boo	but when the pilot reduced power to simulat m on touchdown.	e autorotation during a post-mai	ntenance functional che	ck flight. The main rotor
Sept. 9	Washington, Pennsylvania, U.S.	Piper Navajo	substantial	4 none
Shortly after liftoff, t runway remaining, t	he pilot pushed the control column forward he pilot continued the takeoff and returned	to avoid a flock of geese. The lan to the airport for an uneventful la	ding gear struck the run anding.	way hard. With insufficient
Sept. 10	Houston, Texas, U.S.	Robinson R22 Beta	substantial	2 fatal
Witnesses saw the h descended vertically	elicopter maneuvering about 500 ft over an y to the ground.	industrial site during an aerial ph	otography flight before	it entered a spin and
Sept. 12	Palana, Russia	Antonov 28	destroyed	10 fatal, 4 serious
The An-28 struck tre	es and crashed on a mountain at 900 m (3,00	00 ft) while descending to land.		
Sept. 15	Ronne, Denmark	Learjet 24D	destroyed	2 serious
The Learjet stalled a aircraft revealed no	nd crashed in a cornfield after both engines fuel remaining in the wing tanks or wing tip	flamed out due to fuel starvation tanks; 160 L (42 gal) of fuel were	on final approach. A pre drained from the fuselag	eliminary examination of the get ank.
Sept. 15	West Windsor, New Jersey, U.S.	Aerospatiale AS355-F1	substantial	1 fatal
A witness saw the h	elicopter strike a flock of birds before the rote	or head separated and the AS355	spiraled to the ground.	
Sept. 18	Macon, Georgia	U.S. Raytheon Beechjet 400	substantial	3 minor
The Beechjet overra	n the wet, 4,694-ft (1,430-m) runway and trav	veled down an embankment and	across a highway before	e striking trees.
Sept. 20	Gulf of Mexico	Beech C55 Baron	destroyed	2 minor
The Baron was en ro behind the cockpit p	ute from Baytown, Texas, U.S., to Sarasota, Fl panel.	orida, when the pilot ditched the	airplane after smelling s	smoke and seeing a fire
Sept. 27	Constanza, Dominican Republic	Piper Chieftain	destroyed	2 fatal
The Chieftain crashe	ed and burned shortly after departing for a fl	ight to Santo Domingo.		
Sept. 28	Katmandu, Nepal	Dornier 228-202	destroyed	19 fatal
Shortly after takeoff stalled and crashed.	, the flight crew reported a bird strike and an	engine failure. The crew was atte	empting to return to the	airport when the Dornier
Sept. 30	Ellbögen, Austria	Cessna 414A	destroyed	6 fatal, 2 serious
The aircraft had dep	arted from Innsbruck Airport and was climbi	ing in low visibility when it struck	trees and crashed at ab	out 5,300 ft.
This information, gath	nered from various government and media sou	rces, is subject to change as the inv	estigations of the accident	ts and incidents are completed.

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