AeroSafety WORLD

FAR, FAR AWAY
BARS benefits resource sector

CRUSHING PRESSURE
Money woes influence helicopter pilot

EVERYDAY RISK CHECKS
EVA Airways applies FORAS software

747 CRASH REPORT CITES CATASTROPHIC FIRE

IN-FLIGHT CARGO IGNITION

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

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Pilot Training

MORE THAN JUST STICK AND RUDDER SKILLS

In the wake of Air France Flight 447 in June 2009 and more recent accidents, a lot has been said and written about how pilots are trained and about what seems to be an erosion of basic flying skills. Many subject matter experts (SMEs) agree that airline flying today suffers from what some call "the curse of ubiquitous normalcy," that is, a professional cultural expectation of low-stress operations in which high-risk problems are so rare as to need little attention. The more robust a system becomes, the more likely people are to become complacent. This is where important advances in upset prevention and recovery training (UPRT) will come into play.

Publication of the new International Civil Aviation Organization (ICAO) Doc 10011-2013, *Manual of Upset Prevention and Recovery Training* — expected in mid-October — signals a major transition for the air transport industry from a four-year period of "expert talk" about mitigating loss of control–in flight (LOC-I) to readiness for worldwide implementation of specific changes. It is not the first time the industry has addressed airplane upset recovery, and the validity of previous work (in which Flight Safety Foundation participated) has been an influential bedrock of the new 2013–2014 products.

Details of the transition over the next few years, and further steps for mitigating LOC–I, were discussed in September in London during the Royal Aeronautical Society's International Airline Flight Crew Training Conference. The society's 80-member International Committee for Aviation Training in Extended Envelopes (ICATEE) focused on practical solutions that will make a difference in LOC-I rather than pushing new technology, but the resulting solutions still require strong industry commitment and support. Several presenters said evidence is emerging that these LOC–I mitigations, where voluntarily adopted, already are working and leading to entirely new insights and paradigms for airline pilot training.

One captain said that "when you disconnect the autopilot is where technology becomes art," advocating that regular practice of manual flying builds problem-solving resilience and a reserve of cognitive capacity to handle stall/upset situations. Traditional methods of repeatedly flying familiar maneuvers and scenarios in flight simulators are no longer enough, some SMEs said, because unforeseeable or extremely rare events — not to mention go-arounds, hand-flown visual landings and unreliable airspeed scenarios — today demand a higher level of skill, situational awareness and resilience than many safety specialists long had assumed, given the advanced state of automation.

Other issues include how to carve out adequate time in tight training schedules for UPRT and manual handling practice; ensuring that training addresses real-life survival; refinement of flight simulation training devices to provide highly accurate cues; UPRT instructor qualification; further work on technology-based LOC–I mitigation; further study of root causes of upsets; reaching agreement on contentious human factors issues, such as today's long periods of pilots monitoring automation and managing systems; and optimal crew resource management during upset prevention, recognition and recovery stages.

There is more to LOC–I than just stick and rudder skills. Meaningful guidance compiled from many sources on the various components will be needed to effectively mitigate this threat. Flight Safety Foundation stands ready to facilitate new developments and to see that they are shared.

Capt. Kevin L. Hiatt
President and CEO
Flight Safety Foundation

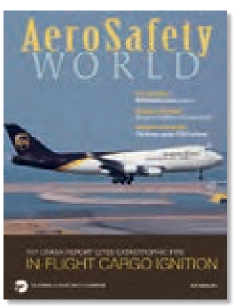
AeroSafety WORLD

contents

November 2013 Vol 8 Issue 10

features

departments



About the Cover
The fatal in-flight fire aboard this Boeing 747-400F erupted in a main-deck cargo pallet.

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FISCAL Crisis

"Two Parties Start Work to Avoid Repeat Crisis"

That headline appeared in the online version of the *New York Times* in mid-October, just a few days after the U.S. Congress reached a last-minute agreement that avoided a debt default and reopened the partially shuttered U.S. government. The 16-day government shutdown closed federal agencies, parks and museums and furloughed hundreds of thousands of federal workers — all because the two major political parties in the United States can't work together. The two sides now have until the end of this year to work out a longer-term solution or face the prospect of another shutdown early in 2014.

What does this have to do with safety? Consider this: After a Spirit Airlines Airbus A319 suffered an engine failure — originally reported to be an uncontained failure — on Oct. 15, the U.S. National Transportation Safety Board (NTSB) had to recall investigators from furlough to look into the matter, according to published reports. While NTSB quickly determined that the engine failure had been contained, the fact remains that the investigators had been furloughed with so many others. Investigations that had begun before the shutdown were slowed or stopped for the two weeks the government was idling, which means that potentially crucial findings also could be delayed.

A few days before the Spirit event, Flight Safety Foundation was one of nearly 50 signatories on a letter sent to U.S. Transportation Secretary Anthony Foxx urging the Department of Transportation to use its discretionary power to reopen the U.S. aircraft registry. The letter, written by aviation attorney Kenneth P. Quinn, who serves on the Foundation's Board of Governors and is its general counsel and secretary, said in part, "operations of the U.S. Registry are vital to protection of human life and property, safety and security."

Aviation safety is a complex, often highly integrated endeavor that requires constant attention. Safety and risk management do not take holidays. You can't furlough thousands of inspectors, engineers, pilots, technicians and others in numerous safety-related jobs throughout multiple agencies and not expect an increase in risk, and that doesn't take into account the human factors issues that come with employment instability and the resulting stress.

Unfortunately, budget showdowns are increasingly common here in the United States. Congress and the Obama administration have another chance to restore some sanity to the situation. Here's hoping that they don't squander that opportunity. As former NTSB Member John Goglia wrote in a recent *Forbes* article, "I hope that both the FAA [U.S. Federal Aviation Administration] and NTSB can get back to focusing on this [the Spirit engine failure] and other significant safety issues."

Frank Jackman
Editor-in-Chief
AeroSafety World

Serving Aviation Safety Interests for More Than 65 Years

Since 1947, Flight Safety Foundation has helped save lives around the world. The Foundation is an international non-profit organization whose sole purpose is to provide impartial, independent, expert safety guidance and resources for the aviation and aerospace industry. The Foundation is in a unique position to identify global safety issues, set priorities and serve as a catalyst to address the issues through data collection and information sharing, education, advocacy and communications. The Foundation's effectiveness in bridging cultural and political differences in the common cause of safety has earned worldwide respect. Today, membership includes more than 1,000 organizations and individuals in 150 countries.

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

NOV. 8–10 ➤ HAC Convention & Trade Show. Helicopter Association of Canada. Vancouver, British Columbia, Canada. Barbara Priestley, <barb.priestley@h-a-c.ca>, <h-a-c.ca>.

NOV.12–13 ➤ Safety in Aviation North America 2013. Flightglobal. Montreal. Hannah Bonnett, <hannah.bonnett@rbi.co.uk>, <flightglobal.com/events>, +44 (0)20 8652 4755.

NOV. 12–14 ➤ Safe-Runway Operations Training Course. JAA Training Organisation. Abu Dhabi, United Arab Emirates. <jaato.com>, +31 (0)23 56 797 90.

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

NOV. 17–21 ➤ Dubai Air Show. F&E Aerospace. Dubai, United Arab Emirates. <dubaiairshow.aero>.

NOV. 18-20 ➤ Regional Runway Safety Seminar. International Civil Aviation Organization. Kuala Lumpur, Malaysia. <icao.int> or Kelcey Mitchell, Flight Safety Foundation, <mitchell@flightsafety.org>.

NOV. 19–21 ➤ Aviation Safety Management Systems Workshop. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. Sarah Ochs, <case@erau.edu>, <daytonabeach.erau.edu/coa/programs/professional-programs>, +1 386.226.6928.

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

DEC. 3-4 ➤ Safety in Air Traffic Control. Flightglobal. London. Stephanie Kluth, <stephanie.kluth@rbi.co.uk>, +44 (0)20 8652 3989.

DEC. 10–11 ➤ AFRR — Aviation Fire, Rescue & Resilience. International Aviation Fire Protection Association. Dubai, United Arab Emirates. Kate Niven, <kniven@tangentlink.com>, <tangentlink.com>, +44 (0)1628 660400.

DEC. 10–12 ➤ Multi-Crew Pilot License Symposium. International Civil Aviation Organization. Montreal, Canada, <www.icao.int>.

DEC.10–12 ➤ Next Generation of Aviation Professionals (NGAP) and TRAINAIR PLUS Regional Symposia. International Civil Aviation Organization. Johannesburg, South Africa. <www.icao.int>.

JAN. 21–22 ➤ MRO Latin America. *Aviation Week*. Rio de Janeiro, Brazil. Helen Kang, <helen_kang@aviationweek.com>, <www.aviationweek.com>, +1 212.904.6305.

FEB. 5–6 ➤ MRO Middle East. *Aviation Week*. Dubai, United Arab Emirates. Helen Kang, +1 212.904.6305. <helen_kang@aviationweek.com>, <www.aviationweek.com>.

FEB. 11–16 ➤ Singapore Airshow 2014. Experia Events Pte. Ltd. Singapore. <enquiries@singaporeairshow.com>, +65 6542 8660.

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

FEB. 24–27 ➤ Heli-Expo 2014. Helicopter Association International. Anaheim, California, U.S. <heliexpo@rotor.org>, <rotor.org>, +1 703.683.4646.

MARCH 10–11 ➤ State Safety Program Solutions Seminar. The Aviation Consulting Group. Myrtle Beach, South Carolina, U.S. Bob Baron, <webinquiry@tacgworldwide.com>, <tacgworldwide.com>.

MARCH 18–20 ➤ African Aviation MRO Africa Conference & Exhibition. African Aviation. Johannesburg, South Africa. <www.africanaviation.com>.

MARCH 19–21 ➤ ARSA Annual Repair Symposium and Legislative Fly-In. Aeronautical Repair Station Association. Arlington, Virginia, U.S. <www.arsa.org>.

MARCH 31–APRIL 2 ➤ 10th Annual CHC Safety & Quality Summit. CHC Helicopter. Vancouver, British Columbia, Canada. <www.chcsafetyqualitysummit.com>.

MARCH 31–APRIL 2 ➤ IATA Ops Conference 2014. International Air Transport Association. Bangkok, Thailand. <www.iata.org>.

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

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

MAY 13–15 ➤ RAA 39th Annual Convention. Regional Airline Association. St. Louis, Missouri, U.S. David Perez-Hernandez, <www.raa.org>, +1 312.673.4838.

MAY 20–22 ➤ IATA Cabin Safety Conference. International Air Transport Association. Madrid, Spain. <www.iata.org>.

JUNE 30–JULY 2 ➤ Safe-Runway Operations Training Course. JAA Training Organisation. Abu Dhabi, United Arab Emirates. <jaato.com>, +31 (0)23 56 797 90.

JULY 14–20 ➤ 49th Farnborough International Airshow. Farnborough International. Farnborough, Hampshire, England. <enquiries@farnborough.com>, <farnborough.com>, +44 (0) 1252 532 800.

OCT. 13–17 ➤ ISASI 2014 Seminar. International Society of Air Safety Investigators. Adelaide, Australia. <www.isasi.org>.

NOV. 11–13 ➤ 67th International Air Safety Summit. Flight Safety Foundation. Abu Dhabi, United Arab Emirates. Namratha Apparao, <apparao@flightsafety.org>.

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

Safety News

North Sea Review

In the wake of five accidents in the past four years, including two fatal accidents, North Sea helicopter operations are under review by a team of regulators and aviation experts.

The review — by the U.K. Civil Aviation Authority (CAA), the European Aviation Safety Agency and the Norwegian CAA, along with a panel of independent experts — is focusing on current operations, past incidents and accidents, and offshore helicopter operations in other countries. It will conclude with recommendations aimed at improving the safety of helicopter operations.

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"The recent accidents have understandably given rise to concerns, particularly with offshore workers who rely so heavily on these helicopter flights," said Mark Swan, director of the U.K. CAA Safety and Airspace Regulation Group. "We are absolutely committed to ensuring that operations are as safe as possible."

In announcing the review, the U.K. CAA noted that the five accidents — each involving a Eurocopter Super Puma being flown in support of offshore oil and gas operations — occurred despite "considerable effort by regulators, operators and the offshore industry to minimize the risk of North Sea helicopter operations."

The most recent accident occurred Aug. 23, when a Eurocopter AS332 L2 Super Puma crashed into the sea during an approach to Sumburgh Airport in the Shetland Islands. Four of the 18 people in the helicopter were killed.

Earlier in August, the three North Sea operators of Super Pumas had begun putting the helicopters back in the air after a 10-month grounding that followed two nonfatal ditchings in 2012. At the time, they said that modifications had been made to prevent cracking in the main gearbox bevel gear vertical shaft of affected EC225s and AS332s. Such cracking had occurred in each of the two ditched helicopters.

The two other accidents involved an AS332 L2 that crashed into the sea 11 mi (18 km) northeast of Peterhead, Scotland, on April 1, 2009, killing all 16 passengers and crewmembers, and an EC225 LP that "landed heavily" on the sea 500 m (1,640 ft) from an offshore platform on Feb. 18, 2009, resulting in three minor injuries to passengers.

First Flight

The first U.S. government–approved commercial flight of an unmanned aircraft was completed in mid-September over Alaska's Chukchi Sea, the Federal Aviation Administration (FAA) says.

An Insitu ScanEagle took off from a research vessel for a 36-minute flight to conduct the surveys of marine mammals and ice that are required by environmental and safety rules before underwater drilling may begin, the FAA said in a Sept. 23 statement.

Preparations for the flight and others like it began in May 2012, with development of a plan to designate three blocks of airspace over international waters where small unmanned aircraft systems (UAS) could operate 24 hours a day for research and commercial purposes. That area sees an "extremely low amount of air and ship traffic," the FAA said.

Under the plan, unmanned aircraft take off from coastal launch sites and climb to altitudes no higher than 2,000 ft.

"The plan also included developing protocols to operate unmanned aircraft beyond the vision of a pilot or observer ('beyond line-of-sight') — a first for small UAS operations," the FAA said.

Two small UAS — the ScanEagle X200 and AeroVironment's PUMA — received the first civil type certificates from the FAA in late July so that both could be flown commercially. Around the same time, the FAA signed an agreement with ConocoPhillips, which previously had expressed interest in using UAS for its marine mammal and ice surveys.

UAS also are expected to be used in the Arctic for scientific research, search and rescue, fisheries and maritime route planning, the FAA said.

"The project is giving the FAA and the industry needed experience and a path forward to certify UAS for more commercial operations, both in the Arctic and elsewhere," the agency said.

© Boeing

Congestion in European Airspace

The European Commission (EC) is pressuring Cyprus, Greece and Italy to establish functional airspace blocks (FABs) — regional air traffic blocks that are required by law to replace the current 27 national air traffic blocks and create the Single European Sky (SES).

The EC, in a letter of formal notice, asked the three countries to show how they have complied with the requirement.

"This legal action should send a strong political message about our determination to push through the reforms to Europe's air traffic control that are so badly needed," EC Vice President Siim Kallas said. "Our airlines and their passengers have had to endure more than 19 years of reduced services and missed deadlines on the route to a Single European Sky. We cannot afford to continue this way. Europe's skies face a capacity crunch, and the reform of our aging air traffic control system is too important … to be allowed to fail."

The EC said it is considering other action to speed the implementation of operational FABs. The deadline for their implementation was December 2012, but by September 2013, none was fully operational, Kallas said.

In addition, the EC has adopted proposals for SES2+ — legislative measures designed to accelerate improvements in the European air traffic management system, including a plan that would make the implementation of FABs more flexible.

Next Steps for Africa


© Anton Balazh/123RF

The International Civil Aviation Organization (ICAO) is pressing to expand its Comprehensive Regional Implementation Plan for Aviation Safety in Africa (AFI Plan) to include technical areas such as air navigation services and aircraft accident investigation.

Bernard Aliu, Nigeria's representative on the ICAO Council and former head of the AFI Plan's steering committee, told more than 200 participants at a September briefing in Montreal that the program has been responsible for recent improvements in aviation safety in Africa.

ICAO Secretary General Raymond Benjamin agreed, adding, "To maintain our momentum, we must now jointly expand our areas of activity and confirm the continued engagement of AFI states and the relevant authorities."

Expansion of the program through 2016 also would allow for a new focus on airports, as well as air routes and ground aids, ICAO said.

In a related development, Tony Tyler, director general and CEO of the International Air Transport Association (IATA), told representatives of Africa's aviation community that the continent continues to face major challenges in several areas, including safety and infrastructure.

He cited data showing that in 2012, African airlines had one accident involving a Western-built jet airplane for every 270,000 flights, compared with the worldwide average of one accident per 5 million flights. However, no air carrier in Africa — or anywhere else — that successfully completed an IATA Operational Safety Audit (IOSA) experienced a hull loss accident with a Western-built jet in 2012, he said.

"It is clear that IOSA is making a difference, not just in Africa but in safety globally," Tyler said, adding that the Abuja Declaration, endorsed by the African Union Summit, outlines a plan for achieving "world-class safety levels" by 2015. One condition of the declaration calls for all African carriers to complete an IOSA audit, and Tyler said African governments should mandate IOSA for their airlines.

License Deadline

European pilots who hold a national pilot license have until April 8, 2014, to convert that license to one issued by the European Aviation Safety Agency (EASA).

The U.K. Civil Aviation Authority (CAA) issued a reminder in late September, noting that the conversion requirement applies to commercial and private airplane and helicopter pilots with a CAA license — also known as a non–Joint Aviation Requirements license. Those licenses were issued before January 2000.

The CAA said that it was "concerned some pilots would be left with invalid licences if they failed to meet the deadline."

Some exceptions will be made for pilots of aircraft that are considered "non-EASA aircraft" — for example, ex-military aircraft and some airplanes that are considered "vintage" types. For most pilots, however, "the need to convert national licences by April 2014 is part of the standardisation of pilot licensing across Europe," the CAA said. The process is expected to be completed by 2017; after that date, all pilots of EASA aircraft must have EASA licenses and EASA medical certificates.

Pilot Outlook

The worldwide expansion of airline fleets and flight schedules will generate a need for 498,000 new commercial airline pilots and 556,000 new maintenance technicians over the next 20 years, Boeing says in its annual *Pilot and Technician Outlook*.

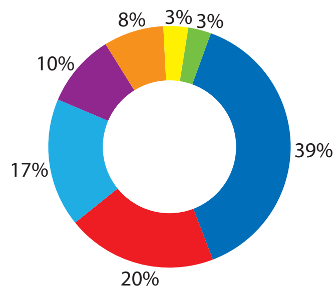
The hiring estimates, published in September, say that the demand for new employees will reach unprecedented levels because of the expected delivery of tens of thousands of new commercial jetliners.

"Meeting this exponential demand growth will require innovative solutions focused on new digital technology to match the learning requirements of a new generation," Boeing said.

The largest expected growth in demand will be in the Asia Pacific region, where an estimated 192,300 new pilots and 215,300 new maintenance personnel will be needed between now and 2032, Boeing said.

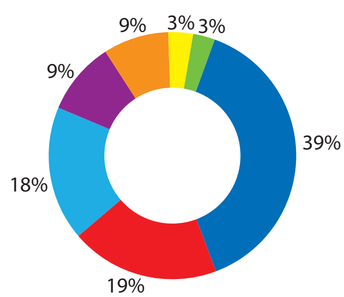
Pilot Outlook
New pilots by region, 2013–2032

Region	Pilots
Asia Pacific	192,300
Europe	99,700
North America	85,700
Latin America	48,600
Middle East	40,000
Africa	16,500
CIS	15,200
Total	**498,000**



Technician Outlook
New technicians by region, 2013–2032

Region	Technicians
Asia Pacific	215,300
Europe	108,200
North America	97,900
Latin America	53,100
Middle East	47,600
Africa	18,000
CIS	15,900
Total	**556,000**



CIS = Commonwealth of Independent States
Source: Boeing

Composite Research

The U.S. National Aeronautics and Space Administration (NASA) has chosen six companies to participate in a program designed to advance composite materials research and certification.

The participants were among 20 firms that submitted research proposals to "reduce the time for development, verification and regulatory acceptance of new composite materials and structures," NASA said.

The selected companies are Bell Helicopter Textron, GE Aviation, Lockheed Martin Aeronautics, Northrop Grumman Aerospace Systems, Boeing Research and Technology, and United Technologies and subsidiary Pratt & Whitney.

NASA's Aeronautics Research Mission Directorate is responsible for seeking solutions to air traffic congestion, safety and environmental issues that affect the air transportation system.

U.S. National Aeronautics and Space Administration/Boeing

In Other News …

The European Aviation Safety Agency and Transport Canada (TC) have agreed to conduct common **inspections** to ensure that the foreign commercial aircraft that operate within their jurisdictions are in compliance with safety regulations. The two will share information gathered during the inspections in what TC described as "an arrangement to strengthen the safety net around international air travel." … The U.S. Federal Aviation Administration (FAA) has upgraded **Ukraine's** aviation safety rating to Category 1, which designates full compliance with International Civil Aviation Organization standards and recommended practices. Ukraine had been assigned a Category 2 rating since 2005; Category 2 indicates either a lack of laws or regulations for overseeing air carriers in accordance with minimum international standards or a deficiency in the civil aviation authority. The ratings are assigned through the FAA's International Aviation Safety Assessment Program.

Compiled and edited by Linda Werfelman.

Shortly after the Boeing 747-400F departed from Dubai, United Arab Emirates (UAE), a fire erupted in a cargo pallet containing lithium batteries and other combustible materials. By the time the flight crew received a warning, a "catastrophic uncontained fire" raged in the forward main cargo deck, and the cockpit soon filled with "continuous blinding smoke," said the report by the Air Accident Investigation Sector (AAIS) of UAE's General Civil Aviation Authority.

Thermal damage to flight control cable supports and oxygen lines, and the failure of a crucial air conditioning pack, minimized the chances of survival. The pilots attempted to return to Dubai, but the captain's oxygen supply was cut off, and he was overcome by toxic fumes while trying to retrieve a portable oxygen bottle. The first officer, alone at the controls, had trouble breathing and could not see his instruments or the view outside the windshield.

Investigators concluded that the first officer eventually became spatially disoriented and lost control of the crippled freighter, which struck terrain on a military base near Dubai International Airport. No one on the ground was hurt.

The investigation of the Sept. 3, 2010, accident generated many safety recommendations, including a review of transport category aircraft fire-protection certification standards; modification of cargo compartments

'Catastrophic Uncontained Fire'

A main deck cargo fire fed by lithium batteries led to the uncontrolled descent of a 747 freighter in Dubai.

BY MARK LACAGNINA

General Civil Aviation Authority of the United Arab Emirates

The auto-ignition of lithium batteries that had not been declared as hazardous material may have contributed to the fire.

and pallet covers to better contain fires; requirements for full-face oxygen masks and vision-assurance devices on the flight deck; more realistic training for emergencies involving smoke, fire and fumes; further testing of lithium battery ignition properties; and development of packaging and technical instructions to ensure safe carriage of lithium batteries aboard aircraft.

'Medically Fit, Adequately Rested'

The flight crew had begun their assignment for United Parcel Service (UPS) several days earlier with a deadhead flight from Anchorage, Alaska, U.S., to Hong Kong, China, via Seoul, South Korea. After a layover of 47 hours in Hong Kong, they flew a different aircraft to Dubai, where they had a 24-hour layover.

The captain, 48, had 11,200 flight hours, including 4,054 hours in type. He had flown for several regional airlines and a major U.S. airline before he was hired by UPS in July 1995.

The first officer, 38, had 5,549 flight hours, including 77 hours as a second-in-command of 747-400s. He had flown as a captain for a regional airline before joining UPS in June 2006.

The report said that neither pilot had a history of accidents, incidents or regulatory violations, and that both were "medically fit and adequately rested in compliance with the fatigue regulations in place at the time of the accident."

Undeclared Hazmat

Another UPS flight crew had flown the accident aircraft from Hong Kong to Dubai the night before the accident. Pallets loaded in the 747's forward cargo deck in Hong Kong contained a significant number of lithium batteries that were not declared as hazardous material in accordance with International Civil Aviation Organization requirements, the report said.

"Lithium batteries have been in the spotlight for the past few years due to their possible involvement in aircraft cargo fires," and the hazards posed by the shipment of lithium-metallic and lithium-ion batteries are still not fully understood, the report said.

Tests performed to date have shown that "the thermal runaway of lithium-ion batteries is capable of causing adjacent combustibles to ignite [and that] in addition to the energy release from batteries resulting in combustion, there is an associated mechanical energy release," the report said. "This mechanical energy release is capable of compromising the integrity of packaging and creating incendiary projectiles."

The pallets remained aboard the aircraft for the subsequent scheduled flight from Dubai to Cologne, Germany. The cargo manifest for the flight showed no declared shipments of hazardous materials.

Also of significance regarding the flight from Hong Kong was a logbook entry about resetting the aircraft's no. 1 air conditioning pack after it failed en route. A ground engineer in Dubai checked the pack, but could not replicate the failure.

The freighter, manufactured in 2007 and registered in the United States as N571UP, was within weight and balance limits when it departed from Dubai International Airport at dusk, 1851 local time, and proceeded northwest in visual meteorological conditions over the Arabian Gulf.

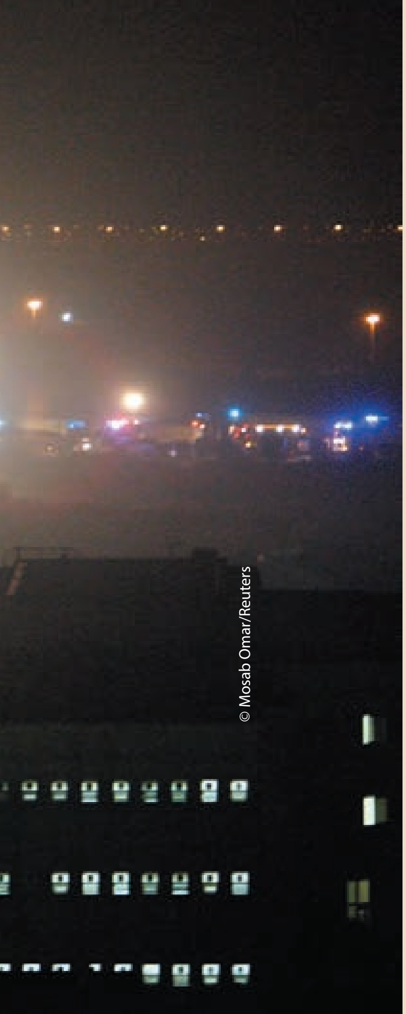
The first officer was the pilot flying. He hand flew the aircraft to 11,300 ft and then engaged the autopilot for the remainder of the climb to the assigned cruise altitude, 32,000 ft.

During the climb, the engine indicating and crew alerting system (EICAS) generated a fault message for the no. 1 pack, the same pack that had failed during the flight from Hong Kong to Dubai. The captain reset the pack, and the EICAS message cleared.

Investigators determined that the no. 1 pack's turbine bypass valve, which works in conjunction with the ram air door, had failed before takeoff, causing the subsequent failure of the pack.

Fire Warnings

About 20 minutes after departure, the flight was handed off by UAE Area Control to Bahrain East Area Control. The aircraft was nearing its



© Mosab Omar/Reuters

assigned cruise altitude two minutes later when the crew received visual and aural warnings of a fire on the forward main cargo deck (Figure 1).

"Fire, main deck forward," the captain announced. He told the first officer, "[All right], I'll fly the aircraft. I got the radio. Go ahead and run [the checklist]."

Investigators were unable to determine conclusively how the fire began, but the report said it might have been sparked by the auto-ignition of lithium batteries stored in one of the cargo pallets: "Lithium batteries have a history of thermal runaway and fire. … It is possible that a lithium type battery or batteries, for reasons which cannot be established, went into an energetic failure characterised by thermal runaway and auto-ignited, starting a chain reaction which spread to the available combustible material."

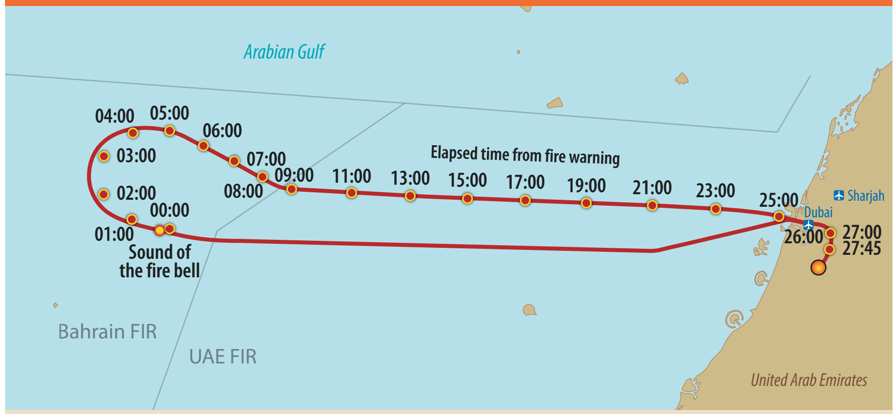
The captain reported the fire warning to Bahrain Control and said that he needed to land as soon as possible. The controller advised the crew that Doha (Qatar) International Airport was at their 10 o'clock position and 100 nm (182 km) away, and asked, "Is that close enough?"

"How about we turn around and go back to Dubai," the captain replied. "I'd like to declare an emergency." The controller cleared the crew to turn right to a heading of 090 degrees and to descend to 28,000 ft. At this point, the Dubai airport was 180 nm (333 km) east.

"There is no direct information as to why the crew elected to choose Dubai [rather than] Doha," the report said. "However, it is likely that at the time of the initiation of the turn-back, the crew was not yet aware of the full extent of the fire and its effects."

The captain flew the aircraft on autopilot while the first officer conducted the "Fire Main Deck" checklist,

747-400F Flight Path, Sept. 3, 2010



Source: General Civil Aviation Authority of the United Arab Emirates

Figure 1

which called for depressurizing the main cargo deck to shut off the ventilating airflow. The report explained that because this deck is classified as a Class E cargo compartment, active fire suppression is not required there: "The fire extinguishing and fire propagation mitigation is through reducing the oxygen available for combustion through depressurization of the compartment."

Pack Fails Again

The depressurization of the main deck involved deactivation of the no. 2 and no. 3 air conditioning packs. With these packs shut down, the no. 1 pack alone provides conditioned airflow to the upper deck. "This provides a positive pressure differential between the upper deck and the rest of the aircraft, preventing smoke or fumes [from] entering occupied areas," the report said.

However, the no. 1 pack subsequently failed again. No discussion of the failure was captured by the cockpit voice recorder, and there apparently was no attempt to reset the pack.

The pilots donned their oxygen masks and goggles when the cockpit began to fill with smoke. Noting that the microphones inside the masks are not "hot" but must be keyed with intercom switches on the control columns or the audio control panel, the report said that the pilots' inability to readily hear what each other was saying caused some confusion and difficulty in communicating.

The captain advised the controller that the cockpit was full of smoke and that they could not see the radios. He requested and received clearance to descend to 10,000 ft. This might have been a mistake, according to the report: "Directly descending to 10,000 ft may have exacerbated the fire and smoke problem due to the extra available oxygen."

The report noted, however, that the "Fire Main Deck" checklist provided conflicting guidance, with successive items on the checklist requiring the crew to "climb or descend to 25,000 ft" and to "plan to land at the nearest suitable airport."

The checklist "does not provide guidance for when or how to transition to landing or the fact that descending early might provide more atmospheric oxygen to the fire," the report said. "There is no intermediate step to verify or otherwise assess the condition of the fire and to evaluate the risk to the aircraft if a descent is initiated."

'I've Barely Got Control'

A few minutes after the crew received warnings about the fire on the main cargo deck, additional warnings indicated that the fire had spread to the aft main cargo deck. By this time, the fire had penetrated the main cargo deck liners and had caused severe damage to flight control cable support trusses.

The captain, who had disengaged the autopilot and was hand flying the 747, told the first officer, "I've barely got control of the aircraft." Recorded flight data indicated that, due to the decreased control cable tension resulting from the damaged supports, even large movements of the control column and rudder pedals had limited effect on the deflection of the elevators and rudder.

The control problems abated somewhat when the captain re-engaged the autopilot, which sends electrical signals to the elevator control servos and hydraulic actuators located in the tail of the aircraft, behind the rear pressure bulkhead. The fire had not damaged the wiring for this system.

The cockpit environment may have worsened when the captain asked the first officer to "pull the smoke handle," which opens a smoke-evacuation port in the cockpit ceiling. The report noted that this action is not on the "Fire Main Deck" checklist and that opening the port, with no air conditioning packs in operation, could have caused a pressure differential that drew more smoke into the cockpit.

'I Can't See'

The pilots discussed and agreed on the option of conducting an autoland approach and landing on Runway 12L at the Dubai airport. Although the first officer was having trouble seeing anything through the smoke, he was able to enter the instrument landing system (ILS) frequency into the flight management system (FMS).

The controller cleared the crew to proceed directly to the final approach fix. "[All right], we're doing our best," the captain replied. "Give me a heading if you can. I can't see."

The 747 was descending through 21,000 ft, about seven minutes after the crew received the fire warning, when the captain commented about the high temperature in the cockpit. Shortly thereafter, the oxygen flow to his mask abruptly ceased when the fire damaged some of the lines leading from the three crew oxygen bottles mounted on the sidewall of the forward main cargo compartment.

"I got no oxygen," the captain said. "I can't breathe. Get me oxygen."

The report said that the first officer was unable to assist the captain because of task-saturation or because he did not know where the portable oxygen system was stowed. "The first officer was already managing a number of other problems, including the [FMS] input and the checklist."

The captain told the first officer to take control of the aircraft. He then left his seat to retrieve the portable oxygen system, which was stowed in the aft

Boeing 747-400F

Frank Kovalchek/Wikimedia CC-BY-SA 2.0

The Boeing 747 entered service in 1970. A windowless freighter version, with a hinged nose that is raised to load and unload cargo pallets and containers, was introduced three years later. Powered by 41,000 lb (18,598 kg) thrust Pratt & Whitney JT9D engines, the 747-200F can carry up to 200,000 lb (90,720 kg) on its main and lower cargo decks, and has a maximum range of 4,100 nm (7,593 km).

General Electric CF6-50 and Rolls-Royce RB211 series engines soon became options. Several modifications have been made over the years to increase the freighter's cargo capacity, range and fuel efficiency. Among the most significant changes, for the passenger-carrier as well as the freighter, was the 747-400's two-pilot glass flight deck, which replaced the traditional three-pilot cockpit.

The 747-400F entered service in 1993. With engines producing about 58,000 lb (26,309 kg) thrust, this version has a maximum takeoff weight of 874,000 lb (396,446 kg), a cargo capacity of 27,467 cu ft (778 cu m) and a maximum range of 4,445 nm (8,232 km).

At press time, Boeing had delivered nearly 300 747 freighters worldwide, including 36 of the current version, the 747-8F.

Sources: Boeing, *The Encyclopedia of Civil Aircraft* cockpit area. The last recorded comment by the captain was: "I can't see." Investigators determined that he was rendered unconscious by toxic fumes shortly after leaving his seat and that he eventually succumbed to carbon monoxide poisoning.

Complicated Communications

The thick, acrid smoke obliterated the first officer's view of the instrument panel. He also was having trouble breathing because his mask had inadvertently been set to the normal mode, which provides a mix of ambient air and 100 percent oxygen, rather than to the emergency mode, which provides only pure oxygen.

He advised Bahrain East Area Control that he was unable to change radio frequencies due to the limited visibility in the cockpit. "Sir, we're going to have to stay with you," he said. "We cannot see the radios."

Eventually, the freighter flew out of radio range with Bahrain Control, but the pilot and the Bahrain controller were able to relay messages to each other through other aircraft operating in the vicinity. The Bahrain controller coordinated via landline with UAE Area Control and the control tower at the Dubai airport.

Recorded voice data indicated that the delay inherent in the relay of messages was problematic for the first officer, who repeatedly said that he was "flying blind" and asked for radar vectors and for information about his current altitude, heading, airspeed and distance from the airport.

Through a relay, the Bahrain controller asked the pilot to change to the guard frequency, 121.5 MHz, but the first officer apparently was unable to do so. Among the messages relayed to the pilot from the Bahrain controller was to maintain his current heading, 105 degrees.

'Too Fast and Too High'

The 747 was descending through 9,000 ft at 350 kt as it neared the ILS final approach fix. The crew of another aircraft relayed the following message: "You're too fast and too high. Can you make a three-sixty [i.e., a 360-degree turn]?"

"Negative, negative, negative," the first officer replied.

Although the first officer had armed the approach mode, the autopilot did not capture the localizer because of the aircraft's relatively high speed and altitude. The 747 was descending through 4,200 ft at 320 kt and was on a heading of 089 degrees when it passed to the north of the airport.

"Sir, where are we?" the first officer asked. "Where are we located?"

Through a relay aircraft, the controller asked the first officer if he would be able to make a left turn, to fly north toward Sharjah International Airport. The controller advised that the Sharjah airport was 10 nm (18 km) away.

"Give me a left turn," the first officer said. "What heading?"

A heading of 095 degrees to Sharjah was relayed, and the first officer acknowledged the information. However, he inadvertently selected 195 degrees on the mode control panel. Recorded data showed that the aircraft rapidly turned right toward the selected heading while descending through 4,000 ft and slowing to 240 kt. The abrupt and unanticipated right turn might have confused the pilot and triggered the onset of spatial disorientation, the report said.

Loss of Control

The freighter was flying southwest, away from both the Sharjah and the Dubai airports, when the first officer disengaged the autopilot. The aircraft abruptly pitched 14 degrees nose-down.

The first officer pulled back on his control column to arrest the descent, but the result was a series of rapid pitch oscillations and only momentary reductions of the descent rate "due to the desynchronisation of the control column inputs and the elevators," the report said.

The first officer received a relayed message advising that Dubai International Airport was 5 nm (9 km) away at his 3 o'clock position. "What is my altitude, and my heading?" he asked. "My airspeed?"

Shortly thereafter, the enhanced ground-proximity warning system generated the first of several "SINK RATE, PULL UP" and "TOO LOW, TERRAIN" warnings. Recorded data indicated that the first officer's control column was fully aft when the aircraft descended out of control and struck the ground 9 nm (17 km) southwest of the Dubai airport.

The crash occurred 51 minutes after takeoff and 29 minutes after the crew received the fire warnings. On impact, the 747 was in a nose-down and right-wing-low attitude. It struck several street lamps before coming down on a service road at the perimeter of the military base, just outside a densely populated area.

"The right-hand wing struck several buildings and vehicle-parking stands before progressing through a line of maintenance storage buildings immediately prior to the forward fuselage contacting an elevated sand bank and additional support buildings," the report said. "The aircraft was completely destroyed by the ground contact followed by a post-accident fire."

This article is based on AAIS Case Reference 13/2010: "Uncontained Cargo Fire Leading to Loss of Control Inflight and Uncontrolled Descent Into Terrain — Boeing 747-44AF, N571UP; Dubai, United Arab Emirates; 03 September 2010." The 324-page report, published in English on July 24, 2013, is available from the UAE General Civil Aviation Authority at <gcaa.gov.ae/en>.

Fly-In Fly-Out

BY WAYNE ROSENKRANS

FSF BARS Program assesses threats to contracted remote operations involving flights to minerals, metals, oil and gas sites.

Flight Safety Foundation's Basic Aviation Risk Standard (BARS) Program was developed from the outset to standardize remote-operations risk mitigation within the natural resource sector (*ASW,* 3/10, p. 14), which focuses on global onshore exploration and extraction of minerals, metals, oil and gas. Approaching 2014, this evolving audit program also extracts precious safety insights from aircraft operators' shared data and influences other types of industries and flying, program veterans say.

"The BARS Program was designed by resource companies, in conjunction with the Foundation, to mitigate the risk of aviation activities undertaken in support of this sector," said Greg Marshall, BARS managing director. "The BAR Standard was derived from an amalgam of different standards that were adopted by a variety of onshore and off-shore resource-sector companies. These different

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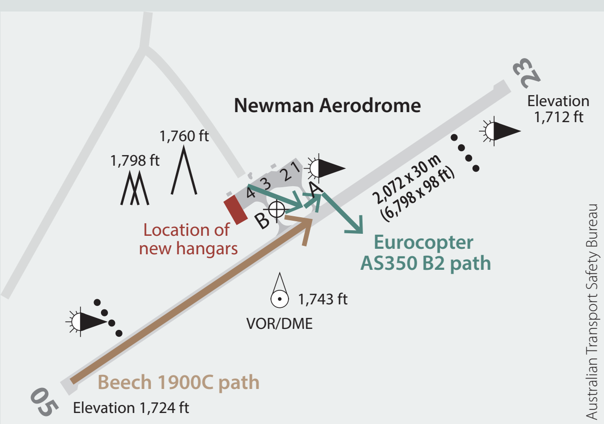
Australian Incidents

One example of an aviation incident in 2012 involved a fly-in fly-out charter operator and a privately operated helicopter — both engaged in remote operations for Australia's natural resource sector. On Sept. 6 at 1300 local time, the pilot of a Eurocopter AS350 B2 helicopter crossed Runway 05 about 200 ft above ground level and 200 m (656 ft) in front of a departing Beech 1900C at Newman Aerodrome, an unmanned/uncontrolled airfield located 5.5 nm (10.2 km) from the iron-mining town of Newman in Western Australia.[1]

The pilot-in-command (PIC) flying the 1900C, seeing the helicopter taxi toward the runway when the airplane was about 300–450 m (984–1,476 ft) down the runway and at 80 kt, and believing that the trajectories of the two aircraft would conflict if the 1900C became airborne, rejected the takeoff at about 120 kt, said the final report of the Australian Transport Safety Bureau (ATSB).

"After ferrying personnel from Rhodes Ridge [a massive iron-ore deposit] to a survey site about 28 km [15 nm] northeast of Newman, the pilot of [the AS350] flew to Newman Aerodrome to refuel and to have a minor unserviceability rectified," the report said. "After waiting some time, the pilot was advised that one of the people at the survey site had been injured and required evacuation."

Pilots of both aircraft had made very high frequency (VHF) radio transmissions about their positions and intentions on the common traffic advisory frequency. "As the [1900C] commenced the takeoff roll, the [PIC] heard the pilot of [the AS350] transmit a taxi call but did not expect the helicopter to commence a takeoff," the report said. The helicopter initially taxied across the apron, entered the runway strip, then turned left to conduct a takeoff parallel to Runway 05.



"The pilot of [the AS350] only became aware of [the 1900C] when he heard the co-pilot transmit 'KFN aborting,'" the report said. The helicopter pilot previously had heard only one garbled radio transmission.

The report said that causal factors included the helicopter pilot feeling pressured to immediately fly to the survey site to evacuate the injured person. "In his haste to transit to the site, he had turned right across the runway when the normal procedures required him to turn left," the report said.

ATSB determined that a number of hangars constructed west of the general aviation apron obstructed pilots' view from that apron to the threshold of Runway 05, and that the hangars probably had blocked VHF radio transmissions between the incident aircraft. Information about the risk of radio-transmission blocking, as well as revised helicopter departure procedures, were scheduled to be published. ATSB currently is conducting investigations into several other incidents involving charter aircraft associated with the resource sector.[2]

Preliminary information said that on May 17, 2012, the flight crew of a de Havilland Canada DHC-8 that had departed from Perth received a ground proximity warning system warning about 10 nm (16 km) from Laverton Airport during their approach to Granny Smith Airport, all in Western Australia. They continued the unstable approach and landed at the airport located at the Granny Smith Gold Mine.

On Oct. 19, 2012, at 1530 local time, the flight crew of a Fokker F-28 Mk 100 that had departed from Perth encountered wind shear during final approach and subsequently made a hard landing at Nifty Aerodrome, also in Western Australia. Serious damage was reported. A newspaper said that 26 fly-in fly-out workers arriving at the Nifty copper mine were aboard but no occupants were injured.

On Jan. 10, 2013, air traffic control advised the flight crew of an Embraer ERJ 170 descending through 18,000 ft to land at McArthur River Mine airport, Northern Territory, that the aircraft was 6 nm (11 km) left of track and diverging. "The crew detected an error in their manual input of data into the FMS [flight management system]," the report said.

— WR

Notes

1. ATSB. "Airspace related event involving Beech 1900C, VH-KFN, and Aerospatiale AS350 B2, VH-VRW, Newman aerodrome, Western Australia, 6 September 2012." ATSB Transport Safety Report, Aviation Occurrence Investigation AO-2012-118, April 23, 2013.
2. ATSB. Investigation numbers, in order, AO-2012-170, AO-2012-137 and AO-2013-10. Adshead, Gary. "'Hard landing' grounds plane." *The West Australian,* Oct. 24, 2012.

standards were derived from experience born of accidents, too many of which, unfortunately, were fatal. The BAR Standard represents the best practice across both BMOs [BARS member organizations] and non-member organizations. A current benchmarking exercise against other standards is validating this.

"Within many companies, safety is the number one priority for all personnel, and many workplace safety risks associated with mining activities are well known. What is less well known are the risks that exist within aviation operations, particularly those that are conducted at remote locations in often-inhospitable environments. A number of unrelated aviation activities have risk profiles similar to those of the resource sector and this means that BARS can easily be adopted within those other sectors as well."

The latest data for the global resource sector show flight operations still increasing as minerals/metals/energy exploration and extraction extend into extremely remote areas. "The global resource sector continues to increase its reliance on contracted aviation activities in remote areas not frequently serviced by regular public transport services," said Cameron Ross, group manager aviation safety, BHP Billiton, a BARS Program member and benefactor. "Large production mine sites, such as those in Western Australia supporting the iron ore business, are typically serviced by dedicated, high-capacity charter aircraft. Globally, fly-in fly-out operations operate in extreme cold weather and remote desert and jungle environments, each with their own added risk factors."

BARS defines a *hostile environment* as one in which "a successful emergency landing cannot be assured, or the occupants of the aircraft cannot be adequately protected from the elements, or search and rescue response/capability cannot be provided consistent with the anticipated exposure." A *non-hostile environment* is one in which "a successful emergency landing can be reasonably assured, and the occupants of the aircraft can be adequately protected from the elements, and search and rescue response/capability can be provided consistent with the anticipated exposure."

These terms have serious practical effects on BMOs' remote operations. "The significance of hostile versus non-hostile is illustrated in the selection of aircraft for passenger-carrying operations, ensuring one-engine-inoperative performance at the ambient conditions being operated in," Ross said. "BHP Billiton operates in hostile environments in the Andes mountains of Chile, deep-water offshore locations and the heavily forested/jungle environments of Indonesia and West Africa."

Gradually, the significant aviation safety events (see "Australian Incidents," p. 18) in the resource sector are being better reported and tracked by the BARS program, and the information is being used to assist BMOs in checking their own aviation assurance controls and in supporting further development of the BAR Standard when reviewed by the participating resource-sector members.

"BARS hasn't yet been identified by a national government as a source of data that can assist with the identification of risk areas within certain regions or countries," Marshall said. "However, the Foundation has signed a memorandum of cooperation with the International Civil Aviation Organization to facilitate the exchange of de-identified data to support regional risk oversight. This is currently in the formative stages. Within the industry, the Foundation has already commenced the publication of de-identified data from a macro perspective on findings from resource-sector audits, in addition to the introduction of our Internet-based Safety Alert system for aviation-related safety events reported by the resource sector. The latest statistical data from audit analysis will be summarized and prepared for broad release by December 2013."

Value of Auditing

Traditional audits in the resource sector have been broad-based, attempting to cover all aspects of an aviation operation — including activities involving little risk — once per year, Marshall said. "Not only are these expensive, they may also offer very little value because the low-risk or inconsequential-risk activities are being assessed."

Today's BARS program has essentially a two-step assessment process. A BARS audit of the aircraft operator at its home base assesses internal systems to ensure that the necessary controls — the proven mitigators of risk — are established. Then, an operational review is conducted of the "identified, higher-endpoint risks at a frequency determined by the level of relative risk," he said.

"These reviews are undertaken by either the BMO's in-house aviation risk manager or by a competent aviation specialist contracted to provide specialist advice," Marshall said. "Low-risk activities can be excluded from reviews when the activities offer little, if any, value. In some cases, operational reviews may not be needed."

At BHP Billiton, contract aircraft operators' remote operations have been enhanced by collective lessons derived from de-identified/aggregate findings of BARS audits. "The data are in, and lack of procedures for stabilized approach is a good example of a finding that has been successfully closed for many operators," Ross said. "This is in line with FSF

ALAR [approach-and-landing accident reduction] work, and is a key control in the prevention of these accidents. Emergency-response planning — which includes comprehensive flight following — is always a challenge for remote area operations, and often discussed during an audit and the operation pre-start phase.

"The ability to review a BARS audit report allows a BMO to readily understand those aspects of the operator's risk-control design that meet the prescribed audit protocol. This is the first step in any assurance process and an important one for the industry. An intended benefit of the program is the data collected from the audit process, which — in addition to tracking industry accident data — allows the Flight Safety Foundation to provide meaningful feedback to the BARS program's Technical Advisory Committee in regard to the BAR Standard and to the program."

Over the years, a number of companies in the resource sector also monitored traffic growth within areas of remote operation, especially those in which national or regional air navigation service providers could have difficulty providing services. Ross said that a new network of ground stations has begun to change the situation, for example, in the northwestern part of Western Australia. Nationwide automatic dependent surveillance–broadcast (ADS-B) avionics coverage takes effect in 2014.

"The use of ADS-B, both onshore and offshore, is widely supported by BHP Billiton, and its implementation in Western Australia has had a very positive effect on our activities," he said. "Satellite flight following, TAWS [terrain awareness and warning systems], GNSS [global navigation satellite system] approaches and any controls that reduce the likelihood of VFR [visual flight rules] flight in degraded visual conditions are supported."

"ADS-B will be a significant contributor to safety," Marshall added. "For example, the huge growth in aviation support of mining in the Pilbara region brought about congestion problems over much of the controlled and uncontrolled airspace, which is outside radar coverage. ADS-B avionics fitment to some of these resource sector–contracted aircraft will minimize traffic conflicts and promote operational efficiency."

Safety Alerts

BARS audits, from their beginning, have been sensitive to threats of high common interest to BMOs: runway excursions, fuel exhaustion, fuel contamination, controlled flight into terrain, incorrect loading, collision on ground, collision in air, structural or mechanical failure, weather, medical evacuation, and preparation for aircraft accidents. BMOs' experiences have validated these priorities heading into 2014, but also have prompted concentration on helicopter external load, offshore and night vision system (NVS) operations to keep pace with industrywide best practices. NVS are widely used in helicopter emergency medical services, and a number of BARS-audited aircraft operators provide contract medical retrieval for the resource sector, Marshall said.

The BARS Safety Alert system and BARSoft online-discussion forums — set to be introduced in a website upgrade by the end of 2013 — will become especially valuable for delivering/exchanging safety information relevant to remote operations.

"The Safety Alert system has been reserved for reporting significant aviation safety-related events, and only a few such alerts have been released since its introduction," Marshall said. "One of these was actually supplied to us by a non-member in the interest of safety dissemination. Initially, the forums will allow us to introduce a Fixed-Wing Working Group and a Rotary-Wing Working Group in which industry participants review and discuss the various BARS elements, and will seek feedback on improvements to the BAR Standard."

Closed Loop

Analyses of BARS safety audits of aircraft operators and BMOs' feedback show that risk controls have been effective elements of safety management systems (SMS), the BARS veterans say. "The whole philosophy of SMS is to improve the resilience of organizations and to make

Resource-sector workers commute to remote field assignments under fly-in fly-out contracts between their employer and BARS-accredited charter aircraft operators (above, Port Hedland, Western Australia; p. 17, Andes mountain range, Chile).

Marshall

Wayne Rosenkrans

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systems safer," Marshall said. "Audit findings have proven to be a very good benchmark in this area. The number of findings emanating from our deep-dive audit has increased over previous audits undertaken using traditional methods. In some parts of the world, the BARS audit is often the first time that an aircraft operator has experienced a comprehensive review of its operations. Our key P1 [highest priority] and P2 [second-highest priority] findings must be closed — and by prescribed dates."

Eventually, in a manner similar to an International Air Transport Association Operational Safety Audit for airlines, the BARS Program envisions capability to compare safety outcomes in remote operations among BARS-accredited and non-BARS-accredited operators over the years. "This process has already commenced," Marshall said. "An initial report was produced in 2012, and a new report will be published in late 2013. As audit volume increases with the growth of the BARS Program, so, too, will the depth of analysis by region and country." Such an independent effort gradually can encompass exposure data (such as accurate total departure numbers) that have been missing for calculating accident/incident rates.

The BARS Program also strongly promotes the use of specific technologies as a best practice and helps the safety specialists at aircraft operators make the business case for them in remote operations. "TAWS/EGPWS [Enhanced Ground Proximity Warning Systems] and GNSS approaches, where published, are significant contributors to safety in remote locations — especially where these occur in challenging environments," Marshall said.

"We are seeing this data start to emerge," Ross said. "But I do see the independence of the Foundation and the BARS Program Office presenting a massive opportunity for the resource sector to gather data and collate it in a non-identifying manner that doesn't implicate resource companies and aircraft operators — it's data that can be used for the benefit of the entire industry. The effectiveness of each control is continuously tested through the review of incident and accident data, and where applicable, involves amending and updating the BAR Standard."

At the remote field level, he said, BHP Billiton's involvement in creating and sustaining the BARS Program has benefited aviation risk mitigation in the transportation of workers to remote mining operations; geophysical surveys; helicopter external load flights; photographic missions; medical evacuation flights; and providing appropriate aircraft rescue and firefighting capability at company-owned and company-operated airports.

The company's offshore safety interests also are compatible with many aspects of the BARS Program's evolution in supporting remote operations. "BHP Billiton operates offshore in the United Kingdom, Trinidad, the Gulf of Mexico, Australia and various exploration sites internationally," Ross said. "Offshore helicopter operations have their own unique hazards, particularly when operations go farther offshore in deep water, where search and rescue, aircraft endurance and survivability factors become tested. Cold-water operations provide additional challenges. Fortunately, there are large global helicopter service providers who understand these risks and provide the equipment and personnel to service these requirements."

Course Work

One notable offshoot of the BARS Program that now influences remote operations is facilitating continuing education for BMOs and aircraft operators. "Such education and training is vital to develop and support a desired safety culture, particularly in remote field operations," Marshall said.

Aviation Coordinator course training has been beneficial in raising awareness of aviation safety risks and how they are to be addressed by non-technical, onshore and offshore personnel, Ross said. "Among other controls, the importance of flight following, manifesting, search-and-rescue capabilities and emergency response planning are all explained in detail with examples," he said.

The *Helicopter External Load Operations* course was developed to provide a standard training course for ground personnel and aircrew. The course — although designed initially for exploration activities such as carrying under-slung loads of remote-site drilling equipment — in practice has attracted diverse operators from other industries.

The course "simply relates to any load that might be hooked onto an aircraft," Ross said. That means it also supports mission readiness for unexpected emergency roles for helicopter operators such as in fire fighting, rescue of mining personnel, and the delivery of food, supplies and people who provide on-site expertise at remote sites.

The current courses have been delivered to resource sector attendees in Yellowknife, Nunavut (the Canadian arctic territory, *ASW*, 9/13, p. 16); Saskatoon, Saskatchewan; and other parts of Canada. "This is expected to continue," Marshall said, as the BARS Program revises and adds courses that tap into expertise in extremely cold environments.

Two courses under development — *Aviation Coordinator for Offshore Personnel* and *Aviation Risk for Managers* — are being designed to fill other knowledge gaps among some personnel in the resource sector. "A beta version of the *Aviation Coordinator for Offshore Personnel* course was held in Houston in October," he said.

Into THIN AIR

BY ED BROTAK

Actual air density must be considered to reduce risk of degraded thrust and lift in takeoffs, landings, cruise and flight path changes.

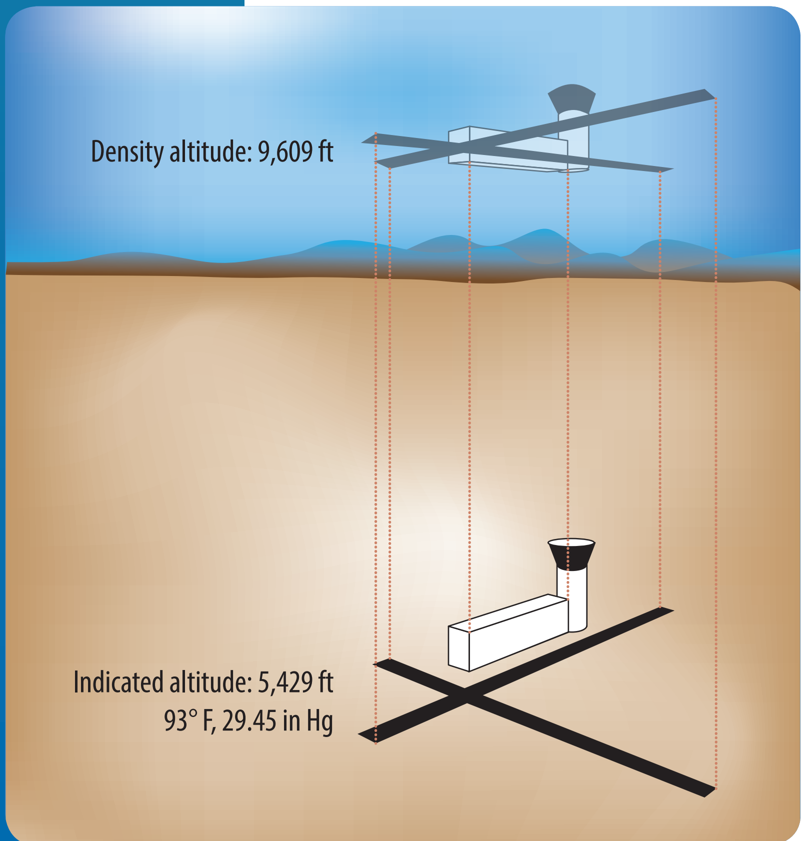
On Aug. 2, 2007, a Robinson R44 II helicopter crashed in the mountainous terrain of west central Washington state, U.S. The crash and subsequent fire took the lives of the pilot and three passengers who were touring logging sites. Witnesses said the helicopter lifted off, climbed straight up and turned left. This put the aircraft into a slight tailwind. They said that, after traveling a few hundred feet, the helicopter began to wobble and yaw back and forth. It then descended quickly, striking the ground. There was an explosion and the helicopter was immediately engulfed in flames.

Subsequent examination of the engine and airframe indicated no anomalies that would have contributed to the crash, the final report said. The 41-year-old commercial pilot had more than 2,000 hours in helicopters and was certified as a helicopter instructor. No evidence of alcohol or drug impairment was found. The weather, suitable for visual flight rules (VFR) operation, was not a factor.

The accident environment, however, involved what is known as *high density altitude*.

The clear-cut area of the logging site from which the helicopter took off was at an elevation of 4,961 ft (1,512 m). The temperature at

Susan Reed



Source: Jeppeson Sanderson. *Private Pilot Manual*, 1984.

In this situation, the temperature is higher than standard and the pressure is lower than standard. The resulting air density at 5,429 ft equals 9,609 ft in terms of standard atmosphere.

the time was above 70 degrees F (21 degrees C). The density altitude was calculated to be 6,841 ft, meaning the air was as "thin" (less dense) as it would normally be at 6,841 ft. The U.S. National Transportation Safety Board (NTSB) concluded the probable cause of the accident to be "the pilot's improper planning/decision in attempting a downwind takeoff under high density altitude conditions that resulted in a loss of control and impact with terrain. Contributing to the accident was the helicopter's gross weight in excess of the maximum hover out of ground effect limit."[1]

High density altitude conditions are a hazard for all aircraft, not just small, propeller-driven ones. The Boeing Co. considers the threat to be so important that it held a three-day conference in October 2007 in conjunction with the Civil Aviation Administration of China, concerning "High and Hot Operations." It used multi-engine airplanes as examples. It also stressed the effects on jet engines, in particular the reduction in thrust at high altitude (i.e., above 25,000 ft).

Topics featured in presentations included, "Elevation vs. Air Pressure, Temperature and Density"; "Types of Altitude"; "Airspeed, True vs. Indicated"; "Distant Obstacle Clearance"; and "Takeoff Distance."[2]

In their basic training, pilots are taught that "high, hot and humid" air can cause performance problems for their aircraft. However, the number of accidents and near-accidents that continue to occur indicate that the hazards associated with high density altitude are not always well understood or fully appreciated. Numerous harrowing videos on the Internet show pilots struggling to control their aircraft in high density altitude conditions.

To fully understand the problem of high density altitude, it is necessary to go back to the basics of atmospheric density, pressure and altimetry, using air pressure as the gauge of altitude.

Atmospheric pressure (measured with a barometer) is simply a measure of the weight of a column of air above a point. The more air above the point, the greater the pressure. At sea level, the entire atmosphere is above and pressure is greatest. The average (mean) sea level pressure is 29.92 in Hg (1013 hPa). At higher altitudes, there is less air above and the pressure decreases —very rapidly, even exponentially. If we assume, reasonably enough, that pressure decreases with height at the same rate everywhere, pressure indicates altitude. The standard altimeter is really just an aneroid barometer set to read pressure as altitude.

But the pressure at sea level is not always 29.92 in Hg. It varies, primarily because of the movement of surface weather systems, the common high- and low-pressure areas seen on standard weather maps. This is why pilots check the altimeter setting at the airport. This is the actual pressure adjusted to mean sea level. Entering this reading on the altimeter enables it to calculate the above sea level (ASL) altitude by comparing the unadjusted actual pressure (what meteorologists call *station pressure*) to the adjusted sea level pressure.

The term *pressure altitude* describes this type of height approximation. The ASL altitude would typically determine a given pressure value. For example, if the measured pressure is 28.00 in Hg, this would equal a pressure altitude of about 1,800 ft ASL.

Air pressure is directly related to air density, a major concern for pilots. Air is a fluid, and fluids are compressible. So the air density increases as pressure increases, and the density of the air is directly related to altitude. For example, at Denver International Airport, 5,431 ft (1,655 m) ASL, the air density is 18 percent lower compared with sea level. Further back in the Rocky Mountains sits the Lake County Airport in Leadville, Colorado. At 9,927 ft (3,026 m), it is the highest airport in North America. Air density there is 30 percent lower compared with sea level. At the El Alto International Airport at La Paz, Bolivia, the elevation is 13,325 ft (4,061 m), and the air density is 40 percent lower compared with sea level.

Besides pressure, air density is affected by temperature and humidity (water vapor or moisture content). Contrary to popular belief, moist air is less dense than dry air because water vapor weighs less than the gaseous constituents of dry air. So, air with higher humidity is slightly less dense than drier air at the same temperature. However, differences in air density due to changes in humidity are usually not significant for flight performance.

Temperature effects, on the other hand, can be profound. Hot air is less dense than colder air (the concept behind hot air balloons). Temperatures near 100 degrees F (38 degrees C) produce air densities nearly 10 percent lower than air at 50 degrees F (10 degrees C). This effect occurs at any height, but seldom causes problems in aircraft operation at low-elevation airports. It's when high temperatures combine with high elevation that low air density becomes a significant concern.

To keep pilots aware of the effects of temperature on air density, we use the term *density altitude*, which is the pressure altitude corrected for a nonstandard temperature. What does "nonstandard" mean in this case? The International Standard Atmosphere has a temperature of 59 degrees F (15 degrees C) at the surface, with the temperature decreasing 3.5 degrees F per 1,000 ft (6.4 degrees C per km) above it. Using these data, the standard temperature at 5,000 ft ASL would be 41 degrees F (5 degrees C). But this is assuming the ground is 5,000 ft *below*. If the ground *surface* is at 5,000 ft, then temperatures during a summer day can be much greater.

With the ground absorbing heat from the sun, surface temperatures can rise to 90 degrees F (32 degrees C) or even higher. The density altitude in that case is 8,200 ft. This is a significant decrease in air density. There is a specific formula to determine density altitude, given the actual pressure and temperature. Typical current tables and graphs, as well as digital devices and apps, have been produced for pilots to enter only pressure altitude and temperature to make the calculations easier for operational conditions.

When the combination of high elevation and high temperature produces a safety-significant decrease in air density, we refer to it as a high density altitude situation. The term could be misleading, though. It does *not* mean high density, just the opposite. It means the pilot will experience the low-density air typically found at high altitudes.

The air density has major effects on aircraft capabilities. First, it affects the performance of the reciprocating or turbine engine. The combustion that generates the engine's power is adversely affected by high density altitude, because there are fewer air molecules in the thinner air. Less air intake means less power


Tenzing-Hillary Airport in Lukla, Nepal, is used primarily for passengers on their way to and from Mount Everest. Its elevation above sea level is 9,200 ft (2,800 m).

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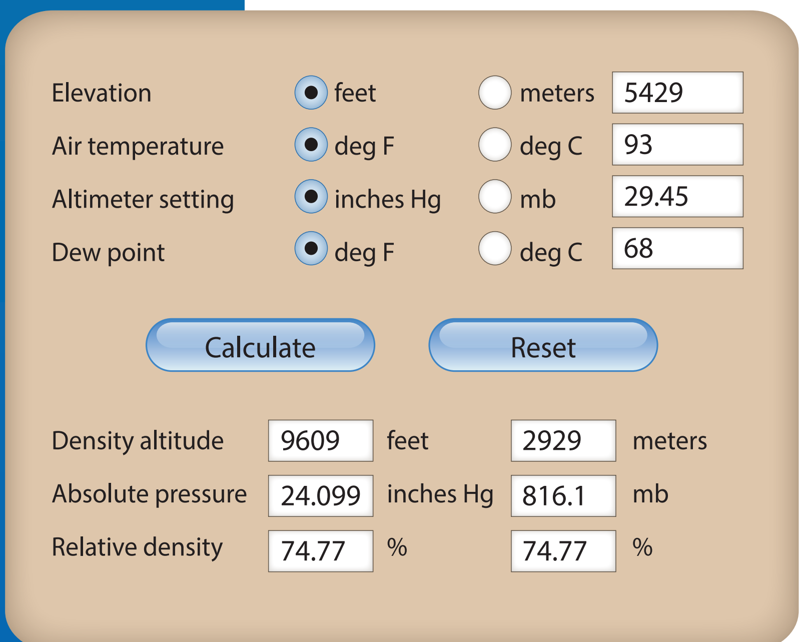
generated unless corrective measures are taken. Second, the thrust produced by a propeller, turbine blades or rotor blades is reduced due to the thinner air. And finally, the lift generated by the wings of airplanes or the rotor blades of a helicopter is a function of air density. In high density altitude conditions, less lift is produced.

High density altitude creates two significant effects on takeoffs. First, it takes longer for an aircraft to become airborne. In the worst case scenario, an airplane pilot can run out of runway before the plane lifts off, which can lead to a runway excursion. To avoid this, it is advisable to check the takeoff performance chart in the pilot's operating handbook.



A drawing of a typical online density altitude calculator.

Susan Reed

In addition, the climb rate after takeoff is reduced compared with low density altitude. The initial flight path is flatter than usual. This is of particular concern because at many high-altitude airports, the terrain rises quickly after the runway end. The U.S. Federal Aviation Administration (FAA) says that pilots should check the operational data section of the aircraft owner's manual or the pilot's operating handbook developed by the aircraft manufacturer to see how aircraft performance is affected by air density. In lieu of these sources, some pilots use the Koch chart, which relates altitude and temperature to takeoff distance and rate of climb. Pilots can check conditions at their location before takeoff and arrival and make the needed adjustments.

Problems with high density altitude are not restricted to takeoffs. For landings, the true airspeed is greater in thin air, even though the indicated airspeed is less. This can lead to excessive landing speed, increased rollout distance and the possibility of a runway excursion.

Even in cruise flight, problems can occur. In August 2006, a Piper PA-28R-2-1 Arrow was flying through mountainous terrain northwest of Salida, Colorado. The experienced pilot found himself trapped in a box canyon, unable to gain enough altitude to escape. The plane crashed, killing the pilot and seriously injuring the one passenger. Salida itself is at an elevation of 7,083 ft (2,159 m). Due to warm temperatures, the density altitude was over 9,000 ft (2,743 m).

In most incidents and accidents, there are a number of causal and contributing factors. At times, the combination of factors has exceeded the pilot's or flight crew's ability to break the causal chain of an accident, even when they respond as trained to a situation. In some of the events described above, the NTSB determined that the airplane was overloaded, which exacerbated the effect of the high altitude conditions. Financial concerns can tempt those in the aviation business to load to the maximum or even a little beyond. A sudden wind shift or a slight pilot miscalculation can also put the aircraft in jeopardy. In such cases, high density altitude can severely reduce the margin of error.

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.

Notes

1. NTSB SEA07FA223. <1.usa.gov/1eN9LdO>.
2. Civil Aviation Administration of China/Boeing, "High and Hot Operations" seminar, Oct. 23–25, 2007. <bit.ly/1eNa7Ry>.

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Rather than just a necessary cost of doing business, insurance can be a safety asset.

They've Got You COVERED

BY MARIO PIEROBON

Insurance pricing for air transport worldwide is subject to sudden and hardly predictable adjustments. The increase in premium costs after the Sept. 11, 2001, terrorist attacks and, more recently but less severely, after the June 2009 crash of Air France Flight 447 in the Atlantic Ocean illustrate how aviation insurance premiums can fluctuate because of unforeseeable events. Since the immediate aftermath of Sept. 11 — when insurance premiums reached levels eight to 10 times higher than today — premiums have considerably decreased, mostly because of the availability of huge financial capacity to absorb losses and strong competition.

Airlines voluntarily purchase insurance coverage or are required to by law because insurance is the most cost-effective financial risk protection against the consequences of major accidents. Airlines typically self-insure most of their non-catastrophic, attritional losses. Insurance contracts are generally written so that airlines pay any damage below agreed deductibles and insurers pay any damage above deductibles. To evaluate a risk and set a premium, insurers focus on various parameters of the airline such as number of aircraft, fleet value, age of aircraft, revenue passenger kilometers and area of operation.

Apart from collecting sufficient aggregate premiums to cover occasional major losses, insurers need to account for administrative costs and add a profit margin. Insurers tend to underwrite based on historical experience: If an insured party has had a major occurrence, premium charges tend to rise at policy-renewal time.

On the contrary, continuous improvement of an aircraft operator's risk profile because of the absence of losses or improvement in the overall safety standard may lead to premium decreases over time and consequently lower airline operational costs.

Learning From Insurance

The International Civil Aviation Organization's (ICAO) new Annex 19, Safety Management Systems (SMS) becomes applicable in mid-November, and regulators such as the European Aviation Safety Agency (EASA) already have clarified that SMS implementation will be required in Europe over the next few years. Risk-management policy and procedures of an SMS allow a structured way of identifying and handling all risks, particularly those that are unacceptable under all circumstances.

Risk management as a business practice distinguishes between all risks and those that can be kept under control by the organization, and only the mitigation of the latter is worth expending significant resources. Risk management, with cost-benefit analyses, allows for a measurement of the returns on investment from alternative control and mitigation options and so allows for efficient allocation of resources.[1]

Aligning the internal risk management approach with the external observations and experience of insurance providers can give airlines the benefit of an enhanced perspective for decision making.

Integrated Risk Management

As the International Air Transport Association (IATA) has noted, an airline is a "system of systems." Management teams must continuously adjust to dynamic financial, competitive and operational pressures that characterize the complex aviation environment.[2]

Integrated risk management (IRM; Figure 1, p. 30) is a principle derived from recent developments in risk management theory in the insurance industry and the financial world. It is "a systematic assessment and analysis of all risks in an organization." IRM analysis is conducted from the bottom up as well as the top down to provide all the information essential in determining a comprehensive view of risk. IRM provides significant input into the development of strategic plans, marketing initiatives, financial plans and resource investments, as well as airline safety.

Included is the assessment of risks that are common to most organizations — for example, strategic risk (market dynamics, resource allocation); financial risk (capital structure, liquidity, credit); operational risk (assets, people, technology); compliance risk (legal, regulatory, best practices); environmental risk (petroleum products, hazardous materials); corporate citizenship/image/reputation risk; and project risk.[3]

IRM is important in aviation because it provides the best framework for considering the connections among risks. As IATA has said, "In order to maximize the value of the organization, it is important to recognize that risks are interrelated and thus cannot be viewed and managed in isolation. As such, risk management is not a one-man show; it is a collaborative effort throughout the organization."[4]

Risk management integration (Figure 2, p. 31) can be seen as a multidirectional process in which any component can influence others. The visualization shown is derived from the Committee of Sponsoring Organizations of the Treadway Commission, a joint initiative of five private-sector organizations "dedicated to providing thought leadership through the development of frameworks and guidance on enterprise risk management, internal control and fraud deterrence."

The figure illustrates the value of strengthening the direct relationships between objectives — what an entity strives to achieve by strategy, operations, reporting and compliance and risk management, what is needed to achieve the objectives. These relationships can be visualized as a three-dimensional matrix. The risk-management components are represented by the horizontal rows, the organization's units by the vertical rows and the categories of objectives by the third dimension.[5]

Data Collection

The insurance industry continually performs statistical analyses of data collected to assess the risks that insurers underwrite. In the airline business, there was not always this level of sophistication in managing risk — and although many airlines already have adopted comparable predictive capacity, others still rely exclusively on qualitative (that is, non-data-driven) observations and experience.

Learning from the insurance industry's example, an airline willing to manage risks with state-of-the-art methods needs to start by developing (or refining) a system that includes routine flight data monitoring and a database of past safety occurrences (including near-misses and employee concerns) by which to assess the risks it faces. It must also develop systems to identify and implement risk-control measures.

The development or refining of the reporting system and of the database needs to account for data quality, and this is ensured only by a taxonomy.

If the aim is to generate consistent and repeatable results, the taxonomy used in the observational programs must be well defined, easily understood and applied by those responsible for recording the observations. The taxonomy's framework has to be in active use by personnel in terms derived from their operational language. It needs to support the human factors model of human error and to provide data that can support the SMS risk management components.[6]

Such database development and ongoing analysis by the airline is normally highly regarded by insurers, which especially are interested in data collection related to safety occurrences, monitoring mitigation outcomes and systematically addressing concerns of personnel. In fact, if the insurer considers the availability and quality of the airline's internal data sufficient, its normal scope of on-site investigation of claims in the case of minor occurrences or near-misses may be reduced, although results still could influence the insurer's risk profile of the operator.

Data collection is, however, a very sensitive area, said Reto Inderbitzin, CEO of Inderbitzin Comprehensive Solutions, a consultancy. "Everybody would agree on collecting data, but would be less enthusiastic if it comes to disclosure," he said. "Some other open questions with regard to data collection are what happens to the data collected, who benefits from the collection, if results are shared or kept under tight wraps and what the consequences for the discloser are.

"Nobody likes to admit inadequacies or issues within their area of accountability if they do not receive support in exchange for shared data regarding such issues. Establishing a data collection and sharing mechanism in an organisation with a 'just culture' might not be a big challenge. Other organizations are more reluctant to share such data. Data sharing is just the top of a sound and established safety culture within an organisation.

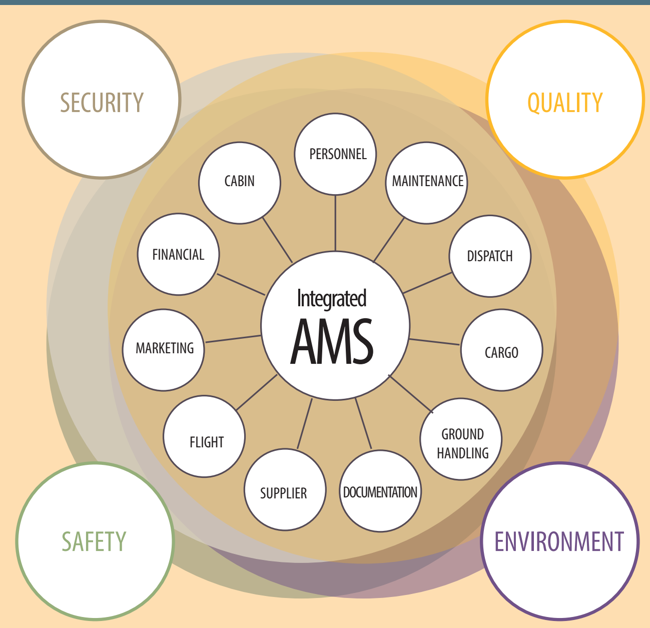
"In addition, performance analysis is an important management task of a properly working quality assurance process. Incidents and accidents are performance indicators. Some of them may even be safety performance indicators and therefore part of an overall safety performance assurance program. A company with a transparent and tangible safety culture would not hesitate to share the required information with its insurance partner and would most likely create increased appreciation and understanding."

Analytical Expertise

It is critically important in SMS that a reporting system and a safety database be suitable for the interpretation of collected data. One of the biggest challenges in this regard is "to acquire or train personnel who possess the skills and knowledge in these disciplines, and an understanding of the tools and analysis methods used in them," said SMS specialists Alan Stolzer, Carl Halford and John Goglia. "Unfortunately, these are not skills that the typical aviation manager currently has."[7]

To acquire and develop the analytical expertise needed, look at the measures used by the U.S. National Aeronautics and Space Administration (NASA) to enhance the agency's probabilistic risk assessment (PRA) expertise. PRA is one of the most sophisticated risk management analytical techniques in aerospace, established by NASA as a decision-making support tool following the 1986 Space Shuttle *Challenger* disaster.

An Integrated Airline Management System



AMS = airline management system

Source: International Air Transport Association

Figure 1

"Real PRA expertise cannot be developed overnight," a NASA document said. "If in-house experts do not exist initially they must be hired or groomed through training and transfer of technology. They have to be able to build PRA knowledge and experience and stimulate cultural changes so that the progressive organization can use these resources to make sound and cost-effective safety improvement decisions."[8]

The following steps have guided NASA in PRA development:

- "Transfer PRA technology to managers and practitioners as soon as possible;
- "Develop or acquire PRA expertise and state-of-the-art PRA software and techniques;
- "Gain ownership of the PRA methods, studies and results in order to use them effectively in the management decision process;
- "Develop a corporate memory of the PRA project results and data on which to build future capabilities and experience; [and,]
- "Create risk awareness in programs and projects that will eventually help to develop a risk-informed culture for all programs and activities."[9]

Negotiating With External Suppliers

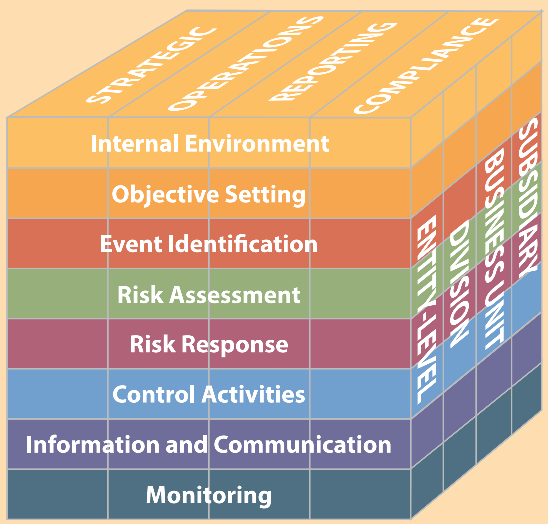
One area of great concern for airline risk managers is that in practice, third parties under contract are almost never liable for consequential damages to an airline's aircraft during the rendering of services such as ground handling. This status of things dates back several decades to when such services were usually provided by in-house companies under the same ownership and with the rigid bilateral agreements then in place, it meant that an airline was as likely to have an aircraft damaged overseas as it was to damage another airline's aircraft at its home base, said Ivar Busk, manager of insurance at SAS Scandinavian Airlines.

Very much as insurance contracts — covering only major losses and catastrophes — stimulate an airline to generate operating efficiencies to reduce more frequent minor losses, making service providers more accountable for the damages they cause can improve the quality and safety of contracted services.

"In my experience over the years, I have become convinced that if a ground service provider pays more of the damage, including consequential losses up to a certain limit, then we will see a more proactive engagement from the service provider. The difficulty is to value the consequential loss without going too far. It is therefore necessary to determine the quantum beforehand, such as a lost bulkhead per aircraft type. This will in the end lead to safer ground handling," said Busk.

In order to update the limits to the liability of ground handling companies to reflect current industry needs, the Association of European Airlines (AEA) has proposed to amend the IATA Standard Ground Handling Agreement. "The proposals from AEA have been presented to the IATA AGSA (ground handling contract group) but, not surprisingly, the requests were not accepted with immediate effect," said Busk. "Ground handling companies want to discuss the matter without any time constraint, but at least they recognize that some changes need to be done." The European Commission in its latest update of Regulation 261/2004 has expressed "that national law and contractual provisions may

Relationship Between RM Objectives and RM Components



RM = risk management

Note: The risk management components are represented by the horizontal rows, the organization's units by the vertical rows and the objectives' categories by the third dimension.

Source: Committee of Sponsoring Organizations of the Treadway Commission

Figure 2

not restrict the air carriers' right to seek compensation from a third party responsible for delays or cancellations. This provision aims to create an economic incentive for third parties to find ways to reduce traffic disruption." This is in line with what airlines want to see implemented, said Busk.

Long-Term Partnering

Airline safety directors and their risk managers can benefit from knowledge that today's considerable competitiveness in the aviation insurance market, characterized by a strong availability of capital as noted, has motivated several aviation insurance providers to launch collaborative services to enhance risk management. This is an attempt to develop a more stable and longer-term partnership with client airlines, instead of these airlines shopping for the lowest premium deal every 12 months.

"Global Aerospace Underwriting Managers, for example, runs a program called SM4 which allows its customers to attend safety assurance and risk prevention seminars," said Inderbitzin. "The benefit is not specifically that of a reduced insurance premium, but of obtaining up-to-date know-how from high-level speakers and recognized industry experts, and also nurturing a network of personal contacts which would otherwise be hard to develop. Putting this learning opportunity into the context of a long-term business relationship, the program provides the customer with a more solid outcome than selecting insurance coverage upon premium level only."

But long-term partnership with an insurance provider typically does eventually offer benefits in terms of premium costs. "If an insurer knows how the client is organized and that it is operating to recognized standards, it would then be more flexible with regard to individual premiums," said Inderbitzin. "It is all about the relationship. Professional insurance brokers who are acting on behalf of airlines develop and maintain an interrelationship to achieve a trustworthy and efficient day-to-day contact, which will eventually also assist in [case of] a claim."

International Safety Standard

Achieving a recognized registration such as under IOSA (IATA Operational Safety Audit) or IS-BAO (International Standard for Business Aircraft Operations) is generally positively regarded by underwriters. The International Business Aviation Council (IBAC) reports that "approximately one-third of IS-BAO registered operators report significant insurance savings as a result of registration, and the number is growing."[10]

Inderbitzin has a similar perspective when airlines and business aviation operators come to negotiate insurance contracts. "Although I cannot speak for all the insurers, as each one has its own individual perception, it is certainly a positive element to recognize an organization which has demonstrated its compliance to standards like IS-BAO or IOSA," he said.

Carl Norgren, formerly an airline training captain and currently an aviation safety consultant, added, "Especially in comparison to other operators in the non-commercial or corporate aviation sector, where the regulator relies on individual accountability rather than a stringent set of regulations or standards, an accreditation is a visible and comprehensible commitment to safety and risk management standards recognized and accepted worldwide."

Open Opportunity

More than 20 years ago, to implement quality management systems, expertise was brought into the airline sector from the manufacturing industry. Today, risk management expertise is required for the full functionality of an SMS, an area in which insurance companies as well as risk management consultants should be invited to contribute.

Senior airline managers and risk managers have a unique opportunity to exploit today's strong competition in the aviation insurance market, which already is making a wealth of risk management expertise, tools and methods more accessible to airline partners.

Mario Pierobon works in business development and project support at Great Circle Services in Lucerne, Switzerland.

Notes

1. ICAO. *Safety Management Manual*. 2009.
2. IATA. *Integrated Airline Management System for Air Transport — Operators*. 2007.
3. Ibid.
4. IATA. *Integrated Risk Management Guidance Manual*. 2010.
5. Committee of Sponsoring Organizations of the Treadway Commission. *Enterprise Risk Management/Integrated Framework (Executive Summary)*. September 2004.
6. Stolzer, A.; Halford, C.; Goglia, J. *Safety Management Systems in Aviation*. Farnham, Surrey, England, and Burlington, Vermont, U.S.: Ashgate. 2008.
7. Ibid.
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The operator's financial predicament prompted its founder to continue a medical flight into IMC, the NTSB says.

U.S. National Transportation Safety Board

BY LINDA WERFELMAN

pressing concerns

The founder and president of a charter operation succumbed to self-induced pressure to complete the flight of a Mayo Clinic doctor to procure a heart for transplant when he flew his Bell 206B into instrument meteorological conditions (IMC) and crashed, the U.S. National Transportation Safety Board (NTSB) says.

The pilot, the doctor and a medical technician were killed when the helicopter struck the ground near Green Cove Springs, Florida, at 0554 local time on Dec. 26, 2011.

In its final report on the accident, the NTSB attributed the crash to "the pilot's improper decision to continue visual flight into night [IMC], which resulted in controlled flight into terrain."

The report cited as a contributing factor the pilot's self-induced pressure, which stemmed largely from millions of dollars in financial losses related to the downturn in the national economy and the knowledge that the Mayo Clinic — his largest customer — had been "identifying other aviation companies that might better fulfill its needs."

Therefore, the report added, "the pilot would have been highly motivated to complete trips as requested so that he could demonstrate

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the reliability of his service. … The pilot likely wanted to make the most of every revenue-generating opportunity."

Flight Request

The pilot received a call from a company scheduler about 0335 informing him of the clinic's request for a flight from the Mayo Clinic Heliport in Jacksonville to Shands Cair Heliport in Gainesville, about 60 nm (111 km) southwest. A few minutes later, he reviewed weather reports for airports along the flight route, and at 0423, he arrived at Northeast Florida Regional Airport (SGJ) in St. Augustine.

He left SGJ about 0517 for Jacksonville and arrived about 0530 after an uneventful repositioning flight. He picked up his two passengers and departed, contacting air traffic control at 0549. Over the next few minutes, the helicopter's altitude varied from 450 to 950 ft above ground level, with calibrated airspeed between 100 and 110 kt.

The last three radar returns indicated that the helicopter had turned right about 45 degrees and descended about 300 ft, nearly on a direct course to Shands Cair. The accident site was about 0.5 nm (0.9 km) south of the last radar return.

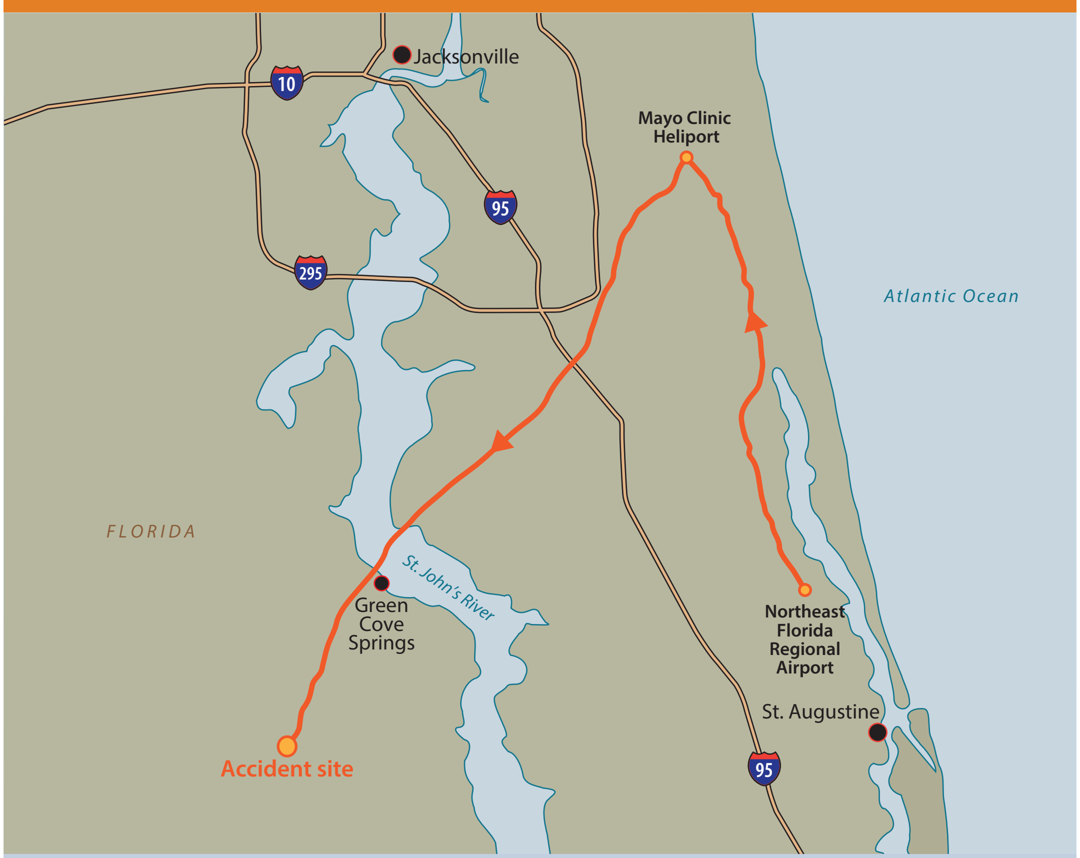
When the helicopter failed to arrive at Shands Hospital, it was reported overdue, and search and rescue operations began. The wreckage was found about 1000 in a remote wooded area.

Founder, President and Pilot

The 68-year-old pilot — also the founder, president, owner and director of operations of SK Jets — had learned to fly when he was 16 and held an airline transport pilot certificate with ratings for single- and multi-engine airplanes, and a commercial pilot certificate and flight instructor certificate with ratings for rotorcraft and instrument helicopter. He had 11,343 flight hours, including 3,646 hours in helicopters and 1,648 hours in Bell 206s. His total time included 3,288 hours of night experience and 3,259 hours of instrument experience. He had flown 10.7 hours, including 3.1 hours at night, in the 90 days before the accident and 2.5 hours, including one hour at night, in the 30 days before the accident; none of that flying involved instrument time. He did not fly during the seven days before the accident.

He had been the pilot of an earlier

Bell 206B Flight Path



Source: U.S. National Transportation Safety Board

Figure 1

The Bell 206B crashed in a wooded area near Green Cove Springs, Florida, after flying into night instrument meteorological conditions.

U.S. National Transportation Safety Board

accident flight involving an Agusta A109 that departed from St. Augustine on Dec. 22, 2007, and was cut short because of a 400-ft ceiling and 2.5-mi (4.0-km) visibility. The helicopter was substantially damaged when its tail rotor struck trees during the return to the fuel pump area. The accident was not reported to the NTSB until Jan. 15, 2008, and the agency noted conflicting reports on whether it occurred during the helicopter's approach to the departure airport or while taxiing.

"According to current and former employees at SK Jets, a different helicopter pilot had turned down the flight due to the poor weather," the report added. "Following that accident, the [accident] pilot successfully completed an FAA reexamination."

The accident helicopter was manufactured in 1979 and had accumulated 11,173 total hours. The helicopter was maintained in accordance with an FAA-approved manufacturer's maintenance program, and its last inspection before the accident was completed Dec. 1. It was flown 3.5 hours after that inspection before the accident.

The Rolls-Royce (Allison) 250-C20B turbine engine had accumulated 11,054 hours total time and 167 hours since an overhaul in 2005, when it was installed.

The helicopter was not certified for instrument flight rules flight and not equipped with a radio altimeter or autopilot. It had a global positioning system (GPS) receiver and a VHF omnidirectional range unit that provided localizer and glideslope indications, but the GPS had not been upgraded to provide terrain/obstacle warnings.

Weather Data

There was no indication that the pilot had contacted a U.S. Federal Aviation Administration (FAA) Flight Service Station for weather information before the flight, but his laptop computer had been opened to an aviation weather website, indicating that he had viewed aviation routine weather reports and terminal area forecasts (TAFs) for the airports along his planned flight route. The service he used was not among those approved in SK Jets operations specifications.

Closer to his departure time, he called the Gainesville automated surface observing system, which was reporting 7 mi (11 km) visibility and a broken ceiling of 1,400 ft.

Information current at the time of his search of weather data reported visibility of 10 miles at SGJ; at Craig Municipal Airport, about 7 nm (13 km) northwest of the Mayo Clinic Heliport; and at Gainesville Regional Airport, 5 nm (9 km) northeast of the destination heliport. Ceilings were reported at 7,000 ft at SGJ and Craig and 1,600 ft at Gainesville.

By the time the helicopter departed from SGJ, there was a broken ceiling at 900 ft. At 0553, the ceiling at Craig had dropped to 700 ft. The TAF at Gainesville for the flight's estimated time of arrival at Shands Cair called for visibility of more than 6 mi (10 km) and an overcast ceiling of 800 ft, with a "temporary condition" around the arrival time of IMC, with 4 mi (6 km) visibility, mist and an overcast ceiling of 400 ft.

Airmen's meteorological information in effect at the time of the accident warned of IMC with mist and fog. Satellite images at 0602 — the time closest to the accident — showed low clouds and stratus over the site.

The report said that a former SK Jets helicopter pilot told accident investigators that the area near the accident site was swampy and "susceptible to fog.

"He added that once fog developed, the area was a 'black hole' at altitudes of 200 to 400 ft agl [above ground level], and a flight in these circumstances was effectively in IMC."

The SK Jets general operations manual specified visual flight rules night weather minimums of a 1,000 ft ceiling and 3 mi (5 km) visibility, "unless otherwise approved by the director of operations or chief pilot." There was no restriction preventing the accident pilot — also the director of operations — from approving his own deviation from the policy.

The report noted that U.S. Federal Aviation Regulations Part 91 prohibits helicopter flight in Class G uncontrolled airspace at or below 1,200 ft at night unless visibility is at least 1.0 mi (1.6 km).

Other company pilots said that, although they would have accepted the flight, based on the weather reports, they also would have had a back-up plan, such as using ground transportation, in case the flight could not be completed.

There was no record that the accident pilot had made such arrangements, the report said, noting that helicopters were the preferred method of transportation because "shorter transportation times increased the odds of a successful operation."

SK Jets had a flight risk analysis tool (FRAT) that called on pilots to complete preflight forms designed to determine whether a flight should be canceled because of risks, but one pilot told investigators that he did not use the forms "because the grading criteria typically yielded such low risk scores that they would never result in a flight being canceled," the report said. A FRAT form was not found for the accident flight.

Company History

SK Jets was founded by the accident pilot in 1997 and, at the time of the accident, had four airplanes and three helicopters, including an A109 that had been down for maintenance for four months. The accident helicopter had been leased to the company several days before the accident.

The company ended flight operations and filed for bankruptcy protection in February 2012.

A former director of safety, director of maintenance, chief pilot and others told NTSB investigators that they had no particular safety concerns and believed that the company had a positive safety culture. Former company pilots said that they were "not worried about repercussions for making safety-oriented decisions," the report said, and the most recent FAA principal operations inspector (POI) said SK Jets seemed to be a "normal" operator.

However, two former company pilots who had witnessed the 2007 accident said they had concerns about the company's safety culture.

"They cited management efforts to cover up the [2007] accident and threats of retribution that they experienced for reporting the accident to the FAA," the report said, noting that both pilots — one of whom flew airplanes and the other, helicopters — had left the company about three years before the 2011 crash.

"The former company fixed-wing pilot said that, when company managers discovered that he had reported the accident to the FAA, they assigned him more difficult work schedules and pressured him to fly in situations that made him feel unsafe. He further stated that if pilots refused such flights, the company would fire them and make them repay their training expenses. He added that the chief pilot and general manager tried to intimidate younger pilots by threatening to provide negative reports to future employers."

The former helicopter pilot said that company pilots were "always on call, and managers urged them to falsify duty time records to indicate that they had received rest periods when they were not flying." The former airplane pilot added that pilots were "retroactively considered to be in a rest period when not called for a flight" while on call.

A former FAA POI said that he had received pilot complaints about scheduling and had told managers that they "could not continuously keep pilots on duty," the report said. The company subsequently instituted a rotating duty schedule, and he heard no further complaints about the issue. He added, however, that pilots who left the company had numerous complaints about how it was operated; when he asked managers to make changes, they complied.

The former airplane pilot also told investigators that pilots had been told not to use aircraft logbooks to note maintenance issues. "They had been advised to instead write up issues on adhesive notes and leave them inside the logbooks so that the company could decide when and if it would address the maintenance issues," the report said.

Recession

Pilots and managers who worked at SK Jets at the time of the accident blamed the economic recession, which began in 2008, for a decline in business. During the bankruptcy filing that followed the accident, the company indicated that it had lost several million dollars in the three years before the crash, and that it had $1.3 million in assets and $9 million in debt.

Mayo Clinic representatives had noticed the delays in aircraft maintenance, including the A109 that had been down for maintenance since August 2011, and an official said that he was "concerned about the company's finances because of its apparent inability to service aircraft in a timely manner." As a result, he had identified other companies that "could better fulfill the Mayo Clinic's air transportation needs"; the accident pilot was aware of his concerns and had scheduled a meeting with him in January 2012 to discuss Mayo's requirements, the report said.

This article is based on NTSB accident report ERA12MA122 and supporting docket information. The report is available at <www.ntsb.gov>.

Putting Fatigue to a Vote

BY LINDA WERFELMAN

European Parliament approves changes in flight and duty time limits.

Voting amid a flurry of pilot fatigue studies and flight crew surveys, the European Parliament has approved a plan intended to strengthen and standardize flight and duty time limitations (FTL) and rest requirements for pilots and cabin crewmembers.

Parliament's support for the new plan took the form of a vote in early October in which it rejected — 387–218, with 66 abstentions — a recommendation from its own Transport and Tourism Committee to disapprove the package of changes. The committee had sought to return the matter to the European Commission (EC) to develop an alternative package with greater protections against crew fatigue.

"Every single national safety regulator supported these measures," Brian Simpson, chairman of the committee and a supporter of the plan approved by Parliament, said during the parliamentary debate.

The changes will "bring a series of clear safety improvements in crew protection against fatigue," according to the European Aviation Safety Agency (EASA), which developed the plan.

European Union (EU) Vice President Siim Kallas praised Parliament's vote as "a victory for common sense."

But critics, including pilot organizations, said the new requirements will not do enough to limit pilot fatigue.

The measure includes provisions to reduce the allowable length of night flight duty to 11 hours, down from 11 hours and 45 minutes; to reduce allowable flight time in 12 consecutive months to 1,000 hours, down from 1,300 hours; and, twice each month, to increase weekly rest

by 12 hours — to two days, up from one-and-a-half days. In addition, combined airport standby time and flight duty time will be limited to 16 hours; current policies differ among member states, some of which impose no limit. Another provision will allow up to five days of rest at home base in case of flights involving "significant time zone crossing"; current provisions allow two days of rest or, in some member states, less.

The effort to modify FTL regulations began more than five years ago, EASA said, noting that the agency will now begin working with representatives of pilots, cabin crews, airlines and national aviation authorities on details of implementing the changes.

The next step is for the EC to formally enact the regulations, which will begin to take effect at the end of the year and will become fully applicable in 2015.

EASA Executive Director Patrick Ky said Parliament's vote means that "Europe now has one of the strictest FTL rules in the world." His agency will "continue to pursue its objective to promote the highest safety standards in civil aviation."

Before the vote in Parliament, Kallas, a leading proponent of the changes, complained that opponents had invoked "misleading scare stories and false claims" in their campaign against the new regulations.

But both advocates of the newly approved package of changes and critics said they were motivated by safety concerns and a desire to limit fatigue in the cockpit.

'Safety Loopholes'

The European Cockpit Association (ECA), which represents 38,000 pilots in national pilot associations in 37 European states, complained that Parliament's support for the changes was "not a 'victory for common sense'" but rather "a victory for in-transparency, commercial interests and short-sightedness."

Philip von Schöppenthau, secretary general of the ECA, added, "The rules have been rushed through the EU Parliament after the … transport committee firmly rejected them. Europe has lost a unique opportunity to be a forerunner on flight safety, to have safe, science-based rules, based on best practices."

The ECA said the new rules are plagued by "safety loopholes" that could actually allow night flights of 12 hours and 30 minutes and situations in which pilots complete flights after being awake for 22 hours or more.

"With this approval, the [Parliament] took a step away from a precautionary approach, ignored scientific expert advice and put passenger safety at risk," ECA President Nico Voorbach said.

The British Airline Pilots Association (BALPA) asked the government in the United Kingdom not to approve the measure, which BALPA says represents a weakening of existing U.K. safety standards.

'Greater Oversight'

The U.K. Civil Aviation Authority (CAA), however, said that it "welcomed a decision by the European Parliament to support harmonised flight time limits for pilots across Europe and give regulators far greater oversight of fatigue."

The CAA added that, under the new regulations, national aviation authorities will have an enhanced role in monitoring pilot fatigue, and will have access to relevant airline flight data.

National aviation authorities will have an enhanced role in monitoring pilot fatigue.

"This will allow regulators to analyse roster and shift patterns to identify problems on specific sectors or routes," the CAA said.

CAA Chief Executive Andrew Haines added, "Pilot fatigue is a real risk in the aviation industry, and we take the management of fatigue very seriously. Fatigue has multiple causes and must be managed in a practical, hands-on way, not simply by asking airlines and pilots to comply with a set of timetables. Responsibility for managing fatigue is three-fold: effective regulation, proactive management by airlines and professional behaviour and reporting by pilots."

The CAA also said that it plans a research project to increase understanding of the causes of fatigue.

'Crucial Milestone'

Organizations representing European airlines praised Parliament's approval of the new regulations.

The Association of European Airlines (AEA) characterized the vote as a "crucial milestone in Europe's aviation safety."

AEA Acting Secretary General Athar Husain Khan noted that the AEA "has been constantly supporting the proposal" and credited members of the European Parliament with recognizing that "one harmonized set of rules for the common aviation market will benefit passengers' safety."

Simon McNamara, director general of the European Regions Airline Association, called the Parliament's action "excellent news."

Admitting to Fatigue

Parliamentary action followed the publication of a number of reports on fatigue among airline pilots.

One of the most recent was a report on a 2012 survey of Portuguese airline pilots that said that more than 90 percent reported having made fatigue-related mistakes in the cockpit, and two-thirds said that they had more than once been so tired that they should not have been at the controls (Table 1).[1]

The report, published in the August issue of *Aviation, Space, and Environmental Medicine*, was based on responses to a survey that was distributed to the total population of 1,500 commercial airline pilots working for Portuguese airlines. Researchers obtained what they considered to be 456 valid responses from survey recipients who were commanders (captains) or first officers between the ages of 20 and 65 who were on active duty and had flown during the previous six months.

Although they admitted having been fatigued in the cockpit, 82 percent of those questioned said they had never reported themselves as "unfit for flight as a result of accumulated fatigue," and 11 percent said they had done so only once, the report said.

Pilots also were asked to assess their fatigue using the nine-item Fatigue Severity Scale, developed to evaluate fatigue associated with a multitude of medical disorders. Pilots who flew medium- and short-haul flights — those less than six hours long with multiple segments — reported higher levels of fatigue than those who

Perception of Fatigue*

Question	Never	Once	Few Times	Frequently
Do you feel so tired that you think you should not be at the controls?	60 (13.2%)	87 (19.1%)	234 (51.3%)	75 (16.4%)
	Yes	**No**		
Has it ever happened that you have made mistakes in the cockpit as a direct consequence of fatigue?	417 (91.4%)	39 (8.6%)		
	Never	**Once**	**Few Times**	**Frequently**
Have you ever reported yourself unfit for flight as a result of accumulated fatigue?	372 (81.6%)	50 (11%)	28 (6.1%)	6 (1.3%)
	Minimum	**Maximum**	**Mean + or - SD**	
How many human factors confidential reports have you made in the last six months?	0 371 (81.4%)	14 1 (0.2%)	0.38 + or - 1.15	

SD=standard deviation
*Based on responses in 2012 from 456 captains and first officers for Portuguese airlines.

Source: Reis, Cátia; Mestre, Catarina; Canhão, Helena. "Prevalence of Fatigue in a Group of Airline Pilots." *Aviation, Space, and Environmental Medicine* Volume 84 (August 2013): 828–833.

Table 1

flew long-haul flights — those lasting longer than six hours but typically consisting of no more than two segments, the report said.

Common Problem

An earlier collection of pilot fatigue studies — assembled by the ECA in its 2012 *Barometer on Pilot Fatigue*[2] — concluded that "pilot fatigue is common, dangerous and an under-reported phenomenon in Europe. … It is more widespread than expected, and, at the same time, it is significantly underreported by pilots themselves."

The document cited studies conducted between 2010 and 2012 by ECA member associations in Austria, Denmark, France, Germany, the Netherlands, Norway, Sweden and the United Kingdom. The studies surveyed more than 6,000 European pilots, asking them to assess the level of their fatigue.

More than half of those questioned said that their fatigue interfered with "their ability to perform well while on flight duty," the report said.

"A common indicator of the problem is that fatigued pilots are prone to fall asleep or experience episodes of micro-sleep in the cockpit. In the U.K. (43 percent), Denmark (50 percent), Norway (53 percent) and Sweden (54 percent), the surveyed pilots reported falling asleep involuntarily in the cockpit while flying. In the U.K., a third of the pilots [were] said to have woken up finding their colleague sleeping as well. Sixty-five percent of Dutch and French pilots stated they have trouble with 'heavy eyelids' during flight."

More than 80 percent of German pilots, and more than 60 percent of those in Sweden, Norway and Denmark, said they had made mistakes because of fatigue, the report said.

Nevertheless, most of the pilots questioned in the eight surveys said they would not report the problem to their employers or declare themselves unfit to fly because of their fatigue, the report said, adding that the pilots feared "disciplinary actions or stigmatization by the employer or colleagues."

In the survey of U.K. pilots, nearly one-third of respondents said that they had not reported their fatigue "because they were too tired to file a report." Forty-one percent said they "could see no benefit in doing so," 14 percent "did not want to make a fuss," and 13 percent "did not want the management to have a less positive opinion of me."

The report added, "Another striking aspect is that those who have already filed a report do not feel motivated to do it again. It could either be because they have already felt negative consequences or have seen no results."

'Pilot fatigue is … significantly underreported by pilots themselves.'

The report said that the national surveys confirm the findings of previous scientific and medical researchers, who identified types of flight operations that have the strongest association with fatigue — for example, "night duties, disruptive schedules, long flight duties and long work days (e.g., standby plus flight duty)."

The report cited, in addition to recent accidents in which pilot fatigue has been singled out as a probable cause or a contributing factor, a May 2012 event in which an Air Berlin flight crew made an emergency landing in Munich because of pilot fatigue. The report did not discuss details of that event, but published reports at the time said that the German air accident investigation bureau reviewed the May 5 request for clearance to land by the Airbus A330 pilots, who had told air traffic control that they wanted to land as soon as possible because they were feeling "extremely fatigued" as they approached Munich after a flight from Palma de Mallorca, Spain. They landed 12 minutes after they made the request.[3]

Notes

1. Reis, Cátia; Mestre, Catarina; Canhão, Helena. "Prevalence of Fatigue in a Group of Airline Pilots." *Aviation, Space, and Environmental Medicine* Volume 84 (August 2013): 828–833.
2. Available at <www.eurocockpit.be/stories/20121105/barometer-on-pilot-fatigue>.
3. Gubisch, Michael. "Air Berlin Crew's Fatigued Distress Call Faces Safety Probe." *Flightglobal*, June 25, 2012. < bit.ly/19AEdCe>.

Trees in the FORAS

BY DANNY C. HO, CHI-BIN CHENG,
HUAN-JYH SHYUR AND MICHAEL HADJIMICHAEL

Custom-designed logic trees in FORAS models focus one airline's risk assessment before hundreds of daily departures, approaches and landings.

During the September 1997 meeting of the Icarus Committee, an expert team affiliated with Flight Safety Foundation, members agreed to form the Safety Index Working Group to develop a safety-metrics model with which an airline can monitor and measure operational safety performance. The model developed into a software system called the Flight Operations Risk Assessment System (FORAS).[1]

The goal in developing FORAS was to create a quantitative index for proactively assessing aviation risk, focusing on the recognition of risk factors involved in aviation safety instead of emphasizing accident rates. Full technical details were published in 2009.[2] FORAS developers adopted a mathematical model to synthesize a variety of inputs (risk factors), including information on crew, weather, management policy and procedures, airports, traffic flow, aircraft and relevant operations.

In FORAS, risk assessment is tackled with a divide-and-conquer strategy. A given risk category is broken down into a small set of sub-risk categories, and each sub-risk is further broken down to a set of risk measures. This process terminates when directly measurable risk factors (operational data) associated with a flight are obtained. This scheme enables knowledge domain experts to deal with a small number of risk factors at a time, reducing the complexity of their work.

The FORAS model contains a great number of risk factors; to illustrate, only a small portion of the FORAS model dedicated to approach and landing risk value (ALRV) assessment is presented (Figure 1, p. 43). The ALRV assessment is broken down into three sub-groups: crew functionality, aircraft functionality and sector threat.

These sub-risks are further subdivided into more detailed sub-risks. For example, crew functionality includes inter-crew communication, pilot experience and pilot fatigue. As noted, the automated breakdown process continues until all measurable risk factors are obtained — in this example, experience pairing, rank composition and communication proficiency. These data are available from the airline's crew and roster databases.

FORAS Model Development

In 2005, EVA Airways collaborated with Michael Hadjimichael (then working at the U.S. Naval Research Laboratory) to develop the first practical application of the FORAS model to monitor the approach and landing risk of each flight. An EVA

Airways team interviewed pilots, safety managers, dispatchers and maintenance engineers and discussed the risk factors that contribute to approach and landing risk and the relationships among these risk factors. The FORAS model for assessing this risk then was successfully implemented at EVA Airways as an online system.

Currently, the approach and landing risk of each flight is computed by FORAS two hours and 30 minutes before its departure, and the resulting risk value is shown on a Web-based interface. During its years of experience in using the FORAS model, EVA Airways has gained insights about the causal relationships among risk factors and their contribution to approach and landing risk. This experience also identified a need to revise the original model.

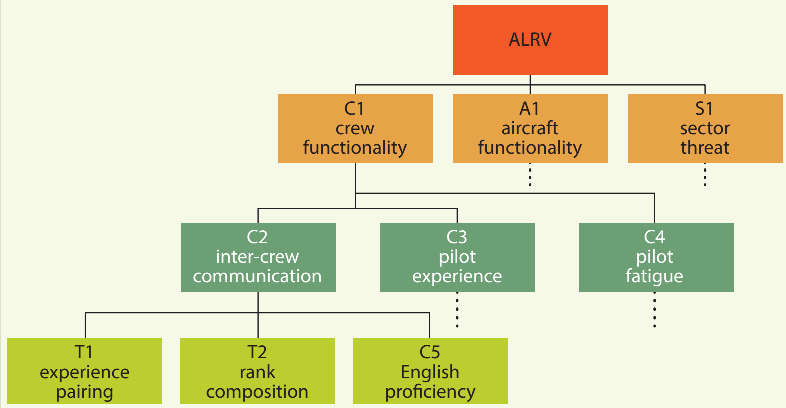
In 2009, EVA Air launched a research project with the Department of Information Management of Tamkang University, to revisit the risk factors and develop a new software system that allows users to construct a new model or change an old model easily. The new software system has been implemented online at EVA Airways and offers great flexibility and convenience whenever the system administrator needs to revise the model.

A Two-Part System

The FORAS software model application is composed of two parts, called the back-end system and the front-end system (Figure 2). The back-end system provides a user-friendly interface for the user to construct a FORAS tree as required by the model (Figure 3, p. 44).

Each node in the tree represents a risk factor and is associated with a set of parameters that specify the node's characteristics. The information is used in online reporting and risk assessments. The back-end system uses information from the model to identify legal input data (that is, data conforming to software-embedded rules), parameters for which missing input data are acceptable and parameters that are controllable. When missing data are allowed, risk-index computation proceeds with default values. Controllable parameters are variables that may

Small Portion of the FORAS Model for Approach and Landing Risk Assessment

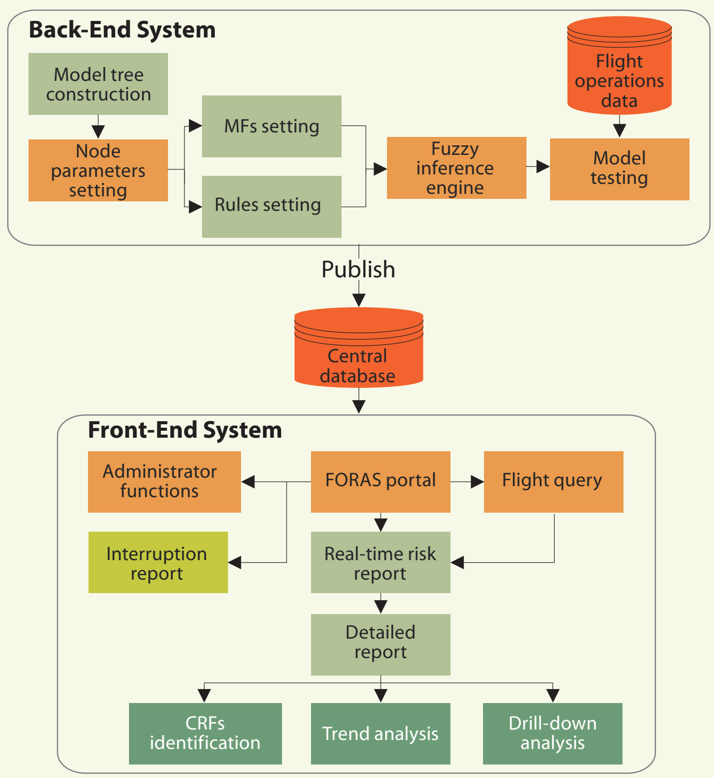


ALRV = approach and landing risk value; FORAS = Flight Operations Risk Assessment System

Source: Chi-Bin Cheng and Huan-Jyh Shyur

Figure 1

FORAS System Architecture

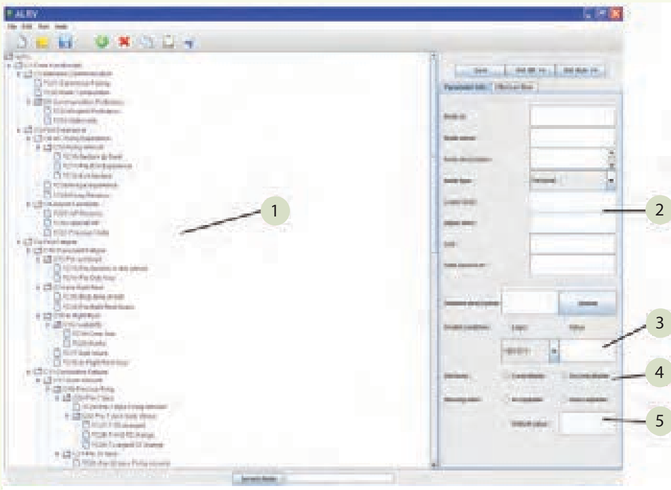


FORAS = Flight Operations Risk Assessment System; MF = membership function
CRF = critical risk factor

Source: Chi-Bin Cheng and Huan-Jyh Shyur

Figure 2

Model Construction Interface



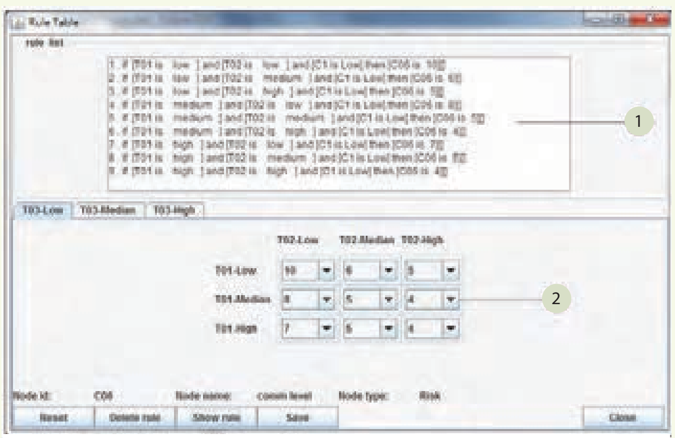
1 Model tree 2 Data range 3 Invalid condition

4 Attribute (controllable/uncontrollable) 5 Missing data default value

Source: Chi-Bin Cheng and Huan-Jyh Shyur

Figure 3

Rule-Setting Module



1 Rule setting in a list format 2 Rule setting in a table format

Source: Chi-Bin Cheng and Huan-Jyh Shyur

Figure 4

be controlled by flight dispatch or by a scheduling action to decrease flight operation risk. These possibilities include crew and aircraft factors. Weather is an example of an uncontrollable factor.

The risk-assessment functionality in the FORAS model is obtained by a series of inference procedures moving upward from the bottom level of the user-constructed tree to the top. Taking Figure 1 as an example, the risk value of inter-crew communication is inferred from three risk factors — experience pairing, rank composition and English proficiency; in turn, the risk value of crew functionality is inferred from inter-crew communication, pilot experience and stress level.

Finally, the ALRV is inferred by the FORAS model from crew functionality, aircraft functionality and sector threat. This logical inference procedure is based on a conditions-consequence relation, also referred to as a causal relation. For example, in inferring the inter-crew communication risk (a consequence), experience pairing, rank composition and English proficiency are the determining conditions.

The Rules

In each airline's FORAS model, the relation between a condition and a consequence is expressed by rules. A rule is used to describe the degree of the resulting risk under various conditions of its causes, and such conditions are assessed in a linguistic manner.

As an example of the simplified user-interface language of the FORAS model, a typical rule — in this case, part of a logical assessment of the inter-crew communication risk — would be, "If T1 is experienced, T2 is ideal and T3 is poor, then C2 is 4."

In plain English, that means, "While planning a specific flight, if the airline safety specialists rank the condition called flight crewmember *experience pairing* (T1) as 'experienced' (from their predefined scale of possible ratings); they rank the condition called flight crew *rank composition* (T2) as 'ideal'; and they rank the condition called flight crew *communication proficiency* (T3) as 'poor,' then the FORAS model must use the value "4" wherever the inter-crew communication risk value is required in the model's trees and algorithms. In this way, that risk value — selected by the specialists using a predefined scale from 1 to 10 (the greater the number, the higher the risk) — will be applied consistently by the FORAS model, representing the specialists' overall perceived risk value for inter-crew communication.

The formulation of such rules is based on experts' knowledge and group decision making. Rules of this type have the advantage of being easy to express and understand for the knowledge-domain experts from whom the knowledge base is derived. In particular, evaluating conditions in a linguistic manner alleviates the difficulty of quantifying an uncertain or subjective judgment that doesn't lend itself to precise numerical expression.

The back-end system contains a rule-setting module, where the setting of rules can be in either a rule format or a table format (Figure 4, p. 44).

Rules Into Equations

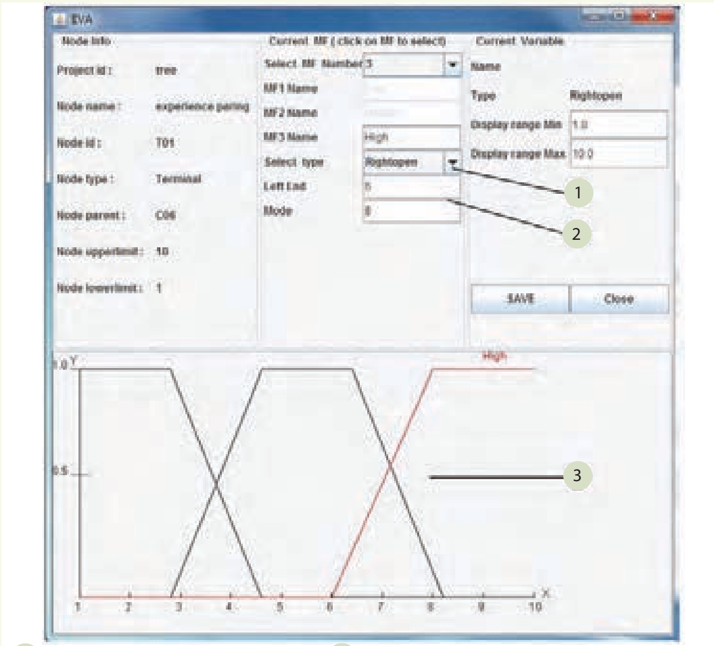
The last thing needed to make such rules work together in risk assessment is to define mathematical equations that quantify the linguistic terms in the rules. This definition of equations is based on the values of the conditions, which the FORAS model's designers call the *membership function of the risk factor*. Membership functions interpret the airline's plain-language linguistics terms (such as "high experience") as specific numerical input values.

The back-end system in the FORAS software also contains a module for membership function–setting, where typical functions are provided and presented in a graphic form (Figure 5).

After a FORAS tree has been built by the airline using the back-end system, it is "published" to a central database. The front-end system then retrieves the tree and its associated parameter settings (input data) from the database to compute the risk value of a flight. This risk assessment of a flight is computed two hours and 30 minutes before its takeoff.

In a snapshot of the online risk report of actual flights (Figure 6, p. 46), various "traffic light–style" signals clearly indicate the risk status of a flight (a green light means *Normal,* yellow means *Warning* and red means *Alert*). If desired, the user can click on the computer display of the flight to read a detailed risk report that lists the risk values of all nodes in the tree associated with that flight. On this screen, users can also request further analysis, including a drill-down analysis, a trend analysis of the risk of interest and a critical risk factor analysis that identifies which factor contributes most to the risk of interest (Figure 7, p. 46).

Membership Function–Setting Module



1 Types of membership functions 2 Membership function parameter setting
3 Membership functions in graphic form

Source: Chi-Bin Cheng and Huan-Jyh Shyur

Figure 5

EVA Airways' Risk Assessment

EVA Airways so far has constructed two FORAS models to construct two risk assessment models, one for routinely assessing approach and landing risk and one for assessing departure risk. Both models are run online for about 200 flights every day worldwide.

Based on FORAS reports, safety managers evaluate the overall level of risks for these aspects of their operations, and analyze the effects of management decisions on this risk level. With the trend analysis function of the system, managers can track various risks over time. The critical, risk factor–identification function assists the safety managers to identify the risk factor that contributes most to the risk of interest. Theoretical concepts and implementation issues of this system were presented at an FSF International Air Safety Seminar in 2011.[3]

The EVA Airways' software application of the FORAS model is installed on a cloud-computing platform to enable sharing FORAS models within the airline industry in the future. The plan is to establish a community-computing, cloud-based system, run by a third-party non-profit organization, with a multi-tenant infrastructure shared among several organizations with common computing interests.

The authors envision customized FORAS models constructed and maintained on the cloud platform, and that individual airlines will access the risk-assessment service by securely sending encoded flight data to the cloud platform. For data security, the cloud platform would not keep the flight data or their computational results. Users could customize their risk models (including trees) by setting model parameters via a Web interface to the front-end system. For airlines that intend to operate the FORAS model on their own, a private cloud-computing platform can be built based on the same architecture.

FORAS development was originated by Flight Safety Foundation, and originally was funded by the U.S. National Aeronautics and Space Administration, the U.S. Naval Research Laboratory and EVA Airways.

Currently, EVA Airways plans to share the latest FORAS model version with interested airlines to promote this proactive and quantitative safety management concept and tool. This promotion of the FORAS model will be non-commercial, in which airlines that are interested in acquiring the system will pay an amount to the FORAS Association based on their fleet size.

Plans call for the FORAS model fund to be managed by a committee of trustees. The fund will be utilized to set up FORAS scholarships and FORAS awards, and to sponsor the future development of the FORAS model, as well as other aviation risk management initiatives.

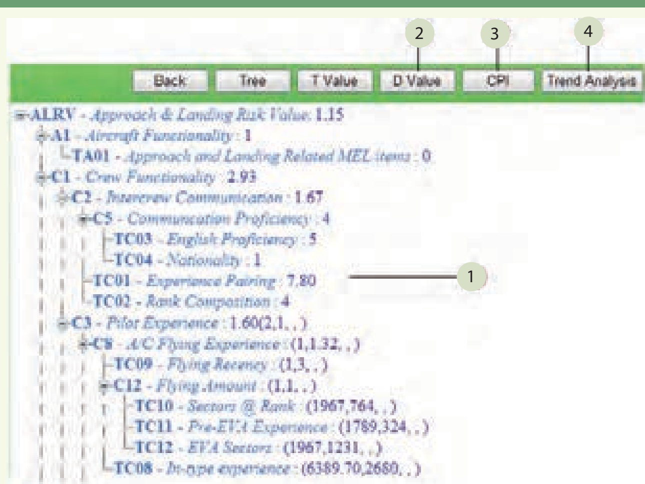
Real-Time Risk Assessment Report

1 Query conditions 2 Risk value of a flight 3 Risk status of a flight

Source: Danny C. Ho

Figure 6

Detailed Risk Assessment Report



1 Detailed risk report 2 Drill-down function
3 Critical risk factor analysis 4 Trend analysis function

Source: Danny C. Ho

Figure 7

Notes

1. Hadjimichael, Michael; Deborah M. Osborne; David Ross; Diana Boyd; and Barbara G. Brown. "The Flight Operations Risk Assessment System: Proceedings of the 1999 ASE Advances in Aviation Safety Conference." Daytona Beach, Florida, U.S., pp. 37–43.

2. Hadjimichael, Michael. "A Fuzzy Expert System for Aviation Risk Assessment." *Expert Systems with Applications*, 36, pp. 6512–6519. 2009.

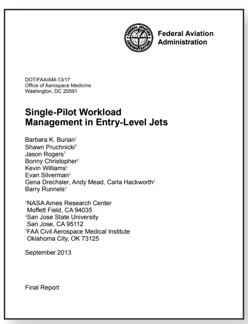
3. Ho, D.C.; H.-J. Shyur; C.-B. Cheng; W.-H. Yeh; S.-C. Kao. "The Enhancement and Implementation of the Flight Operations Risk Assessment System (FORAS)." In Flight Safety Foundation, *Proceedings of the 64th International Air Safety Seminar, Singapore, 2011.*

MANAGING Workload

Researchers examine the cockpit task-management abilities of single pilots of very light jets.

BY LINDA WERFELMAN

REPORTS


Federal Aviation Administration

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Office of Aerospace Medicine
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Single-Pilot Workload Management in Entry-Level Jets

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Final Report

Single-Pilot Workload Management in Entry-Level Jets

DOT/FAA/AM-13/17. Burian, B.K.; Pruchnicki, S.; Rogers, J. et al. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. September 2013. 127 pp. Appendixes, figures, tables. Available from the FAA at <www.faa.gov/data_research/research/med_humanfacs/oamtechreports>.

This report chronicles a study that examined task and workload management by 14 pilots of entry level jets (also known as very light jets) to evaluate pilot errors during high-workload events.

The researchers — from the U.S. National Aeronautics and Space Administration Ames Flight Cognition Lab and the FAA Flight Deck Human Factors Research Laboratory at the Civil Aerospace Medical Institute — observed the pilots as they conducted an experimental flight in a Cessna Citation Mustang flight training device.

Eight pilots owned and operated Mustangs, and the other six were professional pilots who flew Mustangs on the job.

The experimental flight consisted of two legs flown under instrument flight rules and with high workload management. The goal was to determine how the pilots managed their workload, what types of problems they encountered and why, what workload management techniques could be characterized as best practices, and how the pilots benefit from, or experience problems associated with, automation and advanced technologies.

The study also was designed to produce baseline data for use in future studies involving the FAA's Next Generation Air Transportation System (NextGen).

"To facilitate analysis," the report said, "the major high-workload tasks during the cruise portion of flight were grouped into four events. Approximately two-thirds of the tasks within the four events were accomplished by the participants with no difficulties. Though all participants committed a variety of errors during all four high-workload events (e.g., readback error, airspeed violation), most errors were not directly related to overall task success."

Nevertheless, the report said that, in the first event — "setting up the automation to intercept the 208-degree Broadway radial following the completion of the departure procedure out of Teterboro [New Jersey, U.S.] in leg one" — the researchers discovered "a significant effect on task performance success related to hours of experience."

The research also revealed that, for pilots who had difficulty with the tasks, "some type of error" involving their use of Garmin G1000 avionics was to blame. "Consistent with that finding is the result that half or more of the participants were unsuccessful or had problems accomplishing the three major tasks that involved the greatest amount of programming," the report said.

The report noted that, because of the low number of participating pilots, the "statistical power" of the exploratory study was limited, and the findings could not be generalized to apply to pilots other than those who participated.

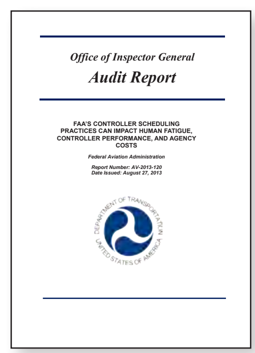
The report suggested several related topics for future research, including determining the "optimal balance between time spent monitoring automation and time spent focusing on other tasks" and examining whether "pilot automation use and errors committed [are] associated with frequency of use or the use of different avionics systems in other aircraft."

The report included several recommendations for workload management and the use of automation, including:

- "To the extent that it is feasible, pilots should consider completing short, easily performed tasks associated with ATC [air traffic control] clearances quickly, such as dialing in a new heading while listening to the rest of the ATC clearance;
- "Pilots should be prepared to copy (in writing) or audio-record an ATC clearance involving a reroute or hold and not try to rely upon their memory;
- "Pilots should complete as many tasks as possible early during periods of low workload. Research is needed to evaluate the cost-benefit tradeoffs of pilots programming an expected, but not confirmed, instrument approach while still at cruise;
- "During periods of automation mode changes (e.g., level off at top of climb), pilots should briefly refrain from other tasks and monitor the automation and aircraft behavior to make sure the aircraft performs the action as intended; [and,]
- "When deferring a task until a later time, we suggest that pilots take a moment and form an explicit intention about completing the task and when. For example, say to yourself, 'Report to ATC when I level out at cruise.' External memory aids or cues, such as placing an incomplete checklist between the throttle levers or on your lap, can also assist with recalling the need to perform deferred actions."

FAA's Controller Scheduling Practices Can Impact Human Fatigue, Controller Performance, and Agency Costs

U.S. Department of Transportation Office of Inspector General (OIG). Report no. AV-2013-120. Aug. 27, 2013. 29 pp. Appendixes, figures. Available from OIG at <www.oig.dot.gov/node/6195>.



This examination of the FAA's air traffic controller scheduling practices — prompted by several reports in 2011 of controllers who fell asleep during overnight shifts — found that controllers' work schedules sometimes do not comply with FAA scheduling policies.

The goals of the OIG audit were to determine how scheduling practices affect safety and air traffic controller performance, as well as to assess the cost effectiveness of the scheduling practices and determine how well air traffic control facilities comply with FAA scheduling policies.

The OIG's review was based on an examination of a sample of 32,814 shifts for 403 controllers at 20 facilities over a 16-week period.

"We found 279 cases where controllers did not have the required nine hours of off-duty time between an evening shift and the following day shift," the report said. "We also found another 102 cases where controllers did not have the minimum required eight hours off between all shifts."

Most of the violations, however, involved periods of less than 15 minutes, the report said.

After the 2011 reports, the FAA took steps to mitigate the impacts of fatigue by revising its scheduling policies to require longer rest periods between shifts, instituting a fatigue risk management system, increasing the number of controllers on midnight shifts and providing breaks during overnight shifts to help reduce fatigue risks.

Facility managers have questioned the effectiveness of these actions, and the FAA lacks the metrics to measure their success, the report said. However, continuing fatigue research may result in additional changes in scheduling practices, the document added.

The report included FAA's response to the report, which noted that in recent years, the agency has tried to ensure the controllers have the correct amount of time off between shifts. Automated reports allow managers to monitor controllers' time off, and new software provides alerts to controllers if they try to sign in to work before completing the minimum required off-duty period.

The FAA agreed with the report's four recommendations, which included identifying all terminal air traffic facilities "that do not meet the established minimum criteria for midnight shift operations" and considering reducing their hours of operations.

The FAA said it has identified 72 air traffic control facilities that do not meet the criteria because they average fewer than four operations per hour for at least four consecutive hours. The FAA is reviewing the studies, and decisions will be made early in 2014 on whether to adjust the facilities' operating hours.

ELECTRONIC MEDIA

Maintenance for Fire Reduction

<www.caa.co.uk/default.aspx?catid=2445&pagetype=90&pageid=14991>

This five-minute video, released by the U.K. Civil Aviation Authority (CAA) and the U.S. Federal Aviation Administration (FAA), is part of a safety-awareness campaign by the two authorities.

The video identifies specific maintenance risks, such as dust accumulation and faulty electrical wiring, that may result in fires aboard aircraft, and discusses "the importance of accurately following aircraft maintenance procedures and also ensuring that electrical wiring is not damaged or contaminated with grease or foreign debris," the CAA said.

The CAA considers fire one of the "significant seven" safety risks in commercial aviation and says it is especially concerned about "the threat of fire breaking out in hidden areas of the aircraft, which cabin crew are unable to access and bring under control."

The video also is available on the CAA's YouTube channel at <www.youtube.com/UKCAA> and a DVD version may be obtained by emailing <press.office@caa.uk>.

Close Call on Climb-Out

A misunderstanding of an altitude assignment led to a near collision between a civilian freighter and a military helicopter.

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

Nonstandard Departure Clearance

Airbus A300-605R, Boeing Vertol CH-47D. No damage. No injuries.

A tower controller's use of nonstandard air traffic control (ATC) communications phraseology in a departure clearance and an A300 flight crew's misunderstanding of an initial altitude assignment resulted in the freighter coming within close proximity of a Chinook helicopter that was orbiting above the military airfield, according to the report by the U.K. Air Accidents Investigation Branch (AAIB).

The incident occurred in visual meteorological conditions (VMC) at RAF Brize Norton Aerodrome in Oxfordshire, England, the afternoon of Nov. 18, 2011. Visibility was greater than 10 km (6 mi), and surface winds were from 180 degrees at 8 kt. There were a few clouds at 1,800 ft and a broken ceiling at 12,000 ft.

The A300 was of Turkish registration. The crew, comprising two pilots and a loadmaster, had flown the aircraft to Brize Norton that morning and were preparing to return to Istanbul with a load of cargo. "It was the commander's first rotation through Brize Norton, but the copilot had been there a number of times," the report said. "Both were Turkish nationals with a good working knowledge of English."

The copilot, the pilot monitoring, was handling ATC communications. The ground controller issued taxi instructions to Runway 26 and a departure clearance specifying a standard instrument departure procedure that included an initial climb to Flight Level (FL) 080 (approximately 8,000 ft).

After the copilot read back the clearance, the flight crew briefed the departure procedure and entered it into the flight management system, with 8,000 ft selected as the initial target altitude. "The commander intended to use the autopilot engaged with the 'Profile Mode' to be selected after takeoff," the report said. "In this mode, the autopilot follows the horizontal and vertical profile of the departure and levels off at the target altitude."

The pilots decided that there was sufficient runway available to begin the takeoff from the

Echo intersection, and the copilot made the request. The ground controller instructed the crew to taxi to Echo and to establish radio communication with the tower controller.

"Having changed frequency, the next information the crew were expecting to be passed was either to line up at Echo or to continue the taxi to holding point Foxtrot, from which the full length of the runway is available for takeoff," the report said.

On initial contact, the tower controller issued an altimeter setting and told the crew that they would have a "climb-out restriction, two thousand two hundred feet."

The pilots misunderstood the instruction. "The crew, who were expecting taxiway- and runway-related information, interpreted the ['two thousand two hundred feet'] to be the runway length reduction when entering the runway from holding point Echo," the report said. "Although both pilots were familiar with the term 'climb-out restriction,' they did not register the information as an altitude and therefore did not read back the phrase."

The copilot read back only the altimeter setting and repeated the request for takeoff from the Echo intersection. The tower controller asked the A300 copilot to confirm the climb-out restriction. The copilot replied, "Yes, good, copied, thank you."

The controller said, "I need you to say back, climb-out restriction two thousand two hundred feet."

"Yeah, two thousand two hundred feet copied," the copilot said.

The report said that the copilot likely still related this to runway length. The climb restriction actually had been issued to provide vertical separation from the Chinook, which was on an instrument training flight with four crewmembers aboard.

The controller did not persist in obtaining a full readback of the instruction. He told the crew to line up and wait on the runway at the Echo intersection. The crew then was cleared for takeoff from Runway 26.

The A300 was on initial climb when the crew was told to contact the departure controller. At the time, the helicopter was at 3,500 ft and entering a holding pattern at a nondirectional beacon near the departure path of Runway 26.

The departure controller, expecting the freighter to level at 2,200 ft, advised the crew that "traffic" (the Chinook) was at their 1 o'clock position, 1,000 ft above and on a similar heading. The copilot replied that they had the helicopter in sight.

The A300 was climbing through 2,200 ft at about 3,000 fpm when the controller asked the crew to report their "passing [current] altitude." The copilot said, "Now above two thousand nine hundred." The controller told the crew to immediately stop the climb. The copilot replied they were climbing through 3,400 ft in compliance with a traffic-alert and collision avoidance system (TCAS) resolution advisory.

"The returns from the two aircraft were seen to merge on the ATC radar display," the report said. "According to TCAS data from the A300, the minimum lateral separation between the A300 and the Chinook was 0.11 nm [0.20 km] and the minimum vertical separation was 496 ft."

The Chinook was in a left turn when the crew saw the A300 pass overhead. The crew later filed an Airprox report.

Although the freighter crew was found to be familiar with the term "climb-out restriction," the phraseology does not appear in the civilian or military sections of CAP 413, *Radiotelephony Manual*, the report said. "It does appear in other military documents, but these are not available to civilian pilots."

According to CAP 413, the proper phraseology for the altitude restriction would have been: "Climb to altitude two thousand two hundred feet."

Moreover, the document requires flight crews to state the altitude through which they are passing and their assigned altitude on initial contact with departure control. The A300 crew did not do this. If they had, it "would have immediately alerted the controller to the fact that the aircraft would not level at 2,200 ft," the report said.

After the incident, Brize Norton authorities revised their controllers' handbook to eliminate the term "climb-out restriction" and to require departure controllers to remind flight crews of their altitude assignments if they are not stated on initial contact.

Impromptu Aerobatics

Cessna Citation 550B. Destroyed. Two fatalities.

The flight crew departed from Prague, Czech Republic, the night of Feb. 14, 2010, for a positioning flight to Karlskrona, Sweden. The pilot-in-command (PIC), 27, had about 1,700 flight hours and had been employed by the aircraft-management company in 2009. The copilot, 32, had about 1,600 flight hours and had been with the company since 2005.

While climbing to the assigned cruise altitude, FL 330, the PIC mentioned that she had not flown at night for a long time. The copilot, who was hand flying the airplane, said, “Have you already experienced a roll during night?”

During the ensuing conversation, the pilots “no longer paid appropriate attention to airmanship and engaged in something neither they nor the airplane could handle,” said the English translation of the accident report published in September by the German Federal Bureau of Aircraft Accident Investigation (BFU).

“At no time during the conversation did the PIC exercise her leadership role,” the report said. “The impression arose [from the cockpit voice recording] that the PIC encouraged the intention of the copilot [to roll the aircraft].”

Neither pilot had received training in aerobatics, and the airplane was not certified for aerobatic flight. The report said, however, that the recorded conversation also indicated that both pilots “had flown aerobatics in the past with other airplanes of the company.”

The copilot leveled the Citation at FL 270 and attempted to roll it. “The nose moved upward until a pitch angle of about 14 degrees was reached [and] the airplane began to roll about its longitudinal axis to the right,” the report said. “Within 4 seconds the airplane reached the inverted flight attitude, and in another 4 seconds it rolled another 90 degrees. … During the roll, the pitch angle decreased to almost –85 degrees, which is almost a vertical nosedive. The computed airspeed increased significantly.”

The airplane struck terrain near Reinhardtsdorft-Schöna, Germany, just north of the border of the Czech Republic. BFU concluded that the pilots had lost spatial orientation and control of the Citation while attempting to roll the airplane on a moonless night that provided no visual references for the unauthorized maneuver.

Seat Detaches on Overrun

Gulfstream G150. Substantial damage. One serious injury, three minor injuries.

The G150 was en route from Stuart, Florida, U.S., to Key West, Florida, the night of Oct. 31, 2011. The destination airport had one runway and was reporting surface winds from 360 degrees at 12 kt, gusting to 17 kt, 10 mi (16 km) visibility and broken ceilings at 1,000 ft and 1,400 ft.

ATC cleared the flight crew to conduct a visual approach to Runway 27, which was 4,801 ft (1,463 m) long and 100 ft (30 m) wide. “The flight crew lost sight of the runway due to some low stratus clouds and discontinued the approach,” said the report by the U.S. National Transportation Safety Board (NTSB). “The controller then instructed them to overfly the airport and enter a right downwind leg for Runway 27, which they did.

“During the second approach, they again temporarily lost sight of the runway due to clouds while turning from the base [leg] to the final leg; however, they were able to visually reacquire the runway on final approach.”

According to the report, the PIC recognized that they were going to land long but continued the approach. The G150 touched down on the main landing gear at 120 kt, the reference landing speed, and 1,650 ft (503 m) from the approach threshold. When the nose landing gear touched down 2.4 seconds later, there was about 2,680 ft (817 m) of runway remaining.

“Landing distance data revealed that the airplane required about 2,551 ft [778 m] to stop at its given weight in the given weather conditions,” the report said. “With a runway distance of 2,680 ft remaining, the airplane could have stopped or gone around uneventfully with appropriate use of all deceleration devices.”

However, the ground spoilers did not deploy on touchdown. Investigators found that the spoilers had been armed for the landing and were not able to determine conclusively why they did not deploy.

“The landing procedure stated to activate the thrust reversers after nosewheel touchdown and then apply the [wheel] brakes, as necessary,” the report said. “However, the PIC only applied the brakes. Further, no callouts were made to verify ground spoiler or reverse thrust deployment.”

The report said that likely due of the absence of deceleration provided by spoiler deployment, both pilots perceived incorrectly that the wheel brakes were not working properly. “The procedure for a (perceived) failed brake system would have been to activate the emergency brake, which neither pilot did.”

The PIC applied takeoff power and announced that he was initiating a go-around, but the second-in-command said that it was too late to go around. The PIC returned the throttles to idle and applied reverse thrust. “The PIC’s delayed decision to stop or go around resulted in about a 22-second delay in thrust reverser activation, which resulted in the runway overrun,” the report said.

One of the passengers was seriously injured when his seat detached as the airplane traveled over a ditch, struck a gravel embankment, crossed a service road and came to a stop at the edge of a pond 816 ft (249 m) from the runway.

Investigators determined that maintenance personnel had not installed the seat properly. It was an aft-facing seat that had been installed in a forward-facing position, and the shear plungers in the frame of the seat had not been lowered into the seat track. "The improper installation most likely resulted in the passenger's seat separating from the seat track and exacerbating his injuries," the report said.

Fuel, Hydraulic Leaks on Takeoff

Cessna Citation 560XL. Minor damage. No injuries.

Shortly after the flight crew retracted the flaps on takeoff from Nantucket, Massachusetts, U.S., the afternoon of Oct. 29, 2012, the tower controller advised that fuel was pouring from the left wing. "The crew also noted hydraulic and stabilizer annunciator lights and a gear unlocked indication," the NTSB report said.

As the crew returned to the airport, they felt a slight airframe vibration and noticed that the fuel quantity in the left wing tank was decreasing rapidly. "The flight remained in the traffic pattern and returned to [the airport] for an uneventful landing with a fuel imbalance of about 1,000 lb [454 kg]," the report said.

Investigators determined that a new left main landing gear trunnion had been installed six weeks earlier and that maintenance personnel had not secured the aft pivot pin correctly. This resulted in separation of the aft portion of the trunnion from its fitting. "The end of the aft trunnion punctured the interior of the gear well, resulting in damage to surrounding structure and damage to the fuel cell and hydraulic line," the report said.

TURBOPROPS

Intruders Force Go-Around

Cessna 208B. Destroyed. One fatality, one serious injury.

The flight crew was conducting an unscheduled cargo flight to a gravel airstrip at 6,950 ft in Bilogai, Indonesia, the morning of Nov. 26, 2011. A curved approach was required due to hills near the runway.

The Grand Caravan was at 94 kt and just about to touch down when the crew saw local villagers walking along the right side of the 590-m (1,936-ft) runway. The crew initiated a go-around, and the aircraft entered a left climbing turn in a nose-high attitude. The Caravan then stalled and crashed in a corn field, killing the copilot and seriously injuring the pilot.

In its report, the Indonesian National Transportation Safety Committee (NTSC) noted that the airstrip is surrounded by agricultural fields and that farm workers often cross the runway to gain access to them. As a result of the accident, NTSC recommended that the runway be fenced to prevent intruders or that a warning system be installed to alert people to aircraft arrivals and departures.

'Very Loud Noise' on Takeoff

Let L-410 Turbolet. Substantial damage. No injuries.

The aircraft was lifting off with 10 passengers and two pilots from the runway at Ronaldsway Airport on the Isle of Man the afternoon of Nov. 5, 2012, when the flight crew heard a very loud noise.

"Suspecting an engine failure, the commander closed the throttles and landed ahead on the remaining runway," the AAIB report said. The noise reduced substantially at the low power setting, and the crew taxied the Turbolet to a parking area and shut down the engines.

ATC discontinued operations on the runway but re-opened it after an inspection revealed no debris.

"After the incident, [the commander] commented that the event was unlike any he had experienced previously while flying or during training," the report said. "In particular, he remarked on the very high level of noise and the absence of yaw [typical of an engine failure]." The copilot described the noise as "terrible."

The left Walter M601E engine showed no external evidence of damage, but a tear-down inspection revealed that a balance plug on the centrifugal compressor disc had broken and separated from the disc.

"Balance plugs are used to balance the compressor disc and are screwed into the disc beneath the compressor blade roots," the report said. "Following an investigation by the engine manufacturer, it was concluded that the broken balance plug had failed due to a fatigue crack. … The damage to the engine was contained within the engine casing and was insufficient to cause a significant loss of power."

Salt Causes Compressor Stalls

Lockheed WP-3D Orion. No damage. No injuries.

The Orion, operated by the U.S. National Oceanic and Atmospheric Administration, was orbiting at 3,000 ft over the Atlantic Ocean in night instrument meteorological conditions (IMC) on Nov. 9, 2007, when compressor stalls and tailpipe fires occurred in three of the four engines.

The incident occurred 540 nm (1,000 km) east of St. John's, Newfoundland, Canada, according to a report published by NTSB in May. The no. 3 engine malfunctioned first, followed moments later by the no. 4 and no. 1 engines. The aircraft commander (AC) told the flight engineer (FE) to shut down the no. 3 and no. 4 engines, apparently due to fire warnings for those engines.

The AC and FE noticed a power loss and an increase in turbine inlet temperature in the no. 1 engine, but there was no fire warning. "The AC directed the FE to pull back power on the no. 1 engine," the report said. "Believing that he heard the order to shut down the no. 1 engine, the FE pulled the emergency shutdown handle for the no. 1 engine.

"While operating single-engine at 800 feet and 140 knots, the AC called for the immediate restart of the no. 1 engine. With the successful restart of the no. 1 engine, the airplane began a slow climb on two engines." The crew subsequently was able to restart the other two engines and return to St. John's for an uneventful landing.

An examination of the Orion revealed significant buildups of salt on all the engine intakes and first-stage compressors, as well as on the fuselage and windows. "After the salt was rinsed away with water, the engine efficiencies improved greatly, and no other anomalies were noted," the report said.

Flight Displays Go Blank

Jetstream 41. Minor damage. No injuries.

About one hour into a flight with 12 passengers and three crewmembers from Southampton, England, to Aberdeen, Scotland, the morning of July 18, 2012, the Jetstream entered IMC, icing conditions and light turbulence at FL 220. Twenty minutes later, the attitude director indicator display in the commander's electronic flight instrument system (EFIS) went blank.

The commander, the pilot monitoring, re-engaged the autopilot and conducted the "Symbol Generator Failure" checklist, which did not remedy the situation. Shortly thereafter, the other three EFIS screens went blank.

"The commander took control and flew the aircraft with reference to the main altimeter and standby instruments," the report said. The crew declared an urgency and diverted the flight to Newcastle. The EFIS displays began to return to normal after the aircraft descended into VMC. The Jetstream subsequently was landed at Newcastle without further incident.

Investigators found that an electrostatic transient absorber (transzorb) in the left windshield heating system had failed, as designed, when it was exposed to a high-voltage static charge that had accumulated on the windshield either during the incident flight or previously. However, the failed transzorb had retained a residual charge and thus had not protected the avionics systems, as it was designed to do.

The transzorbs had reached two-thirds of their service life when the left inboard unit failed. After they were replaced, the EFIS equipment and the windshield heating system functioned normally. "The aircraft was subsequently returned to service, and no further defects regarding the EFIS system were reported," the report said.

'The commander flew the aircraft with reference to the main altimeter and standby instruments.'

Preliminary Reports, September 2013

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Sept. 1	Telluride, Colorado, U.S.	Beech 1900D	substantial	12 none
The left main landing gear collapsed on landing.				
Sept. 2	Harford, Pennsylvania, U.S.	Cessna T-50 Bobcat	destroyed	2 fatal
A witness said there was a severe electrical storm in the area when the Bobcat struck trees and crashed while maneuvering for a night landing at a private airport.				
Sept. 4	Jersey, Channel Islands, U.K.	Cessna 303 Crusader	destroyed	2 fatal
Low visibility in fog prevailed when the 303 crashed in a bay during final approach.				
Sept. 7	Moscow, Russia	Bombardier CRJ200ER	substantial	11 none
The flight crew was unable to extend the main landing gear on approach to Vnukovo Airport and landed the CRJ with only the nose gear extended.				
Sept. 7	Amistad, New Mexico, U.S.	Bell 206L-3	substantial	2 minor
The LongRanger descended and landed hard after the pilot initiated a steep right turn to avoid colliding with large birds while cruising at 300 ft during a public use flight.				
Sept. 8	Bangkok, Thailand	Airbus A330-321	NA	302 NA
At least 12 of the occupants were injured when the A330 veered off the right side of the runway while landing in night visual meteorological conditions (VMC).				
Sept. 8	Doylestown, Pennsylvania, U.S.	Piper Navajo	substantial	1 none
The pilot said that the brakes on the left main gear did not function normally on landing. The Navajo veered off the left side of the runway, collapsing the landing gear.				
Sept. 9	Viña del Mar, Chile	Dornier 228-202K	destroyed	2 fatal
The Dornier was on a positioning flight when it struck power lines and crashed in a field during an approach in fog.				
Sept. 16	Detroit, Oregon, U.S.	Bell UH-1B	substantial	1 fatal
An in-flight breakup occurred before the helicopter struck the ground while carrying an external load of logs.				
Sept. 18	Sovetsky, Russia	Antonov 2R	substantial	7 NA
Three occupants were injured when the biplane landed hard during a passenger flight.				
Sept. 19	Idaho Falls, Idaho, U.S.	Beech King Air C90	destroyed	3 NA
The pilot and two passengers were injured when the King Air stalled and crashed in an open field after experiencing a technical problem on approach.				
Sept. 19	Canton, Mississippi, U.S.	Eurocopter AS350-B2	substantial	4 minor
The emergency medical services helicopter lost power and touched down hard in an open field during an autorotative landing.				
Sept. 21	Cordes Lake, Arizona, U.S.	Bell UH-1V	destroyed	2 fatal
The helicopter crashed after the main rotor assembly separated during a private flight in VMC.				
Sept. 23	Sandpoint, Idaho, U.S.	Piper Aerostar 602P	substantial	1 minor, 2 none
The pilot said that the brakes did not function normally on landing. The Aerostar overran the runway and collided with localizer equipment.				
Sept. 24	Lyon, France	Cessna 421C	destroyed	4 fatal
The 421 stalled shortly after takeoff and crashed near the airport perimeter fence.				
Sept. 25	Hudson Bay, Ontario, Canada	Cessna 208B	destroyed	1 fatal
The Grand Caravan departed from Sault Ste. Marie for a local solo training flight and crashed in the bay 1,200 km (648 nm) north.				
Sept. 27	Zurich, Switzerland	DHC-8-402Q	substantial	65 none
The flight crew was unable to extend the nose landing gear on approach and landed the Dash 8 with the nose gear retracted.				
Sept. 29	Rome, Italy	Airbus A320-216	substantial	151 none
The flight crew was unable to extend the right main landing gear on approach to Fiumicino Airport. No injuries were reported in the subsequent landing.				
Sept. 29	Santa Monica, California, U.S.	Cessna CitationJet CJ2	destroyed	4 fatal
The CJ2 veered off the right side of Runway 21 on landing, traveled through a parking lot, crashed into a hangar and burned.				

NA = not available

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

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