AeroSafety WORLD

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Fatigue Mitigation Proposal

SIGNAL ANOMALY
Probing an ILS Quirk

PILOT MONITORING
A How-to Guide

SURVIVAL
ANALYZING ESSENTIAL FACTORS

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

NOVEMBER 2014

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Data SHARING

You've probably read in *AeroSafety World* about the importance of safety data sharing in aviation. This has been a priority of Flight Safety Foundation for many years, and Foundation founder Jerry Lederer spoke of the issue as long as ago as the 1960s.

As the newest leader of this venerable organization, I join my predecessors in calling for increased data sharing around the world.

Aviation professionals understand that data sharing is crucial to the advancement of aviation safety. While data sharing is advanced and robust in the United States, efforts in other parts of the world need our focus. The International Civil Aviation Organization's (ICAO's) Regional Aviation Safety Group–Pan America (RASG-PA) is leading the way in introducing some of the ideas modeled in the United States through the Commercial Aviation Safety Team (CAST).

With the recent cooperative agreement that the Foundation signed with the U.S. Federal Aviation Administration, we look forward to increasing our work with RASG-PA and other safety groups to further implement data sharing, using many practices already proven effective.

But voluntarily reported safety data is threatened by outside forces. In 2010, ICAO's Air Navigation Commission established the Safety Information Protection Task Force (SIP TF) to provide recommendations for enhanced protection of data. Several months ago, the SIP TF completed its work and submitted the recommendations to the Air Navigation Commission.

These recommendations include commonsense protections that would ensure that voluntarily submitted safety data are used for safety analysis and risk management rather than for punitive purposes.

It is time for states to understand the importance of protecting safety data. We're not trying to protect our own if they have done wrong — all proposals to protect data clearly state that negligent or criminal activity will not be protected from punitive consequences or prosecution. But being able to collect, de-identify and analyze data to better understand risk factors means robust risk mitigation. If you cannot be assured that safety data will not be turned over to an over-eager judicial system, would you voluntarily provide it?

We've seen the safety of aviation reach the highest level. Robust data sharing without fear of prosecution must be the norm in the industry to continue to raise the level of safety.

Jon L. Beatty
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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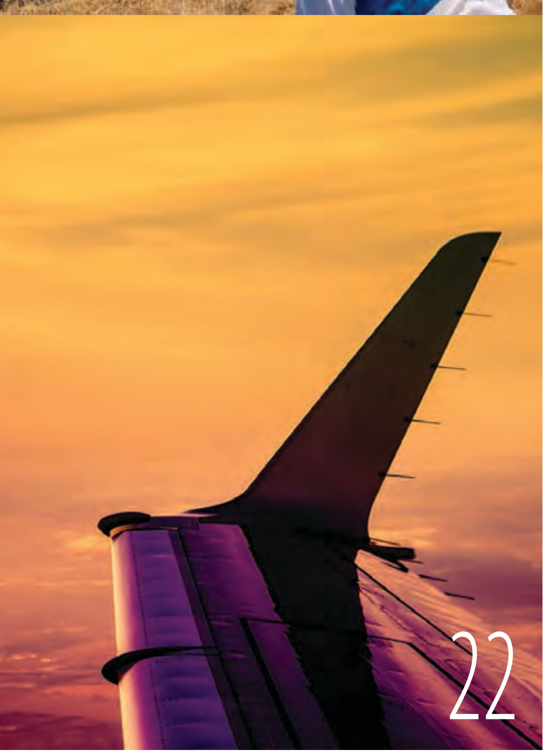

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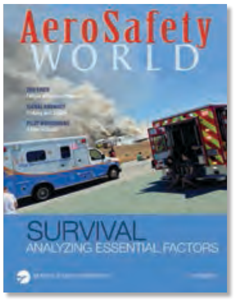

About the Cover
The first aircraft rescue and fire fighting vehicle reached the Asiana Airlines Flight 214 fuselage about three minutes after motion stopped.

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Share Your Knowledge

If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about aviation safety, we will be glad to consider it. Send it to Director of Publications Frank Jackman, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA or jackman@flightsafety.org.

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DESERVED Recognition

Loss of control–inflight (LOC-I) is one of the three most common types of accidents and is, by far, the deadliest. The *Statistical Summary of Commercial Jet Airplane Accidents, Worldwide Operations, 1959-2013*, published in September by Boeing Commercial Airplanes and detailed in "DataLink" on p. 45, indicates that 16 LOC–I accidents resulted in 1,526 on-board fatalities and 50 external fatalities from 2004 through 2013.

Upset prevention and recovery training (UPRT), a frequent topic of articles in *AeroSafety World* and in other industry publications, is widely seen as a primary method of preventing or mitigating LOC-I occurrences. UPRT has been the subject of extensive study, and some debate, over the past several years, and new international regulations and comprehensive guidance documents recently were promulgated.

Some of the most comprehensive and thoughtful work on all aspects of UPRT — whether enhancing the realism of flight simulation training devices, defining the skill set of specialized instructors or engaging the unique capabilities of all-attitude, aerobatic-capable airplanes — has been done by the Royal Aeronautical Society's (RAeS) International Committee for Aviation Training in Extended Envelopes (ICATEE), which was formed in 2009 and is chaired by Sunjoo K. Advani, Ph.D. In late September, Advani was notified by the Council of the Royal Aeronautical Society that ICATEE is to be recognized by RAeS with a Society 2014 Specialist Team Bronze Award for work of merit that has led to advances in specialist disciplines in the aerospace industry.

According to the RAeS, "This award is in recognition of the Committee's exhaustive work in addressing the challenge of reducing the number of loss of control–inflight (LOC-I) accidents and in particular developing a strategy for the definition of structured, standardised and validated Upset Prevention and Recovery Training." The award is to be presented this month at an event in London.

I would like to take this opportunity to pass on my personal congratulations to Sunjoo and the ICATEE members for their years of tireless effort and dedication to a cause that will undoubtedly make aviation safer for all of us. I'd also like to congratulate all those organizations that contributed resources and/or allowed their employees to participate in the UPRT effort. The work done by ICATEE is a wonderful example of what the industry can accomplish when it works together toward a common goal.

With the support of these expert sources, I also look forward to assigning *ASW* coverage of the global implementation of UPRT in the years ahead, to reporting on LOC-I outcomes and, in doing so, to keeping the issue high among aviation safety professionals' priorities.

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. 2–3 ➤ Offshore/Onshore Aviation Conference and Exhibition. Middle East and North Africa Helicopter Safety Team. Abu Dhabi, United Arab Emirates. Alison Weller, <alison@accessgroup.aero>, +971 5 6116 2453.

NOV. 3–5 ➤ 52nd annual SAFE Symposium. SAFE Association, Orlando, Florida, U.S. <safe@peak.org>, <www.safeassociation.com/index.cfm/page/symposium–overview>, +1 541.895.3012.

NOV. 8–9 ➤ Aviation Training Congress China 2014. Pyxis Consult, China Decision Makers Consultancy. Zhuhai, China. Sharon Liu, <Sharon@pyxisconsult.com>, +86 21 5646 1705.

NOV. 9–10 ➤ International Flight Operations Congress China 2014. Pyxis Consult, China Decision Makers Consultancy. Zhuhai, China. Sharon Liu, <Sharon@pyxisconsult.com>, +86 21 5646 1705.

NOV. 11–13 ➤ 67th annual International Air Safety Summit. Flight Safety Foundation. Abu Dhabi, United Arab Emirates. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

NOV. 17–21 ➤ Safety Management Systems for Remotely Piloted Aircraft. University of Southern California, Viterbi School of Engineering. Los Angeles. <aviation@usc.edu>.

NOV. 20–21 ➤ ICAEA Aviation English Workshop, Skills and Competencies Needed in Aviation Communications: The Latin American Challenge. International Civil Aviation English Association (ICAEA). Buenos Aires, Argentina. <cipecertificacioningles@anac.gov.ar>, <icaea.aero>.

NOV. 20–21 ➤ AVM Summit USA. Aviation Maintenance Magazine. Orlando, Florida, U.S. Adrian Broadbent, <abroadbent@aerospace-media.com>, <avm-summit.com>.

NOV. 24–27 ➤ ICAO Regional Aviation Safety Group Asia and Pacific Regions (RASG-APAC) Meeting. International Civil Aviation Organization. Hong Kong. <icao.int>.

DEC. 7–9 ➤ AAAE Runway Safety Summit. American Association of Airport Executives (AAAE). Salt Lake City, Utah, U.S. <aaaemeetings.aaae.org>.

DEC. 8–12 ➤ SMS Principles. MITRE Aviation Training Program. McLean, Virginia, U.S. <maimail@mitre.org>, <mitremai.org/sms_course>, +1 703.983.5617.

DEC. 9–11 ➤ Unmanned Aircraft Systems (UAS) Fundamentals Course. Embry-Riddle Aeronautical University. Daytona Beach, Florida, U.S. <daytonabeach.erau/uas>.

DEC. 11–12 ➤ Safety in Air Traffic Control. Flightglobal Conferences. London. <flightglobalevents.com/safetyATC2014>, <events.registration@rbi.co.uk>.

DEC. 15–17 ➤ SMS Theory and Application. MITRE Aviation Training Program. McLean, Virginia, U.S. <maimail@mitre.org>, <mitremai.org/sms_course>, +1 703.983.5617.

JAN. 13–14 ➤ MRO Latin America. Aviation Week. Buenos Aires, Argentina. <events.aviationweek.com>.

JAN. 14–16 ➤ 2015 Risk Management Conference. Airports Council International–North America (ACI-NA). San Diego. <aci-na.org>.

FEB. 2–5 ➤ 2nd High-Level Safety Conference (HLSC/2). International Civil Aviation Organization (ICAO). Montreal. <icao.int>.

FEB. 10–11 ➤ Approach and Landing Accident Reduction (ALAR) Info Exchange. Flight Safety Foundation. Singapore. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

FEB. 12–13 ➤ Maintenance and Engineering Safety Forum. Flight Safety Foundation. Singapore. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

FEB. 17–18 ➤ 1st International Human Factors Conference. Lufthansa Flight Training. Frankfurt/Main, Germany. <human-factors-conference@lft.dlh.de>, <human-factors-conference.com>, +49 69 696 53061.

MARCH 2–5 ➤ HAI Heli-Expo 2015. Helicopter Association International. Orlando, Florida, U.S. <rotor.org>.

MARCH 10–11 ➤ Air Charter Safety Symposium. Air Charter Safety Foundation. Dulles, Virginia, U.S. <acsf.aero>.

MARCH 10–12 ➤ World ATM Congress 2015. Civil Air Navigation Services Organisation (CANSO). Madrid, Spain. Anouk Achterhuis, <events@canso.org>, +31 (0) 23 568 5390.

MARCH 22–25 ➤ 2015 Operations and Technical Affairs Conference. Airports Council International –North America (ACI-NA). Vancouver, British Columbia, Canada. <aci-na.org>.

MARCH 22–25 ➤ 2015 Public Safety and Security Conference. Airports Council International –North America (ACI-NA). Vancouver, British Columbia, Canada. <aci-na.org>.

MARCH 23-25 ➤ CHC 2015 Safety and Quality Summit. CHC Helicopter. Vancouver, British Colombia, Canada. <chcsafetyqualitysummit.com>.

APRIL 13–15 ➤ IATA Ops Conference. International Air Transport Association (IATA). Los Angeles. <iata.org>.

APRIL 17–23 ➤ 49th International Aviation Snow Symposium. American Association of Airport Executives (AAAE). Buffalo, New York, U.S. <aaae.org/meetings/meetings_calendar/>.

APRIL 21–23 ➤ World Aviation Training Conference and Tradeshow (WATS 2015). Halldale Media. Orlando, Florida, U.S. <info@halldale.com>, <halldale.com>.

APRIL 21–23 ➤ 2015 International Rotorcraft Safety Conference. Rotorcraft Directorate, U.S. Federal Aviation Administration. Hurst, Texas, U.S. <faahelisafety.org>.

MAY 5–7 ➤ IATA Cabin Operations Safety Conference. International Air Transport Association (IATA). Paris. <iata.org>.

MAY 11–14 ➤ RAA 40th Annual Convention. Regional Airline Association (RAA). Cleveland, Ohio, U.S. <raa.org>.

MAY 13–14 ➤ Business Aviation Safety Summit 2015 (BASS 2015). Flight Safety Foundation. Weston, Florida, U.S. Namratha Apparao, <apparao@flightsafety.org>, +1 703.739.6700, ext. 101.

JUNE 7–9 ➤ IATA 71st Annual General Meeting and World Air Transport Summit. International Air Transport Association (IATA). Miami. <iata.org>.

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

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

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

Safety News

FAA Approves Limited UAS Use

Six photo and video production companies have received permission from the U.S. Federal Aviation Administration (FAA) to use unmanned aircraft systems (UAS) in their work in television and film production.

The companies were granted regulatory exemptions that will allow them to operate in the National Airspace System without certificates of airworthiness, which the FAA says will not be required because the aircraft "do not pose a threat to national airspace users or national security."

The companies requested, and received, exemptions from regulations involving general flight rules, pilot certificate requirements, manuals, maintenance and equipment mandates, the FAA said, adding that it would issue certificates of waiver or authorization that also set forth specific flight rules and require timely reports of incidents and accidents.

"To receive the exemptions, the firms had to show their UAS operations would not adversely affect safety or would provide at least an equal level of safety to the rules from which they seek the exemptions," the agency said.

The companies agreed that their UAS operators would hold private pilot certificates. All flights will be conducted within the operator's line of sight and will be restricted to the "sterile area" on the television or movie set, the FAA said. Other conditions include day-only operations and aircraft inspections before each flight.

"We are thoroughly satisfied these operations will not pose a hazard to other aircraft or to people and property on the ground," said FAA Administrator Michael Huerta.

The FAA, which is continuing to develop regulations governing UAS operations, is considering 40 similar requests for exemptions from other businesses.

Crash Testing

Researchers from the U.S. National Aeronautics and Space Administration (NASA) and other government agencies have crash-tested a former Marine CH-46E Sea Knight to examine effects of the accident on 13 instrument-equipped crash dummies and two non-instrumented manikins.

The 45-ft (14-m) long black-and-white spotted helicopter was dropped from 30 ft into a bed of dirt during an early October test at NASA's Langley Landing and Impact Research facility in Hampton, Virginia, U.S. The spotted fuselage was designed to aid in data collection and to help researchers determine how all parts of the fuselage responded to the crash, NASA said.

NASA Langley | David C. Bowman

"The helicopter plowed into the dirt at about 30 mph [48 kph] — a severe but survivable crash, according to civilian and military standards," said lead test engineer Martin Annett.

The test crash resembled another test performed earlier this year, Annett said, noting that a primary difference was that, this time, the helicopter came to an abrupt stop with minimal sliding.

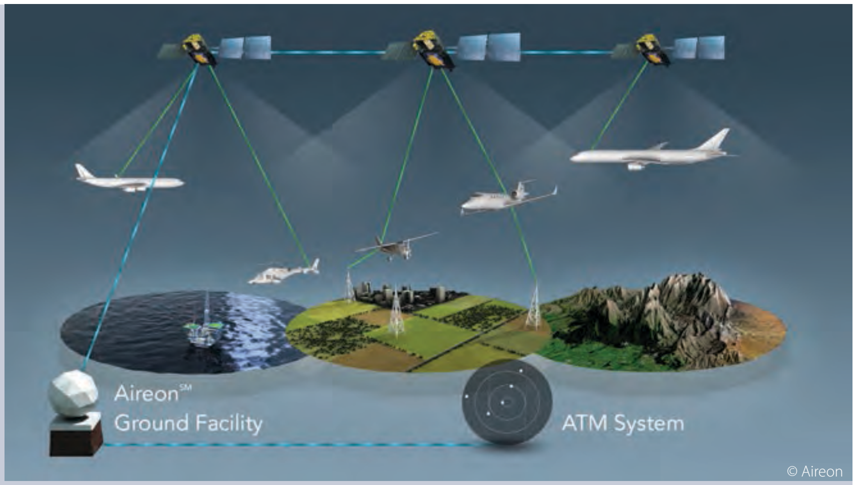
"Because it came to an abrupt stop, there's a lot more load or jerking motion that gets imparted in the longitudinal direction, forward and backward," he said.

The crash was designed to enable a number of experiments, all aimed at designing safer helicopters, NASA said. Forty cameras and on-board computers with 350 data channels recorded all movements of the helicopter and its dummy passengers.

The helicopter had been outfitted with three energy-absorbing composite materials — concepts developed by NASA and the Australian Cooperative Research Center for Advanced Composite Structures — which were installed beneath the passenger floor, NASA said. When the helicopter was dropped, Annett said, the cameras recorded unexpected motion that he described as "an excessive shearing action that almost slipped the entire floor instead of crushing the subfloor like we anticipated."

NASA said it would use the results of the experiments in its efforts to improve rotorcraft performance and efficiency, and to create better computer models to be used in designing safer helicopters.

Aircraft Tracking Service



© Aireon

Aireon, a developer of automatic dependent surveillance–broadcast (ADS-B) systems, says it plans to provide free global aircraft tracking in emergencies.

The Aireon Aircraft Locating and Emergency Response Tracking service will allow search and rescue agencies to request the location and the last flight track of any aircraft that is equipped with 1090-MHz ADS-B and is flying in airspace that has no air traffic surveillance, according to a plan announced by the company and NAV Canada.

"A comprehensive global aircraft tracking solution is essential in emergency situations, as evidenced by [Malaysia Airlines Flight] 370 earlier this year and Air France [Flight] 447 in 2009," said Aireon President and CEO Don Thoma. A search is continuing in the southern Indian Ocean for the Malaysia Airlines Boeing 777 that disappeared March 8 with 239 people aboard; the Air France Airbus A330 crashed into the Atlantic Ocean on June 1, 2009, but its flight recorders were not located for nearly two years.

The emergency locator service will become available after Aireon's ADS-B surveillance capability is fully operational, probably in 2017. The service will be available through an emergency call center, the company said.

"Historical track data will be available to pre-authorized users, including ANSPs [air navigation service providers], airlines, and search and rescue authorities … soon after controller communications are lost with an aircraft, and the system can also provide real-time tracking of aircraft in distress, provided ADS-B transmissions are still operational," the company said.

Aireon is a joint venture involving Iridium Communications and air traffic control providers in Canada, Italy, Ireland and Denmark.

EASA Allows Broader PED Use

European airlines have been given the go-ahead to allow passengers to use some portable electronic devices (PEDs) during flight.

The European Aviation Safety Agency (EASA) says airlines may make their own decisions about whether to allow the use of PEDs, without putting them in "airplane mode," in all phases of flight; cell phones may be used after landing.

EASA said that each airline "will have to go through an assessment process, ensuring aircraft systems are not affected in any way by the transmission signals from the PEDs. For this reason, there may be differences among airlines [about] whether and when PEDs can be used."

Previous requirements, adopted in December 2013, allowed PEDs to be used in airplane mode during almost all phases of flight.

First Fatalities in 3 Years

Preliminary data show that, despite an overall decline in 2013 in the number of accidents involving U.S. civil aircraft, the year also saw the first fatal commercial air transport accident in three years that involved a U.S.-registered airplane.

Preliminary accident statistics released by the U.S. National Transportation Safety Board (NTSB) show that the total number of civil aviation accidents fell to 1,297 in 2013, down from 1,539 accidents in 2012.

The number of accidents involving scheduled U.S. Federal Aviation Regulations Part 121 (commercial air transport) operations declined, but the Aug. 14, 2013, crash of a UPS Airbus A300-600 in Birmingham, Alabama, U.S., was the first fatal accident in that category in three years. The crash killed both pilots — the only people in the airplane (see "Sooo Tired," p. 17).

The crash of another commercial airliner — an Asiana Airlines Boeing 777-ER in San Francisco on July 6 — that killed three passengers was not included in the NTSB statistics because it was a foreign-registered aircraft operating under Part 129.

The preliminary data also showed eight crashes involving Part 135 commuter operations in 2013 (up from four accidents in 2012), including three fatal accidents. There also were increases in crashes and fatalities involving Part 135 on-demand operations — including charter, air taxi, air tour and air medical flights — with 44 total accidents, 10 fatal accidents and 27 fatalities. The accident rate increased to 1.24 per 100,000 flight hours, up from 0.99 per 100,000 in 2012.

General aviation accidents decreased in 2013 to 1,222, down from 1,471 accidents in 2012. Decreases also were recorded in 2013 for fatal accidents (221) and fatalities (387), as well as the accident rate of 5.85 per 100,000 flight hours.

NextGen 'Call to Action'

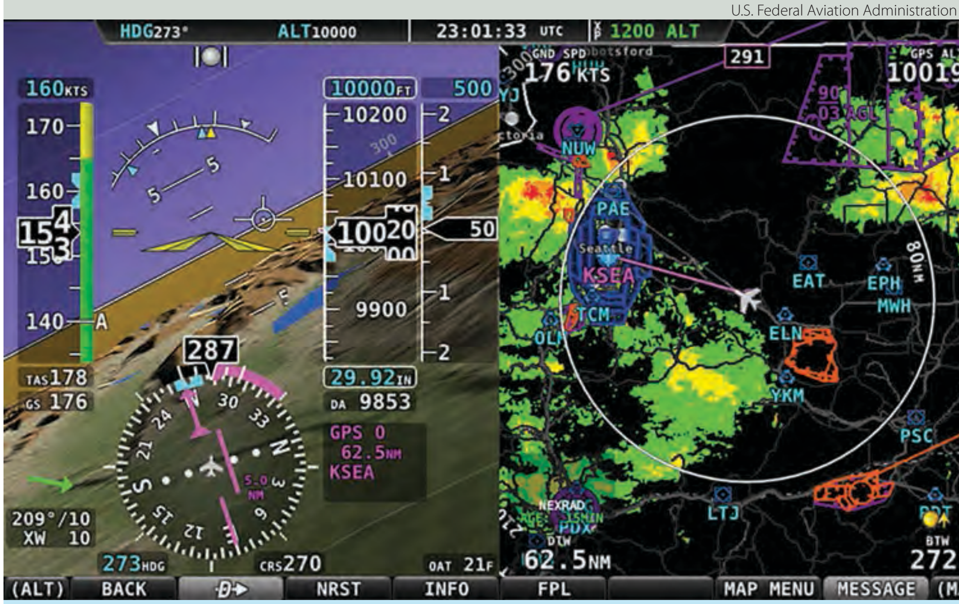
To achieve full safety benefits associated with the upgrade of the U.S. airspace, its users must work together to ensure that all aircraft in controlled airspace are equipped with automatic dependent surveillance–broadcast (ADS-B) avionics, a top U.S. Federal Aviation Administration (FAA) official says.

Deputy FAA Administrator Mike Whitaker said in September that the FAA has built the foundation for ADS-B, and now, "it is time for all users of the national airspace — avionics suppliers, aircraft integrators, operators and installers — to work together to ensure that all aircraft flying in controlled airspace are equipped with these NextGen avionics. The full benefits of increased safety and efficiency of the national airspace depend on 100 percent equipage."

Regulations require that all aircraft operating in specific controlled airspace must be equipped with ADS-B Out avionics by 2020. These systems transmit data, including aircraft identity, position and speed, from aircraft to ground stations and to other aircraft equipped with ADS–B receivers.

The FAA already has completed the ADS-B ground infrastructure with the deployment of 634 radio stations.

U.S. Federal Aviation Administration



Proposed Penalty

Gulfstream Aerospace is facing a proposed $425,000 civil penalty for what the U.S. Federal Aviation Administration (FAA) says was a failure to comply with regulations concerning the training of aircraft mechanics.

Some Gulfstream mechanics "did not complete required training within time limits established in its FAA-approved training manual, and they missed numerous training deadlines," the FAA said. "Additionally, after reviewing employee training records, FAA inspectors could not determine whether some of the employees completed training or whether the records were inaccurate. The FAA also alleges that Gulfstream allowed mechanics to maintain aircraft when they had not completed required training."

The agency said that it identified the discrepancies during inspections in November 2009 and March 2010.

Gulfstream has 30 days from its receipt of the FAA civil penalty letter to respond.

In Other News …

Eurocontrol and the European Global Navigation Satellite Systems (GNSS) Agency have agreed to a plan to develop **GNSS technology** to "improve accessibility, efficiency and safety" in European aviation. Plans include a new focus on aviation-specific GNSS performance monitoring and international promotion of European aviation-related GNSS activities. … The U.S. Federal Aviation Administration (FAA) has adopted a new plan intended to streamline the aircraft **certification** process. The FAA says the plan will allocate resources according to a project's safety benefits and complexity and provide the agency's commitment to a response time for completion of the project review.

Bart J. Crotty … Aviation safety/security consultant Bart J. Crotty, a former director of aviation safety services for Flight Safety Foundation, died Sept. 21. He was 79. During a career that spanned more than four decades, he worked as a U.S. Federal Aviation Administration airworthiness inspector and trainer and a designated airworthiness representative; at various times, he also worked for repair stations, airlines, an aircraft manufacturer, law firms, safety organizations and several non-U.S. civil aviation authorities.

Compiled and edited by Linda Werfelman.

NTSB's analysis of how occupants fared after Asiana Airlines Flight 214 collided with a seawall points to research opportunities.

BY WAYNE ROSENKRANS

Survival Factors

Sensing that the Boeing 777-200ER was about to impact the bay on its final approach to San Francisco International Airport, one of the flight attendants watched the water surface move closer through the window in door L2 (left side, second door from the nose) adjacent to his "A position" jump seat. Suddenly, he yelled for the flight attendant facing him — his "B position" colleague at the same door — to brace for impact. No warning had come from the flight deck.

Several other flight attendants realized, too, that the airplane was traveling or descending too quickly relative to the water surface. Then the airplane pitched up in an odd way, and they felt the first impact, similar to a hard landing, which one of them perceived as being quickly followed by a "crushing sensation." A seawall in front of the Runway 28L threshold had just sheared away the landing gear, part of the lower fuselage and the tail.

Among these details, the U.S. National Transportation Safety Board's (NTSB's) final report on the July 6, 2013, accident also said that the crew of Asiana Airlines Flight 214 perceived the crash sequence and, in some cases, suffered injuries in ways that varied depending on their seat locations (see "Research Directions," p. 16) and other factors.

A previous *AeroSafety World* article (*ASW,* 10/14, p. 14) summarized the probable cause and contributing factors in the crash, detailing the sequence of preceding events involving the flight crew. The final report essentially found that — in addition to the aircraft design meeting current U.S. standards for airworthiness and crash survivability (*ASW,* 4/14, p. 37) — the evacuation of the airplane and the aircraft rescue and fire fighting (ARFF) response proved to be critical, positive factors enabling the survival of 99 percent of occupants.

"Three of the 291 passengers were fatally injured; 40 passengers, eight of the 12 flight attendants and one of the four flight crewmembers received serious injuries," the report said. "The other 248 passengers, four flight attendants and three flight crewmembers received minor injuries or were not injured."

Crash Experiences

"The initial impact with the seawall occurred at 1127:50. … Some flight attendants stated that the first impact was followed by a sensation of lifting off again. Others reported being thrown against their restraints or that the airplane was shaking or rolling," the report said. "The flight attendants reported a second impact that was much more severe than the first. …. Most of the flight attendants reported items flying throughout the cabin and oxygen masks and ceiling panels falling down."

Video images recorded by airport surveillance cameras helped investigators to document the order of the airplane's momentary lifting and pivoting motions, then a sliding deceleration — all resulting in complex patterns of injuries or absence of injury. "When the main landing gear and the aft fuselage struck the seawall, the tail of the airplane broke off at the aft pressure bulkhead," the report said. "The airplane

© Reuters|Eugene Anthony Rah

slid along the runway, lifted partially into the air [tilting the airplane into about a 30-degree nose-down angle], spun about 330 degrees, and impacted the ground a final time [coming to rest off the left side of the runway, about 2,400 ft (732 m) from the initial seawall impact point … about 1128:06.26 local time].

"The impact forces, which exceeded certification limits, resulted in the inflation of two slide/rafts within the cabin, injuring and temporarily trapping two flight attendants. Six occupants were ejected from the airplane during the impact sequence: two of the three fatally injured passengers and four of the seriously injured flight attendants. The four flight attendants were wearing their restraints but were ejected due to the destruction of the aft galley where they were seated. The two ejected passengers (one of whom was later rolled over by two firefighting vehicles) were not wearing their seatbelts and would likely have remained in the cabin and survived if they had been wearing their seatbelts."

Mapping of the crash site (Figure 1, p. 14) showed that some major airplane components had come to rest between the seawall and the runway numbers, including the vertical stabilizer, the left and right horizontal stabilizers, and left and right main landing gear components. The left engine safely separated as per design specifications and came to rest about 600 ft (183 m) north of the main wreckage on a grassy area right of Runway 28L. The right engine safely separated but came to rest against the right side of the fuselage.

Evacuation Difficulties

Fuselage, door and slide/raft damage; debilitating injuries of some occupants; passenger entrapment by damaged cabin equipment; the slide/rafts that did not deploy normally because of door sill position or that inflated inside the cabin; and fire and smoke impeded some occupants when the airplane came to a stop about 16 seconds after initial impact. The oil-fed fire began within the right engine pressed against the fuselage and then destroyed sections of the airplane before being suppressed by ARFF personnel. The airplane's fuel tanks were not breached or involved in the postcrash fire.

The NTSB report contains selected evacuation vignettes and descriptions of occupant ejections. "Based on their injuries, the locations where they were found, and the statements of first responders, the four aft flight attendants were ejected out of the ruptured tail of the airplane during the airplane's slide down the runway," the report said.

When the airplane stopped sliding, flight attendant L2A, who had yelled for his colleague to brace for impact, directed passengers to remain seated while he assessed the postcrash situation for less than 93 seconds. He heard the flight attendant assigned to jump seat R2A screaming for help (Figure 2, p. 15). "Her legs had been pinned against the galley next to her jump seat by the inflated slide/raft, and she could not free them," the report said. "He went over to her to try to assist but was unsuccessful in freeing her. He saw fire and smoke outside the door 2R window and determined that they needed to evacuate. … He initiated an evacuation [entirely on his own], and 98 percent of the passengers successfully self-evacuated."

About 20 seconds after the airplane stopped moving, the captain, who was the pilot monitoring (PM), spent one minute and 11 seconds attempting unsuccessfully to obtain the airport tower controller's assessment of the condition of the airplane, which was temporarily enveloped in dust. The airport tower controller heard these radio transmissions, but, except for the aircraft call sign, they were unintelligible, so the controller repeatedly said only that ARFF vehicles were responding. "When the PM understood emergency vehicles were responding, he read and accomplished the evacuation checklist. … Once the initial steps of the checklist were completed, he issued an evacuation order." The cabin manager later told investigators that when she heard an unidentified voice (L2A) announce the command "Evacuate!" she opened door 1L and began to direct passengers onto the slide/raft at that door.

The flight attendant assigned to door/jump seat R1 was initially unconscious and trapped in her jump seat by an inflated slide/raft. She was freed by the efforts of her husband (a passenger), the cabin manager and another flight attendant and then was assisted in exiting down the door 1L slide/raft. The legs of flight attendant R2A, who was conscious, remained trapped although she had unfastened her restraint and fallen to the floor.

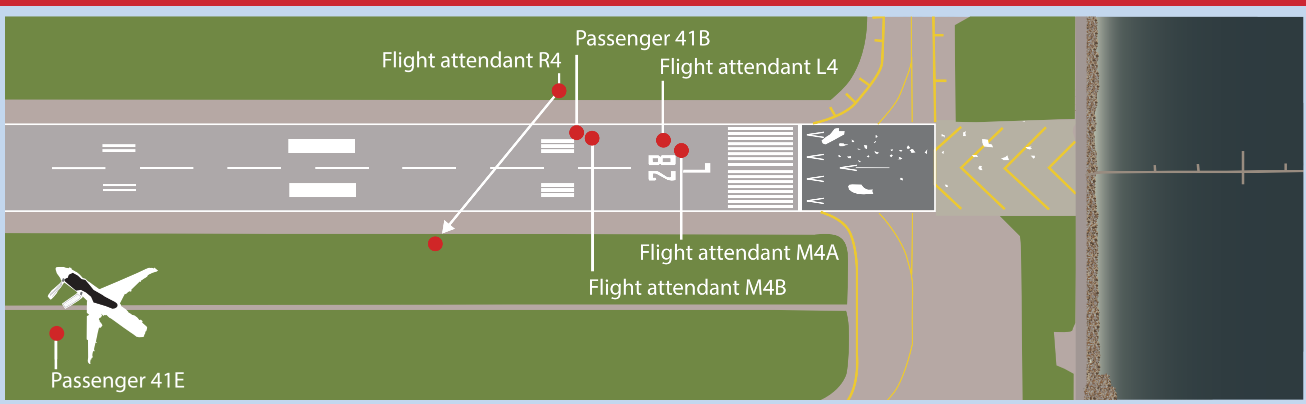
"Several flight attendants and at least one member of the flight crew helped her," the report said, and they used a knife from the galley and had knives provided by emergency responders to puncture the slide/raft and free the trapped flight attendant. The relief first officer tried to extinguish an interior fire while "the remaining flight attendants and flight crew in the front of the airplane evacuated from either door 1L or door 2L."

Only one of the six flight attendants in the rear half of the airplane, who later said she had lost consciousness for a few seconds after impact, was physically able to take part in conducting the evacuation. She was assigned to door/jump seat L3. She told investigators that she had been unable to open door L3 or to command the evacuation of her zone by interphone handset.

A passenger, meanwhile, had opened door 3R and was directing passengers out that door, and from near her jump seat, flight attendant L3 directed evacuating passengers to exit via door 2L and door 3R. The flight attendant responsible for door 3R had been thrown to the floor and seriously injured despite her fastened jump seat restraint, and a passenger helped her exit from her assigned door.

"When all of the ambulatory passengers in her area had evacuated, flight attendant L3 noticed that several passengers were not evacuating," the report said. "She commanded them to evacuate but realized that some passengers were trapped. She went to the back of the airplane and tried to help extricate them until firefighters arrived, but she was forced to evacuate because of the smoke and difficulty breathing. … As the fire spread into the fuselage, firefighters entered the airplane and extricated five passengers (one of whom later died) who were injured and unable to evacuate. … Once outside, the uninjured flight attendants performed various duties, such as gathering passengers together, attending to injured

Positions of Flight 214 Occupants Found Outside the Aircraft



Source: U.S. National Transportation Safety Board

Figure 1

passengers and crewmembers, and notifying responders that the four flight attendants who had been seated in the aft galley area were missing."

How Fatalities Occurred

A deceased 16-year-old female passenger, who had been assigned to seat 41B but reportedly occupied seat 41D for landing, was found on the right side of the runway about midway between the seawall and the main wreckage, the report said. A deceased 16-year-old female passenger, who had been in seat 41E, was found about 30 ft (9 m) in front of the airplane's left wing and about 50 ft from the left side of the fuselage. A 15-year-old female passenger, who had been in seat 42A, "was taken to the hospital from the scene and died six days after the accident," the report said.

Eight flight attendants who were able to provide oral or written statements to NTSB investigators described a normal flight and normal performance of their cabin safety duties in preparation for landing. "They reported that they performed their seatbelt compliance checks and that at least two flight attendants (the cabin manager and flight attendant L2A) checked [the aftmost, travel class zone]," the report said.

"The three passengers who sustained fatal injuries were part of a school group traveling from China to the United States to attend summer camp," the report said, and three surviving students who had been seated near those fatally injured described the circumstances to NTSB investigators. "They reported that their fatally injured friend [occupying seat 41B was] covered by a blanket at the time of landing. They did not know if she was wearing her seatbelt. They also reported that [another] fatally injured friend … was seated in her assigned seat [41E] and was not wearing her seatbelt at the time of landing."

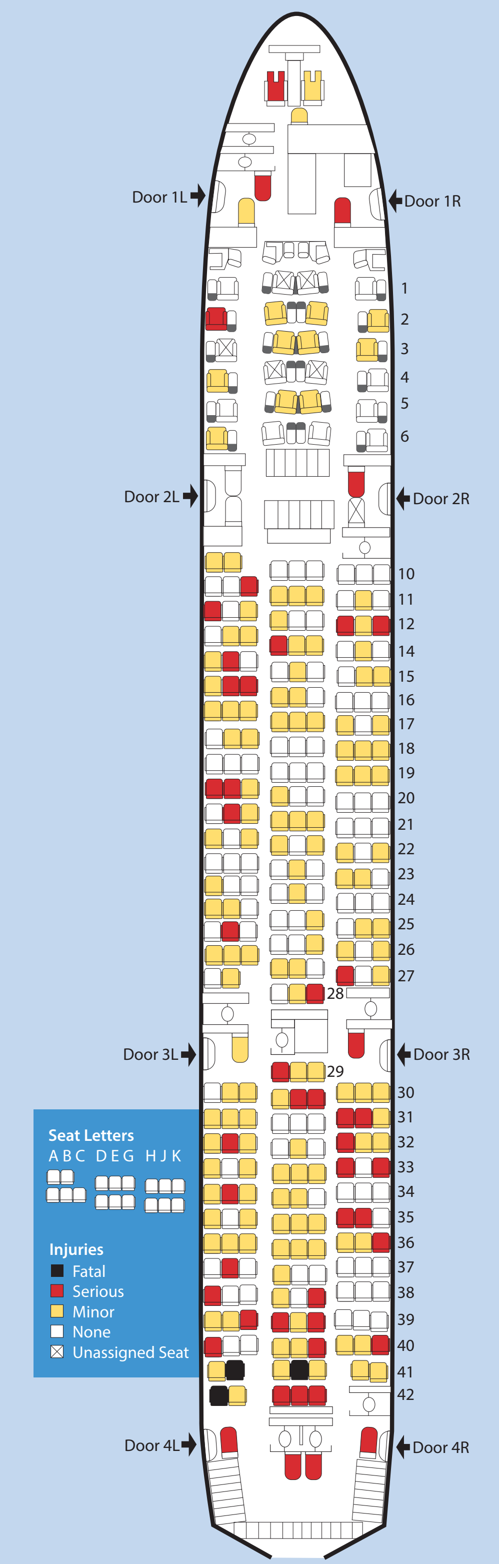
The students said that they did not know the seating/seatbelt status of the third fatally injured student, but one of them said that a flight attendant (L2A) had come through the cabin for the pre-landing check and specifically had reminded her to fasten her seatbelt. A nearby passenger corroborated that the cabin crew had been especially attentive to the student group before landing and had enforced all cabin safety rules.

One student told interviewers that two of the deceased friends' seats were empty when the aircraft came to a stop, the report said, noting, "All three students believed that their friends, passengers 41B and 41E, were ejected from the airplane during the impact. … The NTSB concludes that [two of the] passengers … were unrestrained for landing and ejected through the ruptured tail of the airplane at different times during the impact sequence."

ARFF Operations

The control tower alerted most ARFF units and other emergency responders at 1128:00, about 10 seconds after the airplane collided with the seawall. Highlights from more comprehensive details in the NTSB's report include discussion of the response time; the actions taken to rescue the last group of passengers; finding/accounting for deceased passengers and assisting injured

Flight 214 Occupant Injuries



Source: U.S. National Transportation Safety Board

Figure 2

Research Directions

The U.S. National Transportation Safety Board's (NTSB's) final report on Asiana Airlines Flight 214 called for survival factors–related research into factors that, in some cases, were possibly unique given the unusual dynamic forces and other circumstances.

- **Injury potential from significant lateral forces, as opposed to longitudinal forces, in airplane crashes.** The research objective would be to improve understanding of what caused high thoracic spinal injuries to some occupants of Flight 214. "In this accident, the dynamics were such that occupants were thrown forward and experienced a significant lateral force to the left during the impact sequence," the report said.
- **Adequacy of slide/raft inertia load–certification testing.** Slide/rafts in this case were subjected to impact-sequence forces much greater than those currently established for their performance certification. NTSB recommended that mitigation of overload failures of the slide/raft release mechanisms be considered in relation to data yielded by this investigation.
- **Improvements to ARFF response capabilities.** These would cover issues identified in command assignment, fuselage skin–piercing guidance, a U.S. Federal Aviation Administration (FAA) requirement for minimum staffing level, interoperability of radio frequencies between the airport-based aircraft rescue and fire fighting (ARFF) and non-ARFF/backup fire fighting companies, timely emergency medical supply bus deployment, vehicle operation to avoid striking or rolling over ground casualties (which occurred in this accident to passenger 41E) and FAA oversight of the timely implementation of local procedure manuals. "Although no additional injuries or loss of life could be attributed to the fire attack supervisor's lack of ARFF training [and consequent decisions], it demonstrates the potential strategic and tactical challenges associated with having non–ARFF trained personnel in positions of command at an airplane accident," the report said regarding two of those issues. Vehicles equipped with high-reach extendable turrets and skin-piercing nozzles were not used optimally in the initial Flight 214 fire attack, according to NTSB, indicating a need for updated consensus in the U.S. ARFF community about whether piercing should begin even before all occupants are known to have evacuated the airplane.

— WR

flight attendants ejected from the moving aircraft; and fire suppression.

When the first emergency response vehicle, occupied by one airfield security officer, reached the scene, passengers had been coming down the slide/rafts at doors 1L and 2L for about 25 seconds. The San Francisco Fire Department's first ARFF vehicle arrived at the aircraft at 1131:11 and began to apply foam to the visible fire in the right engine, the report said. The second of seven ARFF vehicles arrived and applied extinguishing agent to the fire about 37 seconds later. "Within about 20 seconds of [the second vehicle's] arrival, most passengers had finished evacuating from doors 1L and 2L," the report said.

During the rescue phase of their response, firefighters searched the smoke-hazy cabin, extinguished the interior fire spreading from the right engine and found an estimated four to six passengers unable to self-evacuate — some pinned beneath seats — while a flight attendant and other passengers stayed with them.

Firefighters and airport police officers, who entered through the tail section opening, removed these passengers from the airplane. "At 1138:37, [the first] three firefighters climbed the 2L slide/raft … and entered the cabin," the report said regarding the elapsed time. "Based on information from multiple sources, it is likely that the last passenger was extricated from the back of the airplane about 1147." The fire was brought under control at 1218:30 after simultaneous, elevated attacks by two ARFF vehicles equipped for fuselage skin piercing and aerial application of extinguishing agents.

After a person was seen walking across the runway toward the aircraft at 1149:41 (Figure 1) from the position where flight attendant jump seat R4 later was found, and was assisted by passengers who had evacuated, the ARFF responders conducted a search of the entire debris field between the seawall and the airplane wreckage.

The distribution of occupants with serious injuries prompted an inquiry into three patterns of injury seen, using the associated medical records. The report said, "The 40 passengers with serious injuries were primarily located in the aft cabin. … Twenty-four passengers and five flight attendants sustained spinal injuries. The passengers with spinal injuries were also primarily located in the aft cabin, with 20 of the 24 passengers (83 percent) with spinal injuries located in C-zone [the aftmost section]."

This article is based on NTSB Accident Report AAR-14/01, "Descent Below Visual Glidepath and Impact With Seawall; Asiana Airlines Flight 214; Boeing 777-200ER, HL7742; San Francisco, California; July 6, 2013." The report is available at <ntsb.gov/investigations/reports.html>.

Commercial flight crews engaged in overnight operations should be required to discuss fatigue in briefings before every departure, the U.S. National Transportation Safety Board (NTSB) says, citing the Aug. 14, 2013, crash of a UPS Airbus A300-600 during an early morning approach to Birmingham, Alabama, U.S.[1]

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'Sooo Tired'

BY LINDA WERFELMAN

The NTSB is urging new steps to mitigate fatigue during overnight flights.

The crash just short of the runway at 0447 local time — 43 minutes after departure from Louisville, Kentucky, U.S. — killed both pilots, the only people aboard. The airplane was destroyed by the impact and subsequent fire.

In its final report on the accident, adopted in September, the NTSB cited flight crew fatigue among four contributing factors to the accident. The report said the probable cause was the crew's "continuation of an unstabilized approach and their failure to monitor the aircraft's altitude during the approach, which led to an inadvertent descent below the minimum approach altitude and subsequently into terrain."

The report noted that both pilots had complained before the accident about fatigue, and that they had discussed their tiredness during the flight.

Accident investigators' interviews with pilots who knew the captain revealed "that he was concerned about his schedules over recent years and that he had told them that the schedules were 'killing' him and becoming more difficult," the report said. Nevertheless, an analysis of his work schedules for the 60 days preceding the accident showed that, although his three previous trip pairings had required him to fly six days straight, after each of those pairings he had at least seven days off, "allowing for adequate time to recover from any sleep debt he may have acquired while on duty."

The captain's wife said he had been healthy and happy and had exercised often in the days before the accident — a description that the report said was "not characteristic of someone experiencing chronic fatigue." He also slept well the two nights before the accident flight, according to his wife, and "took several steps to minimize the effects of fatigue due to the circadian clock[2] before going on duty Monday night [Aug. 12]," including a nap during the day and an 80-minute "rest opportunity" in a crew sleep room at Louisville International Airport.

He spent nearly four hours on duty early Tuesday, Aug. 13, followed by 14 hours 30 minutes of scheduled rest. Records showed he had three separate sleep opportunities totaling about 9 hours 45 minutes, which the report said represented "adequate opportunity to obtain a full eight hours of sleep."

Despite the captain's sleep preparations, the report said that he might have been experiencing fatigue at the time of the accident because of the natural dip in the body's circadian rhythm that occurs between 0200 and 0600 — a time when the human body is programmed to be asleep and alertness and performance are degraded.[3]

Sleep Debt

The first officer began the trip pairing on Aug. 10 with a flight from Louisville to San Antonio, Texas, where she had a scheduled 62-hour layover, the report said. From San Antonio, she boarded a commercial flight to Houston to visit

The NTSB cited pilot fatigue as a contributing factor in the early morning crash of this UPS Airbus A300 in Birmingham, Alabama, on Aug. 14, 2013.

U.S. National Transportation Safety Board a friend. Her husband said that, when she was not working, the first officer typically slept between nine hours and 10½ hours a night. While in Houston the night of Aug. 10, however, she slept about 6½ hours. She returned to San Antonio on an afternoon flight on Aug. 12 and, although she had two opportunities of about an hour each to nap before reporting for duty, investigators could not determine whether she slept at those times.

"It appears that the first officer chose to revert to a diurnal schedule during her 62-hour layover, sleeping at night and being awake during the day," the report said. "Her PED [portable electronic device] usage indicated few opportunities for sleep during the layover. Although she was not required to stay in [San Antonio], she was required to arrive for work fit for duty and should have ensured that she received adequate sleep before reporting for duty on August 12."

UPS would have paid for her to stay in a hotel room in San Antonio during the layover, the report said, noting that she could have taken that opportunity to adjust to a nocturnal schedule.

The report added that, "because the accident occurred during the window of circadian low, the first officer was awake in opposition to her normal body clock and would have been more vulnerable to the negative effects of fatigue that she was already experiencing."

When she reported for duty, the first officer probably had been awake about 13 hours; her duty period required that she be awake for an additional 9½ hours. She texted a friend about 90 minutes before going on duty that she was "getting sooo tired."

She left San Antonio at 2151 on Aug. 12 to fly three legs, and ended her workday after landing at Chicago Rockford International Airport (RFD) at 0553 on Aug. 13. Accident investigators calculated her sleep debt then, at the start of a 14½ hour layover, at more than nine hours. During her layover, she had two sleep opportunities totaling about 5½ hours — less than the seven to nine hours typically recommended for adults and less than the nine to 10½ hours that had been described as typical for her.

"She did not afford herself the opportunity to obtain additional sleep, as evidenced by her repeated PED usage and the fact that she was out of her room from about 1100 to 1522," the report said. "The first officer was aware of her fatigued state, as she texted a friend about 1118, stating … 'i fell asleep on every … leg last nite- in rfd now. … slept like 4 … [hours] … hoping i will nap again this afternoon.' Given the first officer's discussions with friends about her fatigue, she should have used her off-duty time more effectively to obtain as much sleep as possible."

She returned to duty at 2036 on Aug. 13 and flew two legs with the accident captain. When they landed in Louisville, she had a sleep opportunity of almost two hours and obtained a sleep room. The cockpit voice recorder later recorded her telling the captain that she had slept and that she had been tired when her alarm rang before the flight.

"There was no follow-up discussion by the captain about whether the first officer was fit for duty," the report said. "Even if the first officer had been able to take advantage of the full rest period in RFD and the sleep opportunity in [Louisville], due to the excessive sleep debt acquired over the previous two days due to her personal choices and the accident flight occurring during the window of circadian low, it is unlikely that she would have been able to fully recover and be adequately rested for any of her duty period that began on the evening of August 13."

The report said that the first officer made several errors during the flight that would have been consistent with being fatigued; among them were not recognizing "cues suggesting that the approach was not set up properly," not adequately cross-checking and monitoring the approach and missing callouts."

'Pivotal Role'

In a concurring statement included in the final report, NTSB Member Mark Rosekind, an expert in human fatigue, noted that, in 45 years of accident investigation, the agency has identified fatigue as a factor in numerous accidents in aviation and other transportation modes, and issued more than 200 safety recommendations involving scheduling policies, sleep disorders and related technological issues.

In this accident report, he added, the board described "fatigue's pivotal role in the events causing this accident. It is only through a precise and complete understanding of how sleep loss and circadian factors affected the crew's management of the landing approach that we can help avoid incidents like this in the future, see where the related safety gaps are in aviation and apply what we have learned to safety across all transportation modes."

New Rules

The U.S. Federal Aviation Administration (FAA) implemented new, stricter flight and duty time limits effective in January 2014 for Federal Aviation Regulations Part 121 passenger operations, but cargo operators were exempt from the new rules. The NTSB has said repeatedly that the rules should apply equally to passenger and cargo operators — a concept endorsed by UPS pilots but not by the company.

The new rules were not in effect for any operator at the time of the crash. Nevertheless, the report said that an FAA analysis of the accident crew's schedule for this pairing (which constituted four days for the captain and seven days for the first officer) showed that it would have been in compliance with the new scheduling rules.

Mitigation Efforts

At the time of the accident, UPS had a fatigue risk management program, which included training on fatigue and more stringent limits on flight and duty time than required under Part 121. Company policy said that pilots who reported being too fatigued to work "would be immediately removed from duty until they felt fit to fly again," the report said. "The crewmember was then required to complete a fatigue event report that would be reviewed by company and union representatives to determine if the company or the crewmember was responsible for the fatigue. If it was determined that the crewmember was responsible, … the crewmember's sick bank would be debited for the time not flown."

The policy also allowed the crewmember to repay the sick-bank debit by working an extra trip during the current pay period or one of the next two periods, the report said, adding, "The NTSB concludes that the first officer did not adhere to the UPS fatigue policy; she could have called in fatigued for the accident flight if she were not fit for duty and been immediately removed from duty until she felt fit to fly again."

The report noted that when a pilot called in fatigued, the airline placed a note in his or her file — an action that the union, the Independent Pilots Association (IPA), said was punitive.

The report's recommendations said UPS and the IPA should work together to give the pilots more information about fatigue and fatigue mitigation and that they should:

- Review the company's fatigue-event-reporting system "to determine the program's effectiveness as a nonpunitive mechanism to identify and effectively address the reported fatigue issues" and implement whatever changes are needed to "enhance the safety effectiveness of the program"; and,
- "Counsel pilots who call in fatigued and whose sick bank is debited to understand why the fatigue call was made and how to prevent it from recurring."

Fatigue Briefings

Preflight briefings only sometimes discuss fatigue, depending on pilot preferences, the report said.

"Given the increased likelihood of fatigue during overnight operations, briefing the threat of fatigue before every flight would give pilots the opportunity to identify the risks associated with fatigue and mitigate those risks before taking off and throughout the flight," the report said.

The report's fatigue-related safety recommendations also included a call for the FAA to require principal operations inspectors to ensure that operators of overnight flights conducted under Part 121 — and also Part 135 (commuter and on-demand) and Part 91 Subpart K (fractional) operations — brief the threat of fatigue, especially before flights that occur during the window of circadian low.

Notes

1. NTSB. Accident Report NTSB/AAR-14/02, *Crash During a Nighttime Nonprecision Instrument Approach to Landing; UPS Flight 1354, Airbus A300-600, N155UP; Birmingham, Alabama; August 14, 2013*. Available at <www.ntsb.gov>.
2. The body's circadian clock is a biological clock in the brain that regulates patterns of sleep and wakefulness during each 24-hour period.
3. Flight Safety Foundation; U.S. National Business Aviation Association. *Duty/Rest Guidelines for Business Aviation*. April 2014. Available at <flightsafety.org/files/DutyRest2014_final1.pdf>.

Civil aviation authorities must adapt to the latest SMS practices embraced by aviation service providers.

BY MARIO PIEROBON

Performance-Based Oversight

The worldwide implementation of safety management systems (SMSs) by aviation service providers signals a shift from traditional reactive and compliance-based oversight to a new model that includes proactive and performance-based tools and methods. Such a shift, however, introduces a parallel need for civil aviation authorities (CAAs) to perform their safety oversight functions in a similar way. This means accepting performance-based oversight (PBO) as the upcoming challenge in enforcing safety regulations.

Gian Andrea Bandieri, standardization team leader in the Approvals and Standardization

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Directorate of the European Aviation Safety Agency (EASA), defines oversight as "the function by … which a state ensures implementation of aviation regulations, in order to ensure an adequate level of safety across the regulated industry."

Compliance-based oversight (CBO) is built upon "the assumption that if an organization is fully compliant with the applicable safety requirements, then an adequate level of safety is achieved. Hence, CBO focuses on verifying the compliance of service providers with all applicable regulatory requirements and requires such verifications to be repeated at regular intervals, regardless of the level of compliance and maturity achieved by the organization under scrutiny," says Bandieri.

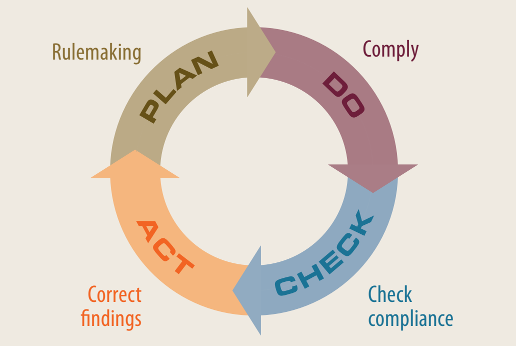
Brooke Williams, regional communications officer at Transport Canada (TC), says that "compliance-based oversight uses a traditional audit approach methodology that looks at line-by-line compliance to a set of regulations or standards."

Safety oversight based on compliance was the predominant characteristic of aviation safety regulation until relatively recently, and it is still in use. It was introduced at the beginning of civil aviation, when any new or amended regulation typically was written after a major or minor occurrence and focused on the technical causes. In a CBO environment, CAAs "look over the shoulder" of the aviation industry and inspect it regularly.

"This approach proved to work from the early years of aviation, and is still valid for small organizations, or when the regulatory environment is not fully mature. However, the regulatory environment in several domains has reached a level of maturity where further safety improvements cannot be achieved by following a purely compliance-based approach," says Bandieri.

According to the French Direction Générale de l'Aviation Civile (DGAC), formal compliance with safety regulations through quality control checks alone is not sufficient to keep upgrading operational safety to the desired level. Available resource utilization is not optimized for safety in this system.[1]

Deming Quality Cycle for Compliance-Based Oversight



Note: In a compliance-based safety oversight culture, the Deming cycle closes upon compliance with the rule.

Source: Vernay and Marcou

Figure 1

The DGAC graphically depicts the traditional compliance-based safety oversight regime in the Deming Quality Cycle (plan, do, check, act) to emphasize that the cycle closes upon compliance with the rule —not based on safety performance — with the continuous alternation of four subsequent steps: rulemaking, compliance, compliance check and correction of findings (Figure 1).[2]

The idea that compliance alone may not be the proper course of action to mitigate all risks led the International Civil Aviation Organization (ICAO) to introduce the framework of SMS, an approach that requires service providers to collect risk data, classify threats according to operational exposure and define and apply appropriate mitigation actions. Under this approach, states are required to do exactly the same thing at a higher level to define and carry out their strategic safety plans.[3]

New Oversight Regime

Bandieri says that PBO is "an answer to the increasing size and complexity of regulated subjects. Regulators needed to find a way to better target the areas posing risks to safety, in order to ensure continuing safety improvements in a more challenging environment. Performance-based safety oversight requires an adequate and mature regulatory environment, where safety risk management is the recognized way forward to address, and possibly improve, aviation safety. The publication of ICAO Annex 19 [*Safety Management*] confirms this worldwide trend."

TC's Williams describes PBO as "an assessment of the level of compliance exhibited by an enterprise with respect to the aviation regulations. This assessment is used to determine whether the organization has effective or non-effective performance, which is one of [the] considerations in risk-based decision making."

PBO is peculiar to the new environment of performance-based regulations, and it implies "a new approach for authorities to discharge their responsibilities, as it considers the implementation of safety management by service providers and links it to the implementation of state safety programmes (SSPs) by states, in the context of performance-based regulations. These are regulations focusing on measurable safety objectives, rather than prescribing mandatory methods of compliance to achieve the same objectives," says Bandieri.

Performance-based safety oversight is not simply meant to monitor how service providers implement the new performance-based regulations related to safety management. It also is meant to continue ensuring service providers' compliance with technical regulatory requirements. However, "it will do it in a completely different way. It will concentrate more on the effectiveness of SMS. It will lead to a compliance optimization of oversight activities," says Thomas Mickler, head of the Standardisation Department at EASA.[4]

Deming Quality Cycle for Performance-Based Oversight

SMS = safety management system

Notes: In a performance-based safety oversight culture, the Deming cycle closes upon actual safety performance.

Source: Vernay and Marcou

Figure 2

The French DGAC also graphically depicts the perspective of the PBO regime by using the Deming Quality Cycle to close the cycle based on actual safety performance with the continuous alternation of four subsequent steps: definition of prioritized risk-mitigation actions (plan); consideration of risk-mitigation actions by operators in their SMSs (do); check of the application of the mitigation actions through the SMS oversight program (check); and revision of action plans where necessary (act) [Figure 2].[5]

Measuring Safety Performance

PBO "must consider the safety performance of service providers both at an individual and aggregate level, where safety performance can be seen as the service provider's ability to manage [its] own risks (safety management capability) in respect to its ability to comply with applicable requirements, implement and maintain effective safety management, identify and manage safety risks, achieve and maintain safe operations," says Bandieri.

He defines the character of today's oversight as the way a regulator collaborates with an organization to meet mutual safety objectives, and he says that in the context of performance-based safety regulations, PBO becomes the key to success. Moreover, PBO will require authorities to assess the safety management capabilities of regulated entities by developing a different oversight regime from legacy practices, that is, a framework that is more tailored to that organization's specific identified risks.

"It will mainly focus on the service provider's ability to identify risks within its operations and [on] mitigating them appropriately, as demonstrated through appropriate [safety] performance indicators. The performance of the service provider should be taken into account, on top of its ability to comply with requirements. This may involve more interaction, monitoring, negotiation and objective judgment, both for the service providers and the authorities' staff involved," says Bandieri.

Performance measurement can occur through multiple means, in particular through qualitative interpretations, actual measurements, predictions and the determination of the appropriate level of risk.[6]

Performance objectives and key performance indicators (KPIs) will form the basis for decision-making processes. There still is debate as to what constitutes a good KPI, and this is the area that is the least mature. More effort needs to be placed on how to define good KPIs. There should not be reliance simply on KPIs; the judgment of the aviation safety inspector is crucial.[7]

Redefining Inspector Functions

If technical expertise was the main skill expected from CAA aviation safety inspectors under the CBO framework, additional skills are now expected from them under the developing framework of PBO.

"Performance-based oversight," says TC's Williams, "includes physical inspections and looks at the effectiveness of the documentation and system that is in place while compliance-based oversight involves a review of documentation, and may include physical inspections as well, to verify that the regulatory requirements are being met and the systems are in place. Inspectors must possess technical expertise, be skilled in analytical thinking and data analysis and be able to apply risk management processes consistently."

Regarding the additional set of skills expected from inspectors, Bandieri says they "need to acquire the ability to assess safety management systems. This requires them to also change their approach to the role … becoming more of a 'sparring partner' of the organization [overseen], rather than an inspector checking compliance with regulatory requirements. To this end, a less rigid and more pragmatic and listening approach would enable inspectors to better understand how risks are mitigated and to assess the effectiveness of the mitigation process."

As CAA oversight becomes increasingly based on performance, "the ability to measure safety performance should also become part of the inspectors' knowledge base. This means a basic understanding of safety analysis techniques and an understanding of how to work with safety indicators," adds Bandieri.

Stephan Eder of Switzerland's Federal Office of Civil Aviation lists some additional inspector skills required under PBO. Specifically, he cites experience in management, competence in identifying and agreeing on safety performance metrics, competence in understanding business processes, and judgment (the ability to deal with subjectivity).[8]

PBO not only requires different qualifications for inspectors but also requires a cultural change; safety professionals have to accept the new safety culture and eventually have to "live" it.[9]

Implementing PBO

In addition to appropriately training inspectors, a CAA should implement a number of additional programs to ensure that a country's aviation industry is thoroughly overseen in a performance-based fashion.

According to TC, the starting point is the state having an SSP. "Every regulatory authority will have its own state safety program as required by [ICAO]. A solid SSP will allow the authority to promote and build awareness of performance-based programs," says Williams.

"The answer to this challenge," according to Bandieri, "is in the adoption of the safety management methodology at all levels — through the state safety program at state level, through the … SMS at service provider's level."

"The SSP provides a structure for meeting state responsibilities for safety management using a systematic, performance-based approach. It provides a framework to system safety that stresses the performance of safety-critical processes in service providers' activities and in state oversight functions. As such, it supplies a framework for safety decision making. An important aspect of the SSP is in defining the relationship between the state, through the SSP, and the system of service providers through their [SMSs]," adds Bandieri.

"Safety improvements will depend on identification and control of hazards in a more nuanced fashion using strategies that help managers of individual aviation organizations identify and control hazards in the context of their unique operations. This is where the SMS is important. Safety measurement must, therefore, include measures that indicate the robustness of SMS design and the performance and effectiveness of the safety management capability of each organization," he says.

It is very important to highlight that in a PBO system, prescriptive requirements and compliance with them are not replaced by safety management, they are *complemented* by it. In fact, this is the only way it is possible to achieve substantial safety improvements when addressing random or unique causes of occurrences, which are specific to a given aviation system or to a certain service provider.

"Prescriptive and performance-based regulations are not mutually exclusive; most regulatory structures will continue to contain both elements with different proportions. When promoting performance-based regulations, it is essential to consider the specific case and regulatory context of the area under consideration, including the capabilities of regulated persons to implement performance-based schemes, as well as of competent authorities to ensure proper oversight. Regulatory policy should set clear criteria for decision making regarding regulatory alternatives," says Bandieri.

Regulatory Progress

ICAO recognized the need to develop a frame of reference for PBO to support implementation by CAAs and responded by publishing Annex 19, the first new ICAO annex in 30 years.

"The regulations contain a mix of prescriptive and performance-based standards. In some cases, prescription is necessary to meet the ICAO requirements. To pursue performance-based oversight, regulators need to define the intent of regulations and develop a solid interpretation of how the regulation can be met. The regulator has to make sure the industry is well informed and aware of the regulatory intent. This is generally accomplished through the SSP and, in particular, guidance material and promotions," says Williams.

"At state level," says Bandieri, "the key enablers for performance-based safety oversight are the mature implementation of state safety programs and the availability of less prescriptive, more performance-based requirements. Several countries have recognized such a need and are on their way to have these enablers in place. The level of achievement so far is quite different, depending on many local and cultural factors, however there is consensus that this is the way forward."

An example of the availability of the key enablers for PBO is Europe, where EASA has been conforming to the worldwide trend for SSP implementation and to the publication of more performance-based requirements by articulating its aviation safety regulations under three broad categories: authority requirements, organization requirements, and technical requirements and standards. These three categories can be seen in recently published EASA regulations, such as *Air Crew* and *Air Operations*.

Authority and organization requirements for PBO address systems and processes, and the rights and obligations, respectively, of competent authorities and service providers required to hold an approval. Technical requirements and standards are applicable either to individuals or approved organizations.[10]

Since 2009, ICAO, the U.S. Federal Aviation Administration, EASA and TC Civil Aviation have convened a working group to collaborate on issues related to PBO implementation, called the Safety Management International Collaboration Group (SMICG). Later, the group was expanded to include Australia, New Zealand, Brazil, Japan and other EASA states, such as the United Kingdom, Spain, Switzerland, France and the Netherlands.

"The purpose of the group," says Bandieri, "is to promote a common understanding of safety management principles and requirements and to facilitate their implementation across the international aviation community. In particular, SMICG members collaborate on common SMS/SSP topics of interest, share lessons learned, encourage the progression of a harmonized approach to safety management and share products with the aviation community. This cooperation indicates that, although there is still some way to go before PBO can be fully implemented, authorities are not just waiting for somebody to provide solutions, but they are active and pooling knowledge and ideas in order to proceed towards the common objective of performance-based safety oversight.

"As a matter of fact, this collaboration is already demonstrating its benefits in avoiding the duplication of efforts for states, assisting in developing robust and affordable safety management systems and increasing knowledge on SSP and SMS. Furthermore, there are also benefits for the aviation industry in terms of harmonization of SMS requirements and activities, consistent application of SMS oversight and provision of guidance material and tools."

Mario Pierobon is a safety management consultant and content producer. He currently is involved in an airside safety Ph.D. project at Cranfield University in the U.K.

Notes

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2. Ibid.
3. Ibid.
4. Mickler, Thomas (EASA head of Standardisation Department). "Conclusions of 2012 EASA Safety Conference." EASA Safety Conference, October 2012.
5. Vernay; Marcou.
6. Kneepkens, Jules (EASA rulemaking director). Presentation on "Performance-Based Regulation." EASA Safety Conference, October 2012.
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FACTOR OF INTEREST

An unexpected pitch-up and near stall during an ILS approach led Dutch authorities to discover a previously unknown — and potentially dangerous — signal anomaly.

BY MARK LACAGNINA

During the investigation of a recent serious incident, the Dutch Safety Board (DSB) found a "factor of interest" — an uncommanded climb and subsequent activation of the aircraft's stick-shaker (stall-warning) system during an autopilot-coupled approach.

This finding prompted a follow-up investigation that revealed previously unknown and potentially dangerous idiosyncrasies of instrument landing system (ILS) signals.

The aircraft, a Boeing 737-800, was inbound from Palma de Mallorca, Spain, to Eindhoven, Netherlands, with 124 passengers and seven crewmembers the morning of May 31, 2013.

The flight crew was receiving radar vectors for the ILS approach to Runway 21 at Air Base Eindhoven, a joint-use facility operated by the Royal Netherlands Air Force. Instrument meteorological conditions prevailed, and the crew had the autothrottle and the autopilot engaged with the approach mode armed, according to the DSB report.

A key element in the incident was that the aircraft remained above the 3-degree glideslope throughout the approach. The published procedure included waypoints defining a wide curve onto final approach. To shorten the route, the arrival controller issued a base-leg vector that bisected the curve but would still position the aircraft to be turned onto the localizer course outside the final approach fix (FAF) (Figure 1, p. 28).

However, unknown to the controller, a 30-kt quartering tail wind caused the aircraft to drift toward the runway. The 737 actually was heading directly toward the FAF when the controller issued the final vector for localizer interception. The aircraft subsequently was inside the FAF when the autopilot captured the localizer.

High and Close

Realizing that the aircraft was inordinately high and close on the approach, the captain told the first officer that a successful landing was unlikely and that they should be prepared for a go-around.

The crew selected a higher descent rate, but the 737 descended on a glide path parallel to and 1,000 ft above the 3-degree glideslope.

The 737 was about 1,000 ft above the ground and 1 nm (2 km) from the runway threshold when then autopilot captured a false (9-degree) glideslope. The pilots saw their glideslope indicators go full-down and then full-up before the aircraft unexpectedly pitched up. The pitch attitude increased about 3 degrees per second, reaching a maximum of 24.5 degrees.

The autothrottle commanded increased thrust, but airspeed decreased and the stick shaker activated. The crew recovered from the incipient stall and initiated a go-around. They subsequently conducted another ILS approach and landed the aircraft without further incident.

'Significant Threat'

Alerted by the flight crew, the operator of the 737 reviewed the recorded flight data and reported the incident to the DSB. "The activation of the aircraft's stick shaker during an autopilot-coupled ILS approach in close proximity to the runway was a factor of interest that prompted the Dutch Safety Board to start an investigation," the report said.

"During the investigation, it became clear that the Eindhoven incident was not unique," the report said. Investigators found four similar incidents in which uncommanded pitch-ups occurred during coupled ILS approaches. "These incidents took place with different types of aircraft, operated by different airlines, on approaches to different airports," the report said.

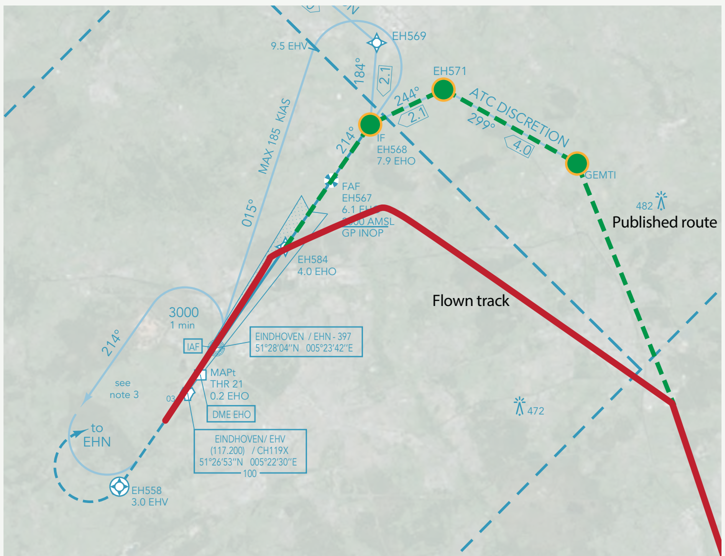
Common factors were that the incidents occurred above 3-degree glideslopes and involved highly automated aircraft that were being vectored to the final approach course by air traffic control.

"In all cases, moreover, the flight crews were aware that they were flying above the normal 3-degree glide slope," the report said. "They were also aware of the need to increase the descent rate of the aircraft to capture the 3-degree glide slope. However, their predictions (flight path management) as to where the 3-degree glide slope would be captured were inaccurate or at least unrealistic."

The report also said the investigation revealed that "flight crews' decisions to execute a go-around or to challenge air traffic control seem to be postponed too long when flying high above the normal vertical profile during an ILS approach."

The follow-up investigation led the DSB to conclude that "unknown ILS signal characteristics pose a significant threat to aviation safety, as

Boeing 737 Flight Path

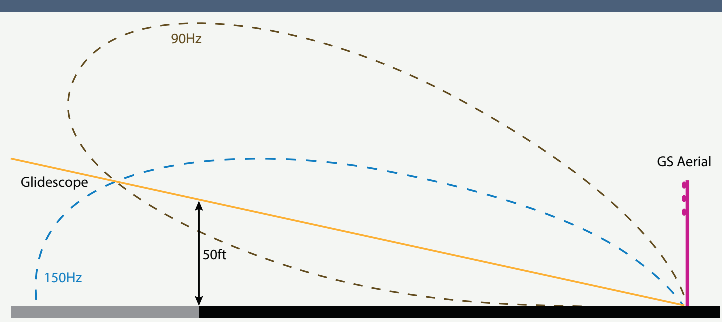


Notes: The aircraft intercepted the localizer inside the final approach fix and about 1,000 ft above the 3-degree glideslope.

Source: Dutch Safety Board

Figure 1

Glideslope Radiation



Notes: The null between the 90Hz (fly-down) and the 150 Hz (fly-up) signals defines the 3-degree glide path.

Source: Dutch Safety Board

Figure 2

they may result in unexpected aircraft behaviour and thus endanger the safety of passengers and flight crews."

Signal Reversal

The follow-up investigation revealed several misconceptions about ILS signal propagation.

"An ILS is commonly perceived as transmitting a focused localiser and glide slope beam, which form[s] a narrow electronic 'funnel' leading to the runway," the report said. "In reality, ILS antennas transmit a complex radiation field."

The report said that the complexity of the radiated field foments *erroneous* as well as *false* glideslope and localizer signals. An erroneous glideslope signal typically is the result of interference to its free radiation by terrain, man-made objects or aircraft taxiing in posted ILS critical areas. Erroneous signals also can occur during ILS maintenance and testing.

False glideslope signals, such as the one involved in the Eindhoven incident, are normal products of signal propagation. A 3-degree glideslope basically is defined by the radiation of two signals, stacked vertically, on different UHF frequencies. One signal (modulated at 150 Hz) causes aircraft navigation equipment to generate "fly-up" commands; the other signal (90 Hz) causes "fly-down" commands. The null that exists between the two signals defines the actual 3-degree glide path (Figure 2, p. 28).

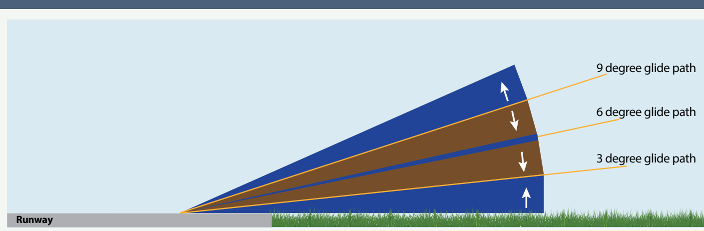
"It should be noted that a glide slope interception from below ensures a capture of the correct 3-degree glide slope," the report said.

The report noted that it is generally known that in addition to the normal 3-degree glideslope, false glideslopes are generated at 6, 9 and 12 degrees and so on at 3-degree intervals. However, the investigation revealed as false the assumption of some pilots that even a false glideslope signal will guide an aircraft to the runway, albeit at a steeper path.

When investigators measured glideslope signals at various airports in the Netherlands and the United States, they found that the signals can be reversed (Figure 3).

"Those measurements have shown that signal reversal with the ILS sometimes occurs at the 6-degree glide slope and always at the 9-degree glide slope," the report said. "As a result, when the aircraft crosses a reversed signal, instead of the required 'fly down' command to the runway, the aircraft systems do the opposite and give a 'fly up' command that causes the aircraft to suddenly pitch up."

False Glideslope Signal Reversal



Notes: Investigators found that reversal of the fly-up and fly-down signals always occurs at 9 degrees.

Source: Dutch Safety Board

Figure 3

The report emphasized that current aircraft instruments and equipment provide no warnings to flight crews about signal reversal.

Safety Alert

Based on the findings of the investigation, the DSB issued a safety alert in November 2013 that, in part, provided details about the potentially hazardous characteristics of ILS signal generation and their effects on aircraft, and recommended that operators provide guidance to flight crews "to mitigate the risks of unexpected autopilot behaviour when on ILS approaches."

The board also recommended that aviation authorities revise and disseminate guidance and training programs to help flight crews avoid the potential hazards of false ILS signals.

Moreover, the DSB recommended that pilots conduct a simple flight path cross-check: Multiply the aircraft's distance from the runway threshold (nautical miles) by three to obtain an estimate of the height (hundreds of feet) at which the aircraft should be to maintain a 3-degree glide path. For example, at 2 nm out, the aircraft should be at 600 ft.

"The use of [advanced] automation can result in situations where the flight crew's flight-path management degrades," the report said. "While supplementary aids or procedures may help [crews avoid] capturing a false glide slope, they should not substitute the regular distance versus altitude crosschecks that are part of the basic flying skills."

This article is based on the English translations of the Dutch Safety Board reports "Pitch-Up Upsets Due to ILS False Glide Slope" and "Stick Shaker Warning on ILS Final, Eindhoven Airport." The reports and links to videos about the Eindhoven incident and false glideslope signals are available at <onderzoeksraad.nl/en>.

Effective Monitoring

New guidance for improving flight path monitoring by pilots should help avoid accidents, working group says.

BY LINDA WERFELMAN

A *Practical Guide for Improving Flight Path Monitoring,* being published this month on the Flight Safety Foundation website <flightsafety.org>, tackles the issue of pilots' ineffective monitoring of the airplane's flight path, identified as a contributing factor in many accidents.

The guide is the final report of the Active Pilot Monitoring Working Group, created in 2012 by the first Human Factors Aviation Industry Roundtable, whose participants were concerned that, although aviation accident and incident rates had fallen to historic lows, too many accidents involved ineffective flight path monitoring as a factor.

"Monitoring is something that flight crews must use to help them identify, prevent and mitigate events that may impact safety margins," the guide says. "Modern data collection methods point toward ineffective monitoring of the flight path as a contributing factor in many accidents."

The guide cites a number of those accidents, including the Feb. 12, 2009, crash of a Colgan Air Bombardier Q400 on approach to Buffalo Niagara Falls (New York, U.S.) International Airport. The U.S. National Transportation Safety Board (NTSB) said the probable cause of the crash, which killed 49 people in the airplane and one person on the ground, was the captain's "inappropriate response to the activation of the stick shaker, which led to an aerodynamic stall." The NTSB's final report also noted a "significant breakdown in [the pilots'] monitoring responsibilities" during the flight.

The guide notes that because "monitoring" is a broad term and the monitoring function is an element of many tasks performed by flight crews, the working group's effort was focused on the monitoring of the aircraft's flight and taxi paths. "It is the errors that result in deviations from these intended paths that may lead to accidents," the guide says.

The working group identified half a dozen barriers to effective flight path monitoring (EFPM), including human factors limitations, time pressure, "lack of feedback to pilots when monitoring lapses," the design of flight deck systems and standard operating procedures, pilots' "inadequate mental models of autoflight system modes" and a corporate climate that has failed to support an emphasis on monitoring.

The group next identified organizational philosophies, policies, procedures, practices and

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training to be used in mitigating barriers to EFPM and developed 20 recommendations that were organized into four categories in the guide:

- Monitoring practices, including clearly defining the monitoring role of each pilot, adopting policies and practices to protect flight path monitoring against distractions and interruptions, and instilling the concept "that there are predictable situations during each flight when the risk of a flight path deviation is increased, heightening the importance of proper task/workload management";
- Procedures, policies and monitoring, including the analysis of corporate messages that conflict with EFPM;
- Monitoring autoflight systems, including addressing monitoring "as part of a comprehensive flight path management policy that includes guidance on use of automated systems"; and,
- Training and evaluating monitoring skills, including reinforcing "the responsibility of monitoring pilots to challenge deviations," incorporating training in monitoring into simulator sessions and increasing the emphasis on monitoring in operators' flight standards programs.

Overall, the guide says, the working group's hope is that "operators and aviation managers will share the vision … that successful flight path management is a keystone to mitigating future accidents."

That kind of success depends on two "equally critical components: proper flight path control and effective monitoring," the guide says.

"Traditional training and evaluation emphasize control of the aircraft over monitoring of the flight path," the document says. "This guide is intended to focus on developing and maintaining effective monitoring skills.

"Ultimately, how effectively the flight path is controlled and monitored is the product of a series of people making a series of decisions. … Managers create the policies and procedures designed to not interfere and/or to support prioritization of flight path monitoring. Pilots make task/workload decisions that expand their ability to monitor during areas of vulnerability to flight path deviations. It is essential that they share a common vision."

Developing a corporate philosophy that assigns a high priority to flight path monitoring is crucial, the guide says, adding that company leaders should emphasize their support for a strong monitoring program.

"Improved flight path monitoring is intended to reduce the amount of errors that result in flight path deviations," the guide says. "Despite the numerous barriers inhibiting monitoring, adopting recommendations in this guide is intended to improve monitoring effectiveness and substantiate the corporate investment in resources to do so."

'Unaware'

An A109E pilot failed to see an unlighted crane shrouded in fog before his helicopter struck it, the AAIB says.

BY LINDA WERFELMAN

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A witness said the top of the building at St. George Wharf was 'in and out of the mist' in the minutes before the fatal January 2013 crash.

The pilot of an Agusta A109E, intent on landing at the London Heliport despite deteriorating weather, turned his helicopter onto a collision course with an unlighted crane that he did not see in time to avoid, the U.K. Air Accidents Investigation Branch (AAIB) says.

The helicopter struck the crane, which was attached to a building under construction about 700 ft above mean sea level (MSL), and crashed onto a street near Vauxhall Bridge, where it burst into flames at 0820 local time on Jan. 13, 2013, killing the pilot — the only person in the helicopter — and a pedestrian.

In its final report on the accident, the AAIB cited as causal factors the pilot's decision to turn — noting that he was "probably unaware of the helicopter's proximity to the building at the beginning of the turn" — and the fact that he either did not see the crane or that he saw it "too late to take effective action." When it struck the crane, the helicopter was about 105 ft (32 m) from the building, the report said.

A contributing factor was the pilot's continuation of the flight "with his intention to land at the London Heliport despite being unable to remain clear of cloud," the report said.

The pilot's workday had begun at 0630, when he arrived at Redhill Aerodrome to prepare for a planned flight to Elstree Aerodrome, where he was to pick up a client and transport him and a second passenger to the north of England.

About 0649, the pilot talked by phone with another pilot employed by a different operator, expressing concern about weather conditions at Elstree and saying that he had decided to cancel the flight, even though he felt pressure to proceed. The accident report said that a third pilot told investigators that the accident pilot had called him at 0706, commented on reports of fog at Elstree and said he "was going to fly overhead to see for himself."

Wreckage of the A109 surrounds a car damaged after the helicopter struck a building and plunged to the street below.

© Olivia Harris|Reuters

The client called at 0718, also to discuss the weather, and said that he would drive to Elstree and call the pilot to report on conditions there.

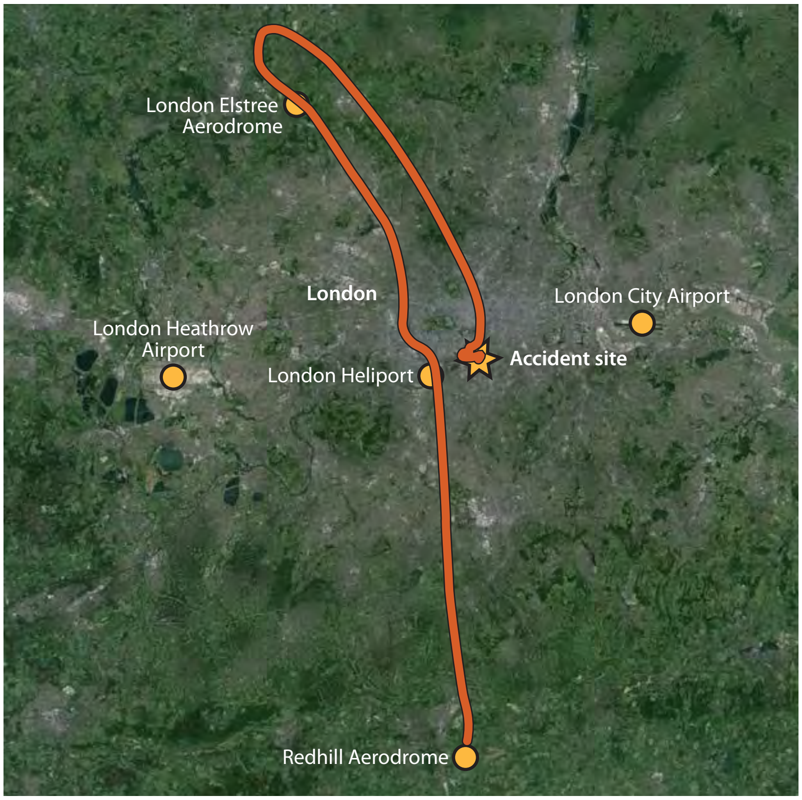
"The client reported that, at 0731 hours, having noticed how poor the weather was during his journey, he called the pilot to suggest that he should not take off until he (the client) had reached Elstree and observed the weather," the report said. "According to the client, the pilot replied that he was already starting the engines, and so the client repeated his suggestion that the pilot should not take off."

After departing from Redhill at 0735, the pilot contacted Thames Radar, received a special visual flight rules (VFR) clearance to transition the London Control Zone (CTR) by way of the London neighborhood of Battersea and proceeded, first at 970 ft MSL and later at 1,470 ft. At 0748, the pilot told air traffic control (ATC) that he had cleared the CTR and was "trying to find a hole" in the clouds to enable a descent, the report said. He flew the helicopter past Elstree, descending as low as 870 ft before he began a climb and turned right to fly southeast toward central London.

At 0751, ATC broadcast weather information for London City airport, which reported visibility of 700 m (less than half a mile), freezing fog and broken clouds with a base 100 ft above ground level. Thirty seconds later, the pilot told ATC he wanted to return to Redhill, and a controller approved the request. About the same time, the pilot texted the client that weather conditions prevented him from landing at Elstree and that he was heading back to Redhill. He sent a similar text to the operator at 0755. A final text, from the operator to the pilot at 0755, was never read.

At 0756, about one minute after receiving a text from the client that said Battersea (the London Heliport) was open, the pilot asked ATC for confirmation.

He entered a hold over the Thames while the controller checked on conditions at the heliport, and at 0759, after the pilot said he could see the river, the controller issued a clearance to proceed to the heliport, either VFR or special VFR, and told the pilot to contact the heliport tower controller.



Background map: © Google; Source: U.K. Air Accidents Investigation Branch

The pilot left Redhill Aerodrome for Elstree, but low clouds prompted his en route decision to divert to the London Heliport.

"This exchange ended at 0759:22 ... [when the helicopter] was approximately 250 m [902 ft] southwest of Vauxhall Bridge," the report said. "The final two recorded radar positions show a turn to the right at 770 ft [MSL], initiated abeam a building development at St. George Wharf, approximately 275 m [886 ft] from the southeast end of Vauxhall Bridge. The helicopter struck a crane attached to the building. The final recorded radar position was at 0759:24 … at an altitude of 770 ft."

The controller who issued the clearance told accident investigators that because clouds at Heathrow and London City Airport were reported as broken and because the pilot had said that he was in visual meteorological conditions (VMC) above the clouds, he believed that the pilot could see the surface. Similarly, when the pilot said that he could see Vauxhall and requested helicopter route H4, a route that follows the Thames River, the controller assumed that the pilot was in VMC.

However, one witness said that, when he saw the helicopter at 0755, it seemed to be "flying actually in the low cloud." Another witness told investigators that the "top half of the building [where the crane was located] was entirely obscured by cloud." A third witness, on the ground near Vauxhall Bridge, said that the helicopter flew out of clouds as it approached, the report said, adding, "He reported that the cloud was 'swirling around' and, although the main body of the building remained clear of cloud, the top of the building was 'in and out of the mist.'"

The witness said he did not observe the accident, but 10 to 20 seconds after he heard the sounds of the impact, "the top of the building was visible," the report said.

ATP License

The 50-year-old pilot held an air transport pilot (ATP) license with an instrument rating and had accumulated 10,234 flight hours, including 9,716 hours in rotorcraft and 30 hours in the 90 days before the accident.

The accident helicopter was manufactured in 1998. Both engines and the airframe had accumulated 2,305 flight hours. Records indicated the helicopter had no outstanding maintenance issues.

It was equipped with two global positioning system (GPS) units, each of which had a moving map display. Both units provided information about terrain and obstacles, and one also was capable — if equipped with a valid database — of providing obstacle warning information. Investigators said that both GPS units were destroyed in the post-accident fire and they could not determine whether the terrain and obstacle database revisions were current. The operator said that it routinely updated the database in March of each year, and because it had acquired the helicopter in May 2012, an update had not been performed.

Freezing Fog

Weather conditions at the time of the accident included temperatures "well below freezing," cloud bases between 100 ft and 400 ft above ground level (AGL), visibility below 4,000 m (2.5 mi) and areas of freezing fog. Freezing fog was in the forecast for Redhill, Elstree and London Heliport until 1000; the forecast also called for isolated areas of freezing fog in the area of the planned flight with visibility of 200 m (656 ft). In some areas, however, the cloud base was forecast to be at the surface.

A notice to airmen (NOTAM) in effect at the time of the accident told pilots about the crane — "an obstacle … affecting both instrument and visual traffic [and] aerodrome and en route traffic." The NOTAM told pilots that the crane, which extended to 770 ft and was lighted at night, would be in place from Jan. 7 until March 15, 2013.

"The operator's *Operations Manual* required NOTAMs to be provided to crews and appropriate NOTAMs and current charts to be carried on each flight," the report said. "NOTAM information can be accessed from the AIS [aeronautical information services] website, but the last time the pilot logged into his personal account was January 2010. However, if a pilot checks NOTAMs using a third-party provider, only the activity of the third party is visible to the system. The operator's pilot brief for the flight did not contain NOTAM information, and the pilot's awareness of relevant NOTAMs prior to the accident could not be confirmed."

The report noted that the U.K. Aeronautical Information Publication for the London Heliport — located in a Class A Aerodrome Traffic Zone that can be accessed only by pilots who have obtained prior permission and a special VFR clearance — tells pilots that "the skyline has changed due to continuing recent development of buildings along the riverside within the heliport circuit."

The heliport, on the east bank of the Thames, about 3 nm (6 km) southwest of Westminster Bridge, is open only when visibility is at least 1,000 m (0.6 mi) and the ceiling is 600 ft AGL or higher.

St. George Wharf, where the building and crane were located, is just outside the heliport's airport traffic zone and "does not impinge upon its takeoff and climb surfaces," the report said. The heliport operator emailed the U.K. Civil Aviation Authority (CAA) Aerodrome Standards Department (now the Aerodrome and Air Traffic Standards Division) in 2008 and 2009, requesting clarification on protecting takeoff and climb surfaces and suggesting that development at the wharf might interfere with standard operating altitudes on route H4. There was no indication of whether the questions were resolved, the report said.

Radar Data

The helicopter did not have — and was not required to have — a flight data recorder or a cockpit voice recorder, but accident investigators used radar information, radio transmissions and other recorded data sources to aid their work.

Radar at London Heathrow Airport, 12 nm (22 km) west of the heliport, recorded the helicopter's position and altitude every four seconds. The helicopter manufacturer's review of the data determined that, because a right turn along the Thames was too tight to have been flown with the autopilot and a 200-ft descent was too rapid, the aircraft was being flown manually.

Distractions

The report noted that the pilot's text messages, including 10 that were sent or received during the 25-minute flight, provided him with useful information but also might have distracted him while ATC was broadcasting weather information. Use of the radio might also have distracted him from flying duties, the report said.

"The pilot last read and sent text messages approximately four minutes before the collision with the crane," the report said. "He was using the radio to talk to ATC until a few seconds before impact. …

"The pilot was cleared by ATC to contact London Heliport, which would have required a change of radio frequency. His response to this transmission ended at 0759:22, … two seconds before the last recorded radar position. It is possible therefore, that the pilot was distracted by the act of changing frequency as he entered the turn towards the building."

Safety Recommendations

The report included 10 safety recommendations, including several focusing on obstacle reporting. Among them were recommendations that the CAA require air navigation service providers to evaluate the effects of obstacles on operational procedures on VFR flights; that the Department for Transport implement a reporting requirement for newly permitted developments; and that the CAA be notified of developments being planned that would include an obstacle, of obstacles that have not previously been noted and of previously noted obstacles that no longer exist.

The CAA should be granted an opportunity to assess "the potential implications of new en route obstacles for airspace arrangements and procedures" before permission is granted for the associated developments, the report said.

Other recommendations said the CAA and the European Aviation Safety Agency should determine whether additional safety benefits would be achieved by requiring the use of helicopter terrain awareness and warning systems.

This article is based on U.K. Air Accidents Investigation Branch Aircraft Accident Report 3/2014, "Report on the Accident to Agusta A109E, G-CRST, Near Vauxhall Bridge, Central London, on 16 January 2013." The report is available at <www.aaib.gov.uk>.

Objective Assessment

An on-board system in development would enable airline pilots to anticipate runway surface condition and braking capability.

BY TROND ARE JOHNSEN

Advances in technology and aviation industry safety initiatives have significantly reduced commercial air transport accidents, but runway safety–related events generally, and runway excursions specifically, persist. Accurately assessing runway surface condition and braking capability have not received the same technological focus as contributing factors in other types of accidents. This article presents progress to date on an on-board system in development that would intercept flight data parameters for real-time analysis early in the landing roll, reference stored data representing the specific airplane's known landing performance and apply an algorithm that helps the flight crew to objectively recognize the actual runway condition and to accurately assess their airplane's braking capability.

Potential delivery modes for this information include near–real time "data push" integration into flight operations/dispatcher flight following tools, existing landing analysis systems and directly informing the flight crew.

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Southwest Airlines Flight 1248, which overran the runway while landing at Chicago Midway International Airport on a snowy night in December 2005, has come to exemplify the shortcomings in the reporting of braking capability on contaminated runways. This accident, which resulted in the death of a young passenger in an automobile that was struck by the Boeing 737-700 after the aircraft crashed through a blast fence and an airport perimeter fence, has served as a catalyst for several industry initiatives and renewed thinking.

Flight Safety Foundation has addressed runway safety repeatedly, and recommended in 2009's *Reducing the Risk of Runway Excursions: Report of the Runway Safety Initiative*[1] that "a universal, easy-to-use method of runway condition reporting should be developed to reduce the risk of runway excursions."

The U.S. National Transportation Safety Board (NTSB), in its Flight 1248 accident report, recommended that the U.S. Federal Aviation Administration (FAA) "demonstrate the technical and operational feasibility of outfitting transport category airplanes with equipment and procedures required to routinely calculate, record and convey the airplane braking ability required and/or available to slow or stop the airplane during the landing roll."[2]

In cooperation with United Airlines, Kongsberg Aeronautical has tested the prototype on-board system, similar to the one proposed in this NTSB accident report, and which also responds to the conclusions and recommendations of the FSF initiative. Installed on United's fleet of Boeing 737s, the system has been subjected to a validation program in cooperation with the FAA William J. Hughes Technical Center. The validation has shown that the Kongsberg Aeronautical system performs as expected and intended.

Outfitting transport category airplanes to use flight data to calculate braking ability may seem a straightforward undertaking, but it is not. There are technical as well as practical issues involving ease of use to consider, including:

- Comprehensiveness of assessment system or model;
- Applicability to guidance materials' advisory data for stopping distance; and,
- Data gathering, flight data integrity and confidentiality.

As to comprehensiveness, the landing roll is a dynamic process with a multitude of factors, including ambient conditions, contributing to the airplane's braking capability at different phases. To single out the braking factors associated with the tire-surface interface is an intricate task.

One scientific approach to this challenge might be to mathematically model and emulate the landing roll and all of its constituent factors for defined ambient conditions. It would hardly be a viable and practical solution, however, because it would be challenging to create a model capable of covering all of the variables and assessing interrelatedness of the factors. Furthermore, being able to obtain the required quality of input parameters would be difficult, even if all the needed input parameters could be acquired.

The objective of any assessment system or model should be to capture the essence of the landing roll, in terms of stopping capability, for use in conjunction with the stopping distance guidance information from the aircraft manufacturers.

As to applicability, airlines base their operational assessment of stopping distances primarily on airplane manufacturers' guidance, which is contained in the quick reference handbook, flight crew operations manual and the flight planning and performance manual. Boeing, for example, has classified its airplane braking coefficient and associated braking action categories as *dry*, *good*, *medium* and *poor*, and provided the corresponding landing distances.[3] This complies with the FAA's Takeoff and Landing Performance Assessment Aviation Rulemaking Committee (TALPA ARC) recommendation for an industry initiative except that the TALPA ARC called for two more intermediary categories — *good to* *medium* and *medium to poor.* Although guidance information details stopping distances down to exact feet, it is important to understand that the data are not absolute; they are based to an extent on empirical data as well as extrapolations.

Thus, providing data for input to a model at a level of accuracy beyond what is required for the aircraft manufacturers' guidance material would be meaningless.

As to data gathering, agreements between airlines and their pilot unions strictly govern the use of flight data; integrity, confidentiality and the framework for managing flight data are important. When flight data change hands and are transferred to a third party in full or in part, the data may become susceptible to compromise and breach of confidentiality, either intentionally or unintentionally. Any effort to reduce the amount of flight data subject to transfer is desirable in terms of both integrity and confidentiality.

Start of a Partnership

A braking action test program was launched at Continental Airlines (since merged with United Airlines) in 2010 by the carrier's flight operational quality assurance group. The program's testing was conducted in cooperation with Kongsberg Aeronautical, which provided the algorithm that was adapted and uploaded into the Boeing 737 test aircraft. The program, which was designed to obtain braking action information through on-board calculations, was quickly streamlined and dynamic noise was eliminated from the source data.

Early results of the braking action test contributed to identifying operational safety action items, which were featured in *AeroSafety World* in 2013.[4] Subsequently uploaded on all of United's 737NGs, the Kongsberg Aeronautical system now acquires data daily on every flight in this fleet. It is a "read only" system located within the aircraft condition monitoring system (ACMS) software and uses flight data from previous landings to calculate maximum braking capability. At the end of each landing roll, only the calculated braking

Pilot Version of Matrix

Braking Action Report PIREPs			
Term	**Definition**	**Associated Runway Surface Condition**	**Runway Condition Code**
Dry		**Any temperature and:** • Dry	6
Good	Braking deceleration is normal for the wheel braking effort applied. Directional control is normal.	**Any temperature and:** • Wet surface (smooth, grooved or PFC runway) • Frost **Any temperature and ⅛ in (3.2 mm) or less of:** • Water • Slush • Dry snow • Wet snow	5
Good to Medium	Brake deceleration and controllability is between *good* and *medium*.	**At or below -13°C (9°F) and:** • Compacted snow	4
Medium	Braking deceleration is noticeably reduced for the wheel braking effort applied. Directional control may be slightly reduced.	**Any temperature when:** • Wet (when runway is reported as "slippery when wet") **At or below -3°C (27°F) and greater than ⅛ in of:** • Dry or wet snow **Above -13°C and at or below -3°C and:** • Compacted snow (any depth, depth not reported)	3
Medium to Poor	Brake deceleration and controllability is between *medium* and *poor*. Potential for hydroplaning exists.	**Any temperature and greater than ⅛ in of:** • Water • Slush **Temperature above -3°C and:** • ⅛ in and greater of dry or wet snow • Compacted snow (any depth, depth not reported)	2
Poor	Braking deceleration is significantly reduced for the wheel braking effort applied. Directional control may be significantly reduced.	**At or below -3°C and:** • Ice	1
Nil	Braking deceleration is minimal to nonexistent for the wheel braking effort applied. Directional control may be uncertain.	**Any temperature and:** • Wet ice • Water on top of compacted snow • Dry or wet snow over ice **Temperature above -3°C and:** • Ice	0

PFC = porous friction course; PIREPs = pilot reports

Source: Trond Are Johnsen

Table 1

action information, in deidentified form, was transmitted to a ground station for the research. The transmitted information therefore could not reflect on the skill and airmanship of the pilots.

Employing a streamlined version of the Boeing aircraft braking coefficient calculation, the on-board prototype system detects *friction-limited braking situations* — situations in which increased brake pressure does not yield increased deceleration, which is the point of maximum braking capability. Braking capability/braking action assessment also is aligned with the guidance material/advisory data for landing distance from the manufacturer.

Cooperation With FAA

Based on the promising results demonstrated through the early 737 tests, the FAA's technical center established a cooperative research and development agreement (CRDA) with Kongsberg Aeronautical in 2012 to jointly evaluate uses for braking action information in real-time, runway-slipperiness condition reporting. The research will assist the FAA Terminal Area Safety Research Program in investigating whether flight data on landing airplanes can provide an accurate and timely assessment of runway slipperiness to prevent runway accidents.

The current system does not capture all of the previously noted dynamic aspects of an airplane's landing roll. It does, however, capture the essence of the landing roll, thereby providing relevant and clear information — quality input parameters to the system that enhance the landing distance advisory data provided by airplane manufacturers. The essence of the CRDA was to analyze and discuss a few of the system's features that differentiate it from conventionally conducting a scientific, full emulation of the landing roll. Among these features are the following:

- Use of a portion of the runway;
- Simplified ambient conditions;
- The impact of runway slope; and,
- Transferability to other aircraft.

For a better understanding of these aspects within the validation process, a brief discussion follows.

Portion of Runway

Do flight crews need to consider the full length of the runway or just a portion to be able to assess braking capability? As noted, separating deceleration force associated with the tire-surface interface from other braking factors is complex. Incorporating this factor in the early phase of an actual landing roll at first sounds more academically interesting than practically valuable. There are several arguments that support such an approach, however.

Any landing, regardless of runway surface condition or the application of braking force at the early phase of the landing roll, can "feel good" to pilots because aerodynamic drag and reverse thrust produce deceleration forces subjectively perceived to result from the brake application. The diminishing impact of the drag will be felt when speed slows below 100 kt. Although present throughout the landing roll, the deceleration benefit from aerodynamic drag therefore can be disregarded for practical purposes at lower ground speeds.

Reverse thrust works much like a parachute and is more effective at higher speed. A common practice is to stow the thrust reversers when the aircraft speed decreases to between 80 and 60 kt. Therefore, the deceleration benefit from reverse thrust also can be disregarded for practical purposes at lower ground speeds.

Winter conditions can create situations in which the friction heating of tires throughout the landing roll affects the tire-surface interface by reducing braking action toward the end of the landing roll. This is particularly valid with snow or icy conditions. In fact, in a number of runway overrun accident reports, pilots describe how they considered braking action good initially and believed that it deteriorated. The United 737 braking action test program did not involve runway overruns, but similarly received reports from participating pilots who described feeling "apprehension" when conditions became slippery as the landing roll progressed.

These tests showed that using just a portion of the runway to make instantaneous assessments could provide the flight crew ample information, essentially revealing critical aspects of braking ability in real time.

Simplified Ambient Conditions

There is a trade-off for flight crews between knowing ambient weather conditions in great detail and having the ability and time to properly assess them. Reports of meteorological conditions, such as temperature, air pressure, wind speed and wind direction, only provide approximate information and may not always be current. Wind and wind direction, air pressure, etc. have a declining impact on stopping capability as the aircraft slows during the landing roll. Accounting for the weather-condition impact at the initial phase of the landing roll would be complicated and, likely, in vain. The reason is that the end portion of the landing roll provides the information critical to understanding braking ability. Therefore, a simplified approach to gathering data on ambient weather conditions has proved sufficient in the Kongsberg Aeronautical system.

Runway slope also normally is taken into consideration among ambient conditions for takeoff and landing safety analysis by means of advisory data. However, runway slope is not a consideration in this system because the slope has, for practical purposes, an inconsequential effect. Runway slope rarely exceeds 2 percent, and most U.S. airports have slopes of less than 1 percent.

Aircraft Transferability

Braking coefficient values are the same for all types/sizes of aircraft. This principle was considered in TALPA ARC recommendations. Aircraft of different sizes may nevertheless experience differences in braking action, given the same objective runway surface conditions. This analysis did not include regional jets, but the analysis shows that there are commonalities and transferability between aircraft within categories, such as the 737 series and the Airbus A320 series. When comparing estimated landing distance, given similar braking action conditions and using aircraft manufacturer guidance material, there are clear parallels for these two aircraft series.

Pilot reports and feedback formed part of the initial phase of the braking action test program. Pilots evaluated situations in which the Kongsberg Aeronautical system detected braking action conditions that were less than good.[5] Landing data and their feedback revealed consistency with actual and prevailing weather conditions, indicating that the system was performing as expected and intended.

As part of today's Phase 2 validation process, FAA engaged the University of Massachusetts and a research group to perform an extensive analysis to assess the correlation between prevailing weather conditions and braking capability as derived from the system.

Because slippery runways are not just a winter problem, the analysis included airports in tropical locations. A foundation for the analysis was one year of information acquired from United's 737 fleet, with the associated and system-calculated airplane-based braking action figures. Historic weather information was consulted to obtain prevailing conditions for each airport that corresponded to the date and time of every landing that involved friction-limited braking conditions.

In summary, unless aircraft manufacturers can derive certified, perfect landing/stopping distances for any given variation of runway conditions, the aviation industry's primary goal must be to develop a system in compliance with guidance material and advisory data. Today, such advisory data is sorted into six "braking action" categories, according to the TALPA ARC matrix (Table 1, p. 38). Any attempt to furnish braking capability information with higher accuracy — beyond the level of advisory data — will not serve any practical purpose. Capturing the essence of the braking coefficient from the aircraft itself during each actual landing roll, however, could provide near-real time information to the flight crew.

Beyond Validation

In aviation, a system has no value unless it can provide the right data to the right users at the right time. This requires schemes for distribution and integration with appropriate user tools and interfaces. At United Airlines, upcoming and post-validation activities involve an early-phase integration with dispatcher tools.

The real potential in the Kongsberg Aeronautical system lies in pooling information from, ideally, all aircraft in service, although obtaining data from several large airlines may prove sufficient. With a common information pool, all airlines could benefit. The power of the system is in the aggregation of the collected information.

Even though airlines fiercely compete for the business of the traveling public, the aviation industry has a longstanding history of cooperation when it comes to safety. With such technology becoming available, it is time to more accurately and efficiently assess runway surface condition and braking capability through joint effort and cooperation among airlines.

Trond Are Johnsen is the general manager of Kongsberg Aeronautical, and has managed the test program since its beginning. His background includes development of technology from early phase to user applications.

Notes

1. Flight Safety Foundation. *Reducing the Risk of Runway Excursions: Report of the Runway Safety Initiative*. May 2009. Available at <flightsafety.org>.
2. NTSB. Accident Report NTSB/AAR-07/06, *Runway Overrun and Collision; Southwest Airlines Flight 1248, Boeing 737-7H4, N471WN; Chicago Midway International Airport, Chicago, Illinois; December 8, 2005*. Adopted Oct. 2, 2007.
3. These landing distances take into account air distance and safety margins for conditions other than *dry*.
4. Vizzoni, Joe. "Your Slip Is Showing." *AeroSafety World* Volume 8 (May 2013): 12–16.
5. Ibid.

HOT Intelligence

Deicing/anti-icing fluids guidance for winter 2014–2015 includes updates to manage risks of extremely cold conditions.

BY WAYNE ROSENKRANS

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Each winter season in Earth's northern hemisphere creates linked challenges for aviation-focused meteorologists and an SAE committee of expert international stakeholders.[1] The committee's pre-season fluids testing, performance validation and technical guidance enable the publication of new aircraft ground deicing/anti-icing holdover time (HOT) tables and allowance times. The season's updated technical standards are reviewed by the Association of European Airlines (AEA), the U.S. Federal Aviation Administration (FAA) and Transport Canada (TC), the principal entities that in turn develop authoritative derivative documents for the industry.

Their documents underscore the addition of newly approved fluids, the removal of obsolete fluids, changes in approved water dilutions and the effect, if any, of such changes on generic HOT table values. Most airport service providers and regional airlines in Europe, for example, have preferred deicing/anti-icing systems combining relatively low cost and HOTs that are suited to diverse airport environments in which frost is more prevalent than the ice/snow contaminants common to the United States and Canada.[2,3]

According to SAE, approved Type I fluids are "generally used heated, either diluted with water, or as supplied, for the removal of, and time-limited protection against, deposits of frost, ice and snow on exterior aircraft surfaces prior to takeoff." The approved Type II, Type III and Type IV alternative fluids comply with one of the SAE specifications for non-Newtonian fluid, also called pseudoplastic fluid, which contains thickeners to improve HOT compared with Type I fluids. In a 2008 article, subject matter specialists from Europe told *ASW* that Type II and Type IV fluids are formulated primarily for anti-icing, keeping airplane surfaces free of frozen contaminants before takeoff, and also are approved for deicing.

Background Issues

Eurocontrol's SKYbrary website describes AEA, FAA and TC as "the main practical sources of HOT information," adding that "each issues [its] own version of the HOT tables and associated support publications independently of each other and SAE. The generic changes from one season to the next are usually relatively few. However, in recent years, issues with residues from thickened fluids have been the main driver for the appearance of product-specific HOT tables, which are increasingly used by operators."[4] Moreover, advisers to SKYbrary have identified, as a winter operations risk factor, the fact that other organizations publish HOT tables less frequently than AEA, FAA and TC. This leads to situations in which aircraft flight manuals go out of date relative to international best practices and safety knowledge (see "Generic Reminders").

A related Eurocontrol concern is assuring the safe performance of new devices that measure precipitation rate in real time and make the data available for flight operations. In this case, SKYbrary's advice says, "These systems, referred to as *liquid water equivalent systems (LWES)*, can be used by *check-time determination systems (CTDS)* and *holdover time determination systems (HOTDS)* to calculate more precise holdover times than can be obtained from the HOT tables. They do this by using the weather data they collect as the input to the underlying assumptions employed in calculating the times in the HOT tables."

Generic Reminders

Beyond differences highlighted by the U.S. Federal Aviation Administration (FAA) in its holdover time (HOT) tables and guidance for winter 2014–2015, this official document — similar to those issued by the Association of European Airlines and Transport Canada — reiterates safety reminders critical to airport deicing/anti-icing service providers, aircraft operators and flight crews.

For example, the FAA cautions this community that fluids used during deicing/anti-icing do not provide in-flight icing protection. A cautionary note on tables warns, "This table is for departure planning only and should be used in conjunction with pre-takeoff check procedures." Another reminder is that although U.S. air carriers may have approval of their winter operations plan for using handheld electronic devices for HOT/allowance time determinations, unreliable accuracy or failure of such devices requires reversion to the official HOT tables as backup.

The document adds, "The time of protection will be shortened in heavy weather conditions. Heavy precipitation rates or high moisture content, high wind velocity or jet blast may reduce holdover time below the lowest time stated in the [HOT table] range. Holdover time may be reduced when aircraft skin temperature is lower than [outside air temperature]."

Preparing for every winter flight also requires the operator/flight crew to recognize when the conditions to be encountered exceed those used in the HOT tables and/or exceed the performance of approved fluids or procedures. "Use light freezing rain holdover times in conditions of very light or light snow mixed with light rain," FAA said. "Use light freezing rain holdover times if positive identification of freezing drizzle is not possible. No holdover time guidelines exist for this condition for 0 degrees C (32 degrees F) and below. [Regarding] heavy snow, ice pellets, moderate and heavy freezing rain, small hail and hail … no holdover time guidelines exist for this condition below [minus] 10 degrees C (14 degrees F).

—WR

Key Changes

This article cites only the *Official FAA Holdover Time Tables, Winter 2014-2015, Revision 1.1* — published Oct. 22, 2014 — which contains agency guidance, holdover tables and allowance times for use during this season. The document states, "It is the responsibility of the end user to periodically check the following website for updates: <www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/deicing/>."

Winter operations specialists will find new holdover/allowance time adjustments built into this season's tables because of early fluid failure recently observed when the slats and flaps of test aircraft had been deployed prior to deicing/anti-icing. The change was based on research that found that the steeper angles of the flaps/slats in the takeoff configuration accelerate the flow-off degradation of fluids, with "the degree of potential degradation … significantly affected by the specific aircraft design."

The document also refers to new scientific research indicating that, in some conditions, HOTs of Type III fluid can be shorter when fluid is applied heated versus unheated. Therefore, a note stresses that generic HOT table values for Type III fluids are applicable only when the fluid is applied unheated.

The document points out specific adverse HOT effects from nonstandard dilutions of Type I, Type II, Type III and Type IV fluids. "When a Type II, III or IV fluid is diluted to other than the published 100/0, 75/25 or 50/50 dilutions, the more conservative holdover time [and lowest operational use temperature (LOUT)][5] associated with either the dilution above or below the selected dilution are applicable," FAA said. "For example, the holdover time and LOUT of an 80/20 dilution would be the more conservative holdover time and LOUT [compared with] either the 100/0 or 75/25 dilutions. The holdover time and LOUT of a 60/40 dilution would be the more conservative holdover time and LOUT [compared with] either the 75/25 or 50/50 dilutions."

Ice Pellets and Small Hail

Also new for this season are ice pellet and small hail allowance times. "Additional research has been conducted to provide guidance for aircraft operations during ice pellet conditions when operating with Type III undiluted (100/0) fluid applied unheated," FAA said. "A separate ice pellet allowance time table has been developed for Type III fluids. … Small hail has been added to the allowance time tables as it has been determined to be meteorologically equivalent to moderate ice pellets.

"Research has indicated that Type IV propylene glycol (PG) fluids are removed less effectively during takeoff [by the airflow] when contaminated with moderate ice pellets at temperatures below [minus] 16 degrees C [3 degrees F]. Therefore, operations in these conditions are not recommended and no allowance times exist for PG fluids in conditions of moderate ice pellets at temperatures below [minus] 16 degrees C, irrespective of aircraft rotation speed. Research has provided data to support a new Type IV allowance time of seven minutes for light ice pellets mixed with moderate snow at temperatures below [minus] 5 to [minus] 10 degrees C [23 to 14 degrees F].”

Cues From Visibility

New guidance on airport surface visibility and snowfall visibility in relation to use of HOT tables also applies this season. “Whenever surface visibility is available from an official source, such as a METAR [aviation routine weather report], in either the main body of the METAR or in the Remarks (‘RMK’) section, the preferred action is to use the surface visibility value,” as opposed to tower visibility, if shown, FAA said. Operators are not permitted to apply runway visual range data for determining the visibility used with the HOT tables.

Although no changes were made to the standard table showing snowfall intensities as a function of prevailing visibility, FAA this season allows optional use of locally adapted summaries written by the operator. The guidance says that an air carrier’s winter operations plan simply could say, for example, “Since very light snow is being added to some of the Type II and Type IV [fluid HOT] tables, and since the METAR and the associated ATIS [automatic terminal information service broadcasts] do not report very light snow, a METAR-reported visibility of 2.5 mi [4 km] or higher can be used as an indication that the snowfall intensity is very light. An air carrier certainly would also have the option of providing a more detailed description utilizing lower METAR reported visibilities for specific day/night and temperature conditions.”

FAA policy on *hail* versus *small hail,* terms that are not equivalent in this HOT tables and guidance context, also is new. “No holdover times exist for either of these conditions; however, it has been determined that small hail is meteorologically equivalent to moderate ice pellets and therefore moderate ice pellet allowance times can be used in small hail conditions,” the agency said, pointing to relevant changes throughout the document.

Not all countries follow the World Meteorological Organization’s application of the METAR code *GS* to snow pellets and small hail, FAA found, adding that this creates a safety concern. “The use of the reported GS code can potentially lead to difficulties in determining which condition (snow pellets or small hail) is occurring and therefore in establishing the appropriate holdover time/allowance time,” the document said in providing updated guidance on which to term to use.

Notes

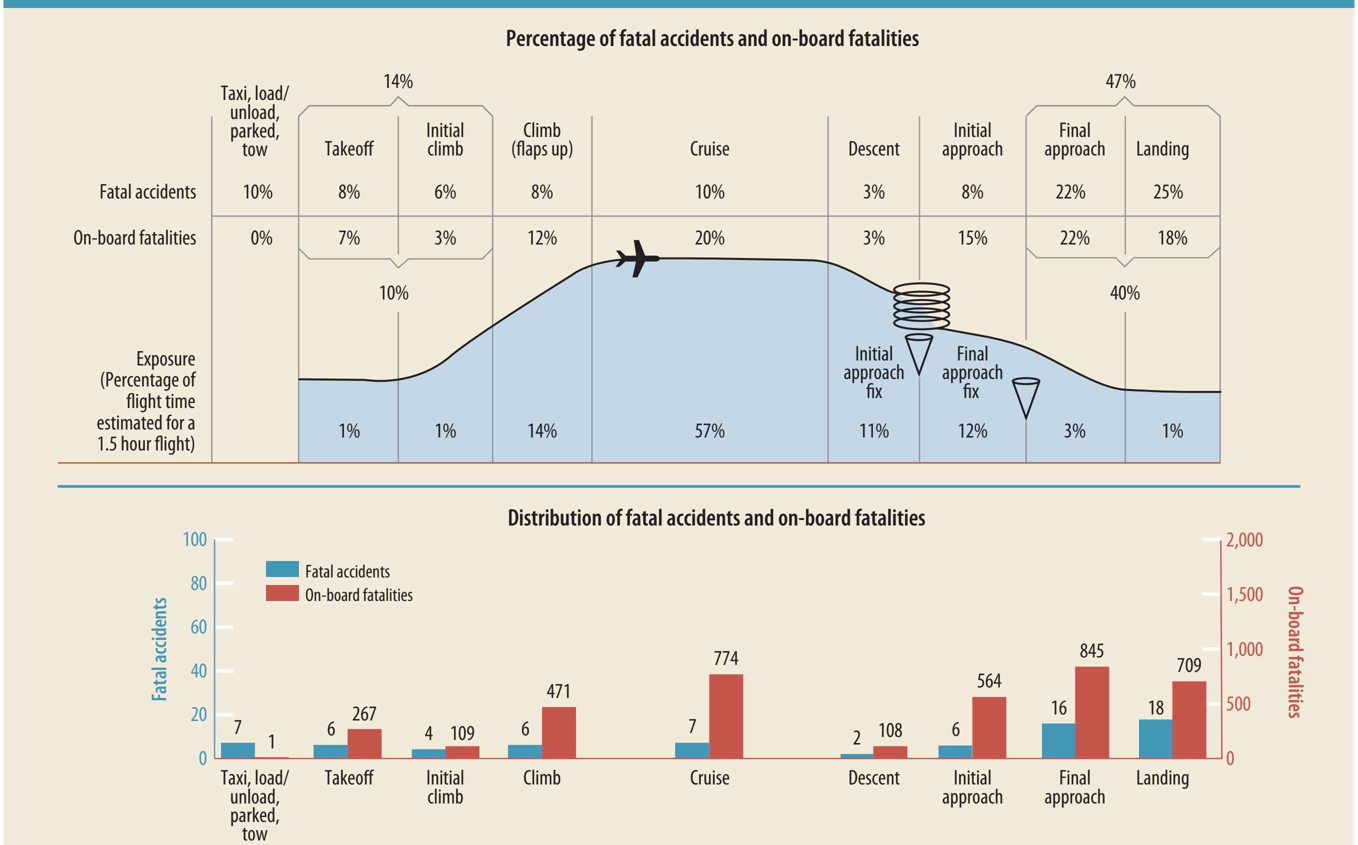
1. Eurocontrol SKYbrary. “Holdover Time (HOT) Tables.” <www.skybrary.aero/index.php/Holdover_Time_(HOT)_Tables>. Sept. 29, 2014. The international body responsible for the annual testing and calculations is the SAE G-12 Aircraft Ground De-Icing Steering Committee <www.sae.org/works/committeeHome.do?comtID=TEAG12>.
2. Six years ago, *AeroSafety World* reported on consensus-building difficulties among European regional airlines, scientists and deicing/anti-icing service providers regarding the selection of deicing/anti-icing fluids offered to operators, safe application procedures and related ground-handling practices. The objective was to reduce the risk of accumulated gel-like fluid residues freezing and impeding the concealed control linkages of susceptible aircraft types (*ASW,* 10/08, p. 26 and *ASW,* 11/08, p. 15). SAE G-12’s latest specification for Type II, Type III and Type IV fluids (issued in December 2010) responded to that safety issue and others by changing its fluid-qualification process; changing how the test laboratory inspects fluid-covered test plates for dry-out after exposure to cold dry air, and how it performs the thin-film thermal stability test; changing the hard-water stability test; changing the lot-acceptance test to allow measurement of fluid viscosity at 0 degrees C (32 degrees F) or 20 degrees C (68 degrees F); and changing the successive dry-out and rehydration test.
3. European Aviation Safety Agency (EASA). “Ground De-/Anti-Icing of Aeroplanes: Intake/Fan-blade Icing and Effects of Fluid Residues on Flight Controls.” Safety Information Notice (SIN) no. 2008-29, April 4, 2008. EASA said, “Type II and Type IV [anti-icing] fluids contain thickeners which enable the fluid to form a thicker liquid-wetting film on surfaces to which it is applied. Generally, this fluid provides a longer holdover time than Type I [deicing] fluids in similar conditions. … Type III [is a] thickened [anti-icing] fluid intended especially for use on airplanes with low rotation speeds.”
4. SAE G-12 subcommittees focus on aircraft deicing fluids, runway deicing fluids, deicing facilities, holdover testing, methods, equipment, ice detection, training, and future deicing. The most recent standards development or revision activities have focused on Type II, Type III and Type IV fluids; aircraft after-market surface-coating interaction with fluids; the processes for qualifying and testing the endurance of Type I fluids; ramp de-icing; design of aircraft deicing facilities; and the Weather Support to Deicing Decision Making Winter Weather Nowcasting System. A recent example of an addition to supporting documents for these activities is SAE AS5681A, “Minimum Operational Performance Specification for Remote On-Ground Ice Detection Systems.”
5. FAA defines *LOUT* as the lowest temperature at which a deicing/anti-icing fluid will adequately flow off aircraft critical surfaces and maintain the required anti-icing freezing point buffer. This buffer is 10 °C (18 °F) below outside temperature (OAT) for SAE Type I fluids. The buffer is 7 degrees C (13 degrees F) below OAT for SAE Type II, Type III and Type IV fluids.

BY FRANK JACKMAN

Nearly Half of Commercial Jet Accidents Occur During Final Approach, Landing

Nearly half of all worldwide commercial jet airplane accidents during the 10-year period from 2004 through 2013 occurred during the final approach or landing phases of flight, according to statistics published in September by Boeing Commercial Airplanes. Of the 72 fatal accidents recorded during the period, 22 percent (16 accidents) occurred during the final approach phase and 25 percent (18) during landing. Those 34 final approach or landing accidents accounted for 1,554 on-board fatalities, or roughly 40 percent of the 3,848 on-board fatalities suffered during the decade (Figure 1).

Fatal Accidents and On-board Fatalities by Phase of Flight, Worldwide Commercial Jet Fleet, 2004–2013

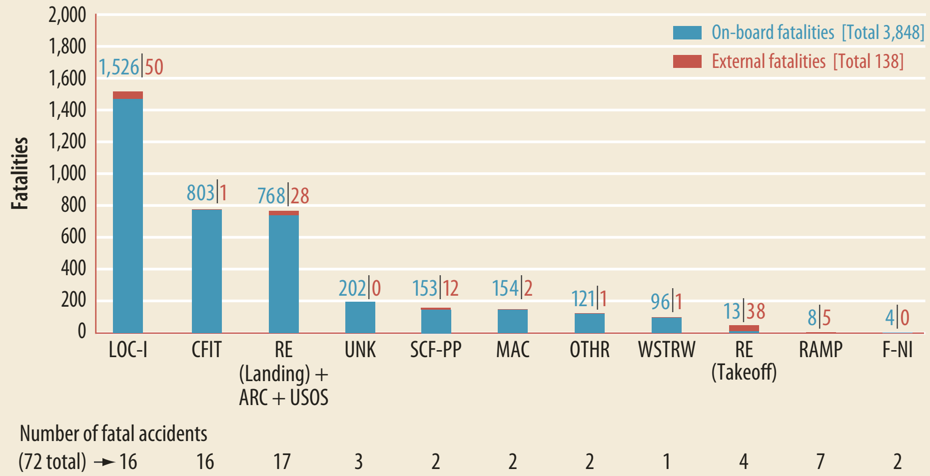


Note: Percentages may not equal 100% because of rounding.

Source: Boeing Commercial Airplanes

Figure 1

Fatalities by CAST/ICAO Taxonomy Accident Category, Worldwide Commercial Jet Fleet, 2004–2013



CAST = U.S. Commercial Aviation Safety Team; ICAO = International Civil Aviation Organization; ARC = abnormal runway contact; CFIT = controlled flight into terrain; F-NI = fire/smoke (non-impact); LOC-I = loss of control – in flight; MAC = midair/near midair collision; OTHR = other; RAMP = ground handling; RE = runway excursion; SCF-PP = system/component failure or malfunction (powerplant); UNK = unknown or undetermined; USOS = undershoot/overshoot; WSTRW = wind shear or thunderstorm.

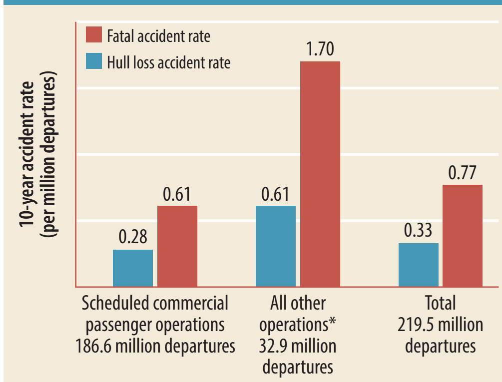
No accidents were noted in the following principal categories: aerodrome; abrupt maneuver; air traffic management/communications, navigation, surveillance; bird strikes; cabin safety events; evacuation; external load-related occurrences; fire/smoke (post-impact); fuel related; ground collision; icing; low altitude operations; loss of control – ground; runway incursion – animal; runway incursion – vehicle, aircraft or person; security related; system/component failure or malfunction (non-powerplant); turbulence encounter; wildlife.

Note: Principal categories are as assigned by CAST. Airplanes manufactured in the Commonwealth of Independent States or the Soviet Union are excluded because of lack of operational data. Commercial airplanes used in military service are also excluded.

Source: Boeing Commercial Airplanes

Figure 2

10-Year Accident Rates by Type of Operation, Worldwide Commercial Jet Fleet, 2004–2013



*Charter passenger, charter cargo, scheduled cargo, maintenance test, ferry, positioning, training and demonstration flights

Source: Boeing Commercial Airplanes

Figure 3

Approximately 14 percent of the fatal accidents occurred during the takeoff (8 percent) and initial climb (6 percent) phases of flight; 10 percent occurred in cruise; 10 percent during taxi, towing, loading/unloading or while parked; 8 percent during climb (flaps up); 8 percent during initial approach and 3 percent during descent. Accidents in cruise accounted for 774 on-board fatalities, or approximately 20 percent of the total.

The data were analyzed in Boeing's *Statistical Summary of Commercial Jet Airplane Accidents, Worldwide Operations, 1959–2013*. The aircraft manufacturer publishes similar sets of statistics on an annual basis. The statistics are for worldwide commercial jet airplanes that are heavier than 60,000 lb (27,216 kg) maximum gross weight, but exclude airplanes manufactured in the Commonwealth of Independent States or the former Soviet Union because of the lack of operational data. Commercial airplanes operated in military services also are excluded unless a military-owned commercial jet transport is used for civilian commercial service. Also, definitions related to the development of statistics in the summary are primarily based on corresponding International Civil Aviation Organization (ICAO), U.S. National Transportation Safety Board (NTSB) and Flight Safety Foundation terms.

ICAO and the U.S. Commercial Aviation Safety Team (CAST) have chartered the CAST/ICAO Common Taxonomy Safety Team (CICTT) to develop common taxonomies and definitions for aviation accident and incident reporting systems. The CICTT Aviation Occurrence Taxonomy is designed to permit the assignment of multiple categories as necessary to describe an accident or incident. In addition, CAST assigns each fatal accident to a single principal category.

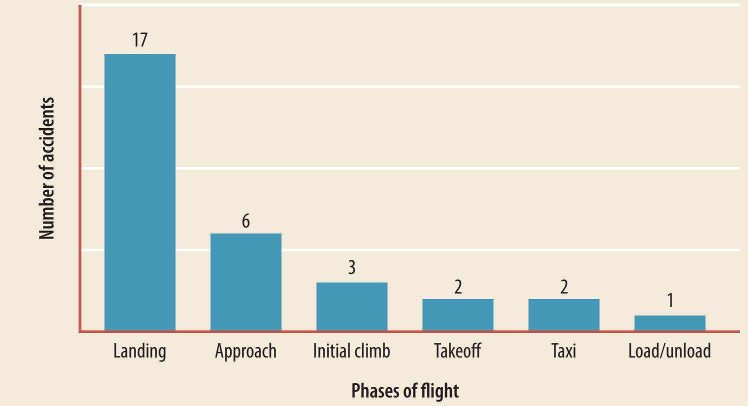
CAST assigned 16 of the 72 fatal accidents that occurred from 2004 through 2013 to the loss of control–inflight (LOC-I) category; 16 to the controlled flight into terrain (CFIT) category and 17 to the runway excursion (landing) category, including abnormal runway contact and undershoot/overshoot accidents (Figure 2). The LOC-I accidents accounted for 1,526 on-board fatalities and 50 external fatalities. The CFIT accidents accounted for 803 on-board fatalities and one external fatality, and the runway excursion accidents accounted for 768 on-board fatalities and 28 external fatalities. A further four fatal runway excursion accidents on takeoff resulted in 13 on-board fatalities and 38 external fatalities during the period.

Over the 10-year period, the fatal accident rate for scheduled commercial passenger operations was 0.28 accidents per million departures, and the hull loss accident rate was 0.61, based on 186.6 million departures, according to the Boeing summary (Figure 3). The fatal accident rate for all other operations — including charter passenger, charter cargo, scheduled cargo, maintenance test, ferry, positioning, training and demonstration flights — was 0.61, and the hull loss accident rate was 1.70, based on 32.9 million departures. The total fatal accident rate, based on 219.5 million departures, was 0.33 and the hull loss accident rate was 0.77.

For 2013, Boeing counted 31 commercial jet airplane accidents, of which 17 (55 percent) occurred during the landing phase (Figure 4). Of the remaining 14 accidents, six occurred during approach, three during initial climb, two during takeoff, two during taxi, and one during load/unload operations. Four of the 31 accidents were fatal accidents, and an additional four involved serious injuries. A *serious injury* is defined as one sustained by a person in an accident and that, among other factors, requires hospitalization for more than 48 hours commencing within seven days from the date the injury was received; results in a bone fracture; causes severe hemorrhage, nerve, muscle or tendon damage; or involves injury to any internal organ. There were 62 on-board fatalities and no external fatalities in the four fatal accidents.

Twenty-four of 2013's accidents occurred during scheduled passenger operations; six occurred during scheduled cargo operations and one during a charter passenger flight (Figure 5). Of the 31 accident airplanes, 25 suffered *substantial damage*, defined as "damage or failure that adversely affects the structural strength, performance, or flight characteristics of the airplane, and that would normally require major repair or replacement of the affected component." Five of the 31 accident airplanes were categorized as destroyed and one was characterized as having no damage. In that case, a ground worker delivering final paperwork to the flight deck before takeoff fell from the entry door and was seriously injured. Thirteen of the accident airplanes were considered hull losses.

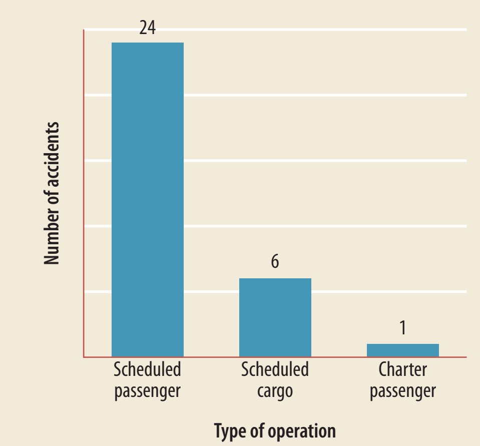
2013 Worldwide Commercial Jet Airplane Accidents by Phase of Flight



Source: Boeing Commercial Airplanes

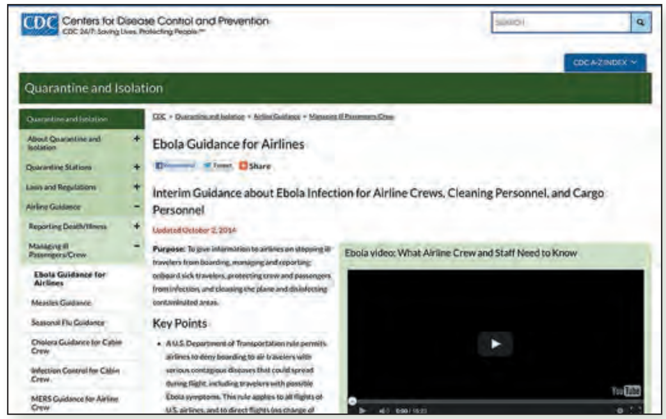
Figure 4

2013 Worldwide Commercial Jet Airplane Accidents by Type of Operation



Source: Boeing Commercial Airplanes

Figure 5



BY WAYNE ROSENKRANS

Ebola Updates

Risk-manager mindset and attention to detail may help airline professionals avoid unprotected exposure to the virus.

WEBSITES

Precautions Against Virus

Ebola Guidance for Airlines: Interim Guidance about Ebola Infection for Airline Crews, Cleaning Personnel, and Cargo Personnel

U.S. Centers for Disease Control and Prevention, Atlanta <www.cdc.gov/quarantine/air/managing-sick-travelers/ebola-guidance-airlines.html>. Sept. 19, 2014.

This page on the public website maintained by the U.S. Centers for Disease Control and Prevention (CDC) provides airline personnel access to the latest authoritative information about Ebola — which health care professionals call *Ebola virus disease.* As a preliminary point, it says that "the risk of spreading Ebola to passengers or crew on an aircraft is low because Ebola spreads by direct contact with infected body fluids. Ebola does *not* spread through the air like flu."

Precautions against such direct contact, however, rely on aircraft crewmembers to always follow basic infection control precautions and procedures — such as strictly applying their training on hand hygiene — applicable to any type of infectious disease. Above all, this means treating all body fluids as though they are infectious. When warranted, crews also are expected to follow their routine procedures for retrieving and wearing airline-furnished personal protective equipment, stored in a universal precautions kit, CDC said.

"Ebola spreads through direct contact by touching the blood or other body fluids (like feces, saliva, urine, vomit and semen) of a person who is sick with Ebola," the website guidance says. "Infected blood or other body fluids can spread Ebola through breaks in your skin or if they get into your eyes, nose, or mouth. … Employers must provide protective clothing and equipment for workers who may perform tasks that could result in exposure to Ebola virus. This would include employees whose work tasks include cleaning up blood, vomit or other body fluids from a sick passenger."

The website's information and links help airline workers with relevant duties to be effective in preventing people with symptoms of Ebola (and any other serious contagious disease) from boarding the aircraft; in managing sick travelers aboard the aircraft and properly reporting their condition to health care professionals and public health authorities; in protecting themselves, aircraft crewmembers and passengers from infection; and in post-flight cleaning of the airplane and the disinfection of contaminated areas.

The reporting duty is significant, CDC says, partly because, "If a traveler is confirmed to have had infectious Ebola on a flight, CDC will conduct an investigation to assess risk and inform passengers and crew of possible exposure. … Reporting to CDC does not replace usual company procedures for in-flight medical consultation or getting medical assistance."

Exposure Risks

One CDC-linked web page maintained by the U.S. Occupational Safety and

Health Administration (OSHA; see "Airline-Focused Ebola Knowledge.") elaborates on the theme of constantly being prepared for exposure. OSHA said, "Workers involved in airline and airport service operations — including flight attendants, cleaning and provisioning staff, and cargo personnel — may be exposed to Ebola virus in a number of scenarios, including exposure to infectious body fluids in lavatories and direct exposure to individuals sick with [Ebola hemorrhagic fever, a previous term for Ebola still in use]. Currently, airline service worker exposure to Ebola virus is unlikely. … Passengers originating from locations affected by the ongoing [Ebola] outbreak pose the greatest hazard to workers in the airline service industry."

The first stage in managing Ebola exposure to crewmembers and passengers should be invoking the U.S. regulation (and its international counterparts)

Airline-Focused Ebola Knowledge

U.S. Centers for Disease Control and Prevention

As the Ebola outbreak continues in Guinea, Liberia and Sierra Leone — an outbreak the United Nations World Health Organization classified in August as a "public health emergency of international concern" — *AeroSafety World* reviewed the comprehensive information and links on the web page titled "Ebola Guidance for Airlines" within the website of the U.S. Centers for Disease Control and Prevention (CDC). From this link <www.cdc.gov/quarantine/air/managing-sick-travelers/ebola-guidance-airlines.html>, the following pages/documents — and directions to similarly authoritative links — are available at no cost:

- CDC. "Aircrew RING" (wallet card/poster). September 2014. <wwwnc.cdc.gov/travel/pdf/ebola-air-crew-ring-card.pdf> and <wwwnc.cdc.gov/travel/pdf/ebola-air-crew-ring-poster-small.pdf>. These Ebola-specific memory aids are similar to aviation quick-reference checklists, focusing on recognizing an ill traveler (passenger or crewmember), isolating the ill traveler at a gate or during flight, notifying airline officials at a gate or during flight to initiate medical evaluation, and giving support to the airline's response to the ill traveler.
- CDC. "Case Definition for Ebola Virus Disease (EVD)." Sept. 4, 2014. <www.cdc.gov/vhf/ebola/hcp/case-definition.html>. This explains Ebola-related terminology (e.g., *person under investigation, probable case* and *confirmed case*) that health care providers and public health officials use to assess a person's current symptoms and his/her risks for exposure to Ebola during the preceding 21 days.
- U.S. Occupational Safety and Health Administration (OSHA). "Ebola: Control and Prevention." Oct. 7, 2014. <www.osha.gov/SLTC/ebola/control_prevention.html>. This details precautionary measures that employers and workers should take to prevent exposure to Ebola depending on their type of work, the potential for Ebola contamination within their workplace, and what is known about other potential exposure hazards.
- CDC. "Possible Exposure — Ebola: What you need to do." <wwwnc.cdc.gov/travel/pdf/ebola-travel-health-alert-notice.pdf>. This includes messages to formally notify passengers and crewmembers without symptoms that they might have been exposed to Ebola by virtue of being seated on an airplane near a person under investigation, or that they had contact with such a person in an airport, and what follow-up communication they should expect.
- CDC. "Guidance for Airlines on Reporting Onboard Deaths or Illnesses to CDC." Aug. 25, 2014. <www.cdc.gov/quarantine/air/reporting-deaths-illness/guidance-reporting-onboard-deaths-illnesses.html>. This page includes downloadable "reporting tool" documents designed for use by pilots and flight attendants to comply with U.S. and international laws.
- CDC. "Personal Protective Equipment (PPE) for Airport and Airplane Cleaning Crews." <wwwnc.cdc.gov/travel/pdf/ebola-ppe-cleaning-crews.pdf>. This reminds airline personnel, among other precautions, of the safest procedures to put on and take off booties, inner gloves, gowns, face masks, face shields (preferred) or goggles, and outer gloves in the Ebola context.
- CDC. "Infection Control Guidelines for Cabin Crew Members on Commercial Aircraft." March 14, 2014. <www.cdc.gov/quarantine/air/managing-sick-travelers/commercial-aircraft/infection-control-cabin-crew.html>. This recaps practical measures for flight attendants to use when interacting with anyone aboard an airplane who is ill with a possible contagious infection.
- International Air Transport Association. "Suspected Communicable Disease: General Guidelines for Cleaning Crew." March 2014. <www.iata.org/whatwedo/safety/health/Documents/health-guidelines-cleaning-crew.pdf>. This summarizes post-landing procedures such as correct use of cleaning agents and disinfectants; what to clean at an affected seat and surrounding seats, and in what order; and safe and effective cleaning and disinfection of lavatories, carpets or storage compartments soiled by blood and other body fluids.

— WR

that permits airlines — specifically, all U.S. airlines and all non-U.S. airlines conducting direct flights to/from the United States — to deny boarding to air travelers with serious contagious diseases that could spread during flight. In the case of an Ebola-infected traveler, this means watching for and recognizing potential Ebola symptoms, such as a specified level of fever, and/or linking the travelers to other defined risk factors such as personal contact, during the preceding 21 days (the longest-known virus incubation period), with a person diagnosed with or suspected of having Ebola or someone who has traveled from a country experiencing an Ebola outbreak.

CDC's recommended links clarify the difference between an air traveler who may have been infected with Ebola but has no symptoms — such as fever 101.5 degrees F (38.6 degrees C) or higher — and an air traveler who has Ebola symptoms, which indicate that the virus can be spread by direct contact with body fluids infected with the virus.

To manage an in-flight situation in which an ill person is suspected of having Ebola, the CDC says, "It is important to assess the risk of Ebola by getting more information. Ask sick travelers whether they were in a country with an Ebola outbreak. Look for or ask about Ebola symptoms: fever ([the person] gives a history of feeling feverish or having chills), severe headache, muscle pain, vomiting, diarrhea (several trips to the lavatory), stomach pain, or unexplained bleeding or bruising.

"Even if the person has been in a country with Ebola, cabin crew won't know for certain what type of illness a sick traveler has. Therefore, cabin crew should follow routine infection control precautions for all travelers who become sick during flight, including managing travelers with respiratory illness to reduce the number of droplets released into the air. … [They should] consider providing sick travelers with surgical masks (if the sick person can tolerate wearing one) to reduce the number of droplets expelled into the air by talking, sneezing or coughing." Airsickness bags, not masks, should be given if the ill person reports feeling nauseated or is vomiting, CDC noted.

Universal precautions for providing direct care to any ill passenger begin with wearing waterproof disposable gloves before directly touching the sick person, blood or other body fluids, and separating the sick person from other airplane occupants to the extent possible. In the specific case of a person who shows the Ebola symptoms and who acknowledges coming from a country with an Ebola outbreak, CDC recommends that the flight attendant(s) "wear a surgical mask (to protect from splashes or sprays), face shield or goggles, and protective apron or gown." A surgical mask also should be worn by the sick person unless the person is vomiting or nauseated, or he or she should use tissues to cover the nose and mouth when coughing or sneezing, with a plastic bag at hand for waste disposal.

A critical aspect of preventing Ebola infection, CDC says, is awareness that the personal protective equipment worn can transfer infected substances to the wearer or others, and so requires absolutely correct adherence to training for safe removal and disposal — including the precise sequence of donning and removal steps.

Exposure Concerns

The CDC recommends that any airline workers who think they may have been exposed to Ebola immediately notify their company and then follow CDC guidance to self-monitor their health for 21 days. "Watch for symptoms of Ebola: fever (temperature of 101.5 [degrees] F/38.6 [degrees C] or higher), severe headaches, muscle pain, diarrhea, vomiting, stomach pain, unexplained bleeding or bruising. … If you develop symptoms after possible exposure to Ebola, get medical attention right away. Before visiting a health care provider, alert the clinic or emergency room in advance about your possible exposure to Ebola so that arrangements can be made to prevent transmission to health care staff or other patients."

The web page similarly makes clear the need to adhere to every detail of prescribed aircraft-cleaning procedures to eliminate the possibility of direct contact with Ebola virus, beginning with cabin crew ensuring that the cleaners have been fully informed of the situation. "Disinfection and clean up should include wiping down lavatory surfaces and frequently touched surfaces in the passenger cabin, such as armrests, seat backs, tray tables, light and air controls, and adjacent walls and windows with an Environmental Protection Agency (EPA) registered cleaner/disinfectant that has been tested and approved for use by the airplane manufacturers. … Do not use compressed air, pressurized water or similar procedures, which might create droplets of infectious materials."

As for air cargo personnel, CDC advises, "Packages or luggage should not pose a risk. Ebola virus is spread through direct contact with blood or body fluids … from an infected person. Don't handle packages visibly dirty from blood or body fluids. Wash your hands … often to prevent other infectious diseases."

'Totally Dark'

Heavy rainfall reduced visibility to zero during the final stage of a nonprecision approach.

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

Go-Around Too Late

Boeing 737-800. Substantial damage. Four serious injuries.

The 737 was on a scheduled passenger flight the afternoon of April 13, 2013, from Bandung, Indonesia, to Bali, where visual meteorological conditions prevailed with a few thunderstorms in the area. The second-in-command (SIC) was the pilot flying (PF) when the flight crew began the VOR/DME (VHF omnidirectional radio/distance measuring equipment) approach to Runway 09 at Bali's Ngurah Rai International Airport.

The aircraft was on final approach, about 900 ft above the Bali Sea, when the SIC announced that he did not have the runway in sight. The pilot-in-command (PIC) replied that he had the approach lights in sight and told the SIC to continue the approach.

The PIC then noticed a "dark area" ahead on the right side of the approach path. "The PIC predicted that the dark area was narrow and the runway would be visible after a short time," said the report by the National Transportation Safety Committee of Indonesia (NTSC). The dark area actually was a thunderstorm moving north over the airport.

The cockpit voice recorder captured the sound of rain striking the windshield as the aircraft descended through 200 ft. The PIC told investigators that the outside environment then became "totally dark," and he took control from the SIC.

The 737 was about 20 ft above the sea when the PIC initiated a go-around. The aircraft struck the water almost immediately thereafter. Four passengers were seriously injured; the other 97 passengers and seven crewmembers sustained minor or no injuries. "The aircraft was substantially damaged and submerged in shallow water," the report said.

The NTSC concluded that factors contributing to the accident were that the pilots did not receive timely and accurate information about the weather conditions at the airport; they did not notice that the approach became unstabilized, with a descent rate exceeding 1,000 fpm below the minimum descent height; they "lost situational awareness in regards to visual references" when the aircraft entered the thunderstorm; and the decision to go around was made at an altitude that "was insufficient for the go-around to be executed successfully."

Misloaded Cargo

Boeing 737-300F. No damage. No injuries.

The load order form for the cargo flight from Edinburgh, Scotland, to London the morning of Nov. 19, 2013, showed that the eight unit load devices (ULDs) were to be loaded in descending weight order, with the heaviest toward the rear of the aircraft.

However, neither the loading team nor the flight crew noticed that the ULDs inadvertently were loaded in the reverse order, which resulted in the center of gravity being more than 12 units beyond the forward limit. "The commander stated that, because the turnaround had been rushed due to the late arrival of the load and fuel, this check had not been carried out," said the report by the U.K. Air Accidents Investigation Branch.

On takeoff, the commander had to apply greater-than-normal back pressure on the control column to rotate the aircraft, and more-than-usual nose-up pitch trim was required during the climb. "The crew discussed the situation and concluded that there may have been a loading error," the report said. "However, as the aircraft was apparently flying normally, they elected to continue to the destination."

An abnormal amount of nose-up pitch trim was required during cruise flight and the subsequent approach, but the freighter was landed without further incident at London Stansted Airport.

"In order to prevent a reoccurrence, the operator now requires a flight deck crewmember to check each ULD number as it is loaded and has adopted a 'pyramid' loading system whereby the heaviest ULDs are loaded towards the centre of the aircraft in order to mitigate the effects of any errors," the report said.

In-Flight Incapacitation

Boeing 747-400. No damage. No injuries.

The aircraft was crossing the east coast of North America during a scheduled passenger flight from Newark, New Jersey, U.S., to Frankfurt, Germany, the night of Nov. 18, 2012, when the first officer, the PF, told the commander that he was feeling tired and wanted to rest for 10 minutes. The commander took control of the 747.

"After the first officer woke up, he reported that he was still feeling very tired, dizzy and had difficulties concentrating," said the report by the Air Accident Investigation Unit of Ireland. The purser obtained the assistance of three physicians among the passengers to attend the 35-year-old first officer in the crew area behind the cockpit.

"The first officer slept again, but when he awoke he complained of a severe headache and commenced vomiting," the report said. "The principal doctor … then advised that the first officer would be unable to return to his duties and that he should be removed to hospital."

At the time, the 747 was about halfway across the Atlantic. The commander decided to declare an emergency and divert the flight to Dublin, Ireland. The passenger list showed that several airline pilots were aboard, including a 767 captain for another airline. "The commander, having checked this captain's pilot's license and identity, ascertained that he could assist him on the flight deck and allowed him to sit in the first officer's seat while performing PM [pilot monitoring] duties under his command and supervision," the report said.

The 747 was landed in Dublin without further incident, and the first officer was transported to a hospital. A relief crew later arrived to complete the flight to Frankfurt. The report did not specify the first officer's illness but noted that he received further medical examination and treatment in Ireland and in Germany.

Setup for an Overrun

Learjet 25B. Substantial damage. No injuries.

The absence of company guidance for landing with a tail wind on a wet runway, a malfunctioning anti-skid braking system and a late touchdown were among the elements involved in the Learjet's overrun at Portland-Hillsboro (Oregon, U.S.) Airport the afternoon of Nov. 17, 2010, according to the U.S. National Transportation Safety Board (NTSB).

The flight crew, who were completing a positioning flight, conducted a VOR/DME approach to Runway 30 with an 8-kt tail wind. "Despite the tailwind, the captain elected to land on the 6,600-foot [2,012-m] runway instead of circling to land with a headwind," the NTSB report said. "Moderate to heavy rain had been falling for the past hour, and the runway was wet."

The first officer had consulted the company's landing data card and had calculated a landing distance of 4,538 ft (1,383 m) on the wet runway. However, unlike the airplane flight manual (AFM), the company card did not provide corrections for tail winds. Investigators found that the wet stopping distance with an 8-kt tail wind was 5,110 ft (1,558 m).

The pilots later told investigators that the Learjet touched down about 1,200 ft (366 m) beyond the approach threshold. The spoilers were extended and brake pressure was applied, but there was no discernable deceleration. "The captain stated that he thought about performing a go-around but believed that insufficient runway remained to ensure a safe takeoff," the report said.

The anti-skid braking system did not function properly, and the Learjet hydroplaned on the wet runway. It then overran the runway at about 85 kt and traveled about 618 ft (188 m) on wet terrain before striking a drainage ditch, collapsing the nose landing gear.

The NTSB concluded that the probable cause of the accident was the PF's "failure to attain the proper touchdown point." Contributing factors were the company's deficient landing data card and the malfunctioning anti-skid system.

TURBOPROPS

'It's No Problem'

Socata TBM 700. Destroyed. Five fatalities.

The pilot of the turboprop single reported light icing conditions while climbing on a flight from Teterboro, New Jersey, U.S., to Atlanta, Georgia, the morning of Dec. 20, 2011. The controller asked the pilot to tell him if the conditions worsened, and the pilot replied, "We'll let you know what happens. … If we can go straight through, it's no problem for us."

Shortly thereafter, while cruising at 17,000 ft, the pilot requested clearance to climb to a higher altitude as soon as possible. The controller asked the pilot to stand by and, after coordinating with the controller of an adjacent sector, cleared him to climb to 20,000 ft.

Recorded radar data showed that the TBM 700 subsequently entered a steep left turn at 17,800 ft and descended rapidly. Investigators determined that the airplane broke up before striking the median of a highway near Morristown, New Jersey.

The NTSB concluded that the probable causes of the accident were "the airplane's encounter with unforecast severe icing conditions … and the pilot's failure to use his command authority to depart the icing conditions in an expeditious manner, which resulted in loss of airplane control."

Loose Injector Causes Fire

ATR 72-212A. Minor damage. No injuries.

The flight crew was starting the left engine in preparation for a scheduled passenger flight from Moorea, French Polynesia, the morning of Nov. 18, 2011, when they noticed that the inter-turbine temperature increased more slowly than normal and then stagnated between 300 and 400 degrees C (572 and 752 degrees F). Engine speed also stagnated between 30 and 40 percent.

"The captain was thinking of abandoning the start-up sequence when the engine fire alarm came on," said the report by the French Bureau d'Enquêtes et d'Analyses. "He applied the engine ground fire procedure and fired extinguisher no. 1 without success. Firing the second extinguisher put out the fire." The passengers subsequently were evacuated without incident.

Investigators found that the fire had been caused by a fuel leak emanating from a damaged O-ring in a fuel injector that had not been tightened properly during maintenance. The report noted that the engine manufacturer, Pratt & Whitney Canada, subsequently published a service bulletin clarifying procedures for installing and leak-checking the injectors in PW120 engines.

Ice Triggers Control Loss

Beech King Air F90. Destroyed. One serious injury.

Light freezing drizzle had been forecast along the route from Wharton to Midland, both in Texas, U.S., the morning of Dec. 2, 2011. The pilot told investigators that despite the use of all the ice-protection systems, the King Air accumulated moderate to severe airframe icing as it neared the destination, which was reporting 1 3/4 mi (2,800 m) visibility in mist and an 800-ft overcast.

During the subsequent global positioning system (GPS) approach to Runway 25 at Midland Airpark, the airplane deviated from the published course. The approach controller canceled the pilot's approach clearance and provided vectors to position the King Air for another attempt.

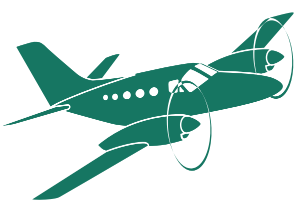
During the second approach, the controller advised the pilot that the airplane was about a half mile south of course and provided heading and climb instructions for a missed approach.

Although the AFM prohibits the use of the autopilot in icing conditions because it can mask tactile clues to adverse changes in handling characteristics, the pilot continued the approach with the autopilot engaged. He also conducted the approach at airspeeds ranging from 120 kt to 100 kt, which are below the AFM's recommended minimum airspeed of 140 kt for sustained flight in icing conditions.

"The airplane descended under the cloud deck, and the pilot began to look for the runway," the NTSB report said. He advanced the power levers, and the airplane abruptly rolled about 90 degrees left. "He disengaged the autopilot and attempted to use the yoke to level the airplane. The airplane then rolled about 90 degrees to the right. The pilot was unable to regain airplane control, and the stall-warning horn came on seconds before the airplane impacted the ground."

The King Air crashed into a house about a mile from the runway, and a fire erupted. Although seriously injured, the pilot was able to exit the airplane. No one on the ground was injured.

The NTSB concluded that the probable causes of the accident were "the pilot's failure to maintain the recommended airspeed for icing conditions and his subsequent loss of airplane control while flying the airplane under autopilot control in severe icing conditions, contrary to the airplane's handbook." A contributing factor was "the pilot's failure to divert from an area of severe icing."



PISTON AIRPLANES

Fuel Selector on Empty Tank

Piper Chieftain. Destroyed. No injuries.

The Chieftain was climbing through 9,000 ft during a flight from Gauteng, South Africa, to Limpopo the morning of Nov. 25, 2012, when the left engine lost power. The pilot feathered the propeller and turned back to Gauteng, but he was unable to maintain altitude.

"The pilot realised he was losing height rapidly and decided to do a wheels-up forced landing in an open field 1 nm [2 km] north of Gauteng," said the report by the South African Civil Aviation Authority (CAA). "As the pilot was about to land the aircraft, a fire erupted in the right engine and continued until touchdown." After the Chieftain came to a stop in the field, the pilot exited before the fire engulfed the aircraft.

Investigators found both fuel selectors positioned to the main tanks. The left main tank was empty, but the left outboard tank was full. The CAA concluded that the left engine had failed due to fuel starvation. The cause of the fire in the right engine could not be determined.

Load Shifts on Takeoff

Douglas DC-6. Substantial damage. No injuries.

Shortly after departing from Nuiqsut, Alaska, the night of Nov. 25, 2013, to deliver a load of oversized oil-drilling tools to Deadhorse, the first officer, the PF, noticed that elevator control was "momentarily stiff."

The flight engineer inspected the cargo and found that two of the four 31-ft (9-m) drilling tools had shifted aft and damaged the aft pressure bulkhead. "The captain did not declare an emergency, and the airplane landed at the destination without incident," the NTSB report said.

Examination of the cargo revealed that some of the nylon straps securing the drilling tools likely had loosened slightly during taxi and takeoff. "The crew also noted that the drilling tools were covered with ice and snow, which likely aided the tools in sliding along the aluminum, diamond-plate-covered floor of the airplane," the report said.

Night-Flight Decision Faulted

Cessna 421C. Destroyed. Two fatalities.

One of the airplane's two vacuum pumps had failed on a previous flight, and the pilot was unable to have it repaired before departing from Salinas, California, U.S., for a flight to Omaha, Nebraska, the night of Nov. 10, 2012.

Recorded radar data showed that shortly after leveling at 27,000 ft, the 421 rolled right and entered a rapid descent. The airplane subsequently broke up before striking terrain near Shaver Lake, California.

"The breakup sequence was most likely inadvertently induced by the pilot as he attempted to recover control of the airplane during the dive," the NTSB report said. "The airplane was flying toward an uninhabited mountain range and a largely unpopulated desert area at the time of the upset. The moon had set, and the pilot would have had limited reliable external visual cues should the airplane have experienced a failure of either the flight instruments or the autopilot."

The NTSB determined that a contributing factor in the accident was "the pilot's decision to make the flight with a failed vacuum pump, particularly at high altitude in night conditions." The report noted that the 421's master minimum equipment list permits operation of the airplane with one vacuum pump inoperative only during the day and under visual flight rules.

HELICOPTERS

'Extremely Foggy'

Aerospatiale AS355. Substantial damage. One fatality.

Witnesses said that it was dark and "extremely foggy" when the pilot departed from Erwinna, Pennsylvania, U.S., the morning of Oct. 17, 2012, for a positioning flight to Philadelphia's Wings Field.

Data recovered from a handheld GPS receiver aboard the helicopter indicated that it stayed low and entered a right turn after lifting off from the helipad. The turn rate gradually increased, and the helicopter descended into trees and terrain.

Noting that the AS355 was not equipped for instrument flight, the NTSB report said that the probable cause of the accident was "the pilot's decision to depart under visual flight rules in dark night instrument meteorological conditions, which resulted in subsequent spatial disorientation."

Half Fuel, Half Water

Aerospatiale Alouette. Substantial damage. No injuries.

Shortly after the helicopter departed from Libode, South Africa, to provide support for the construction of a power line the afternoon of Nov. 22, 2012, the engine lost power. "The pilot elected to execute a forced landing on a ridge," the South African CAA report said. "The left wheel caught the contour and lifted the tail boom before it impacted with the ground. … The tail rotor broke off, and the helicopter rolled over."

The pilot, who was not hurt in the crash, told investigators that he had conducted a thorough preflight inspection of the helicopter, which had been refueled five weeks previously and parked. The report noted that the pilot had not flown the helicopter during that time because of rainfall and a strike at the construction company.

A post-accident examination of the helicopter by the operator revealed a 50 percent water/fuel mixture in the fuel filter and the main fuel line; "minimal amounts" of water were found in the fuel tank, however, the report said.

"Given the quantity of water present and where it was found, there can be no doubt that the fuel supplied and used for refueling of the helicopter [five weeks earlier] was contaminated with water that directly contributed to the helicopter suffering an engine failure," the report said.

Mast Bumping

Robinson R22 Beta II. Substantial damage. One fatality.

Witnesses said that the R22 was cruising about 500 ft over Apollo Beach, Florida, U.S., the afternoon of Nov. 30, 2012, when they heard a bang and saw both main rotor blades separate. The helicopter rolled right and descended in a nose-down attitude into the bay.

One of the main rotor blades was not recovered. Examination of the recovered rotor blade, the rotor hub and the teetering stops showed signs of mast bumping. "The observed mast bumping could have resulted from large, abrupt flight control inputs or from a mechanical failure of the unrecovered main rotor blade," the NTSB report said.

Preliminary Reports, August 2014

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Aug. 1	Tahoma, California, U.S.	Airbus AS350 B	substantial	2 serious, 2 none
The helicopter struck trees and crashed on the shoreline while departing from Buck Island for a charter flight.				
Aug. 6	Paris	Socata TBM 700	destroyed	2 fatal, 3 serious
The aircraft descended and crashed in a wooded area after encountering unknown problems during a flight from Cannes, France, to Courtrai, Belgium.				
Aug. 10	Tehran, Iran	HESA IrAn-140	destroyed	39 fatal, 9 serious
The aircraft, an Antonov 140 built under license by HESA, crashed in a residential area after the right engine lost power during takeoff.				
Aug. 11	Idaho Falls, Idaho, U.S.	McDonnell Douglas 500N	substantial	3 none
The pilot said that he lost tail rotor control on takeoff. The helicopter rotated left, struck the ground and rolled over.				
Aug. 13	São Paulo, Brazil	Cessna 560XLS	destroyed	7 fatal
Visibility was 3,000 m (2 mi) in rain and mist when the Citation Excel crashed in a residential area about 4 km (2 nm) southwest of Santos Air Base during an attempted go-around. The airport reportedly has only a nondirectional beacon approach.				
Aug. 14	Salt Lake City, Utah, U.S.	Boeing 737-700	substantial	5 none
A baggage cart at the end of a string of carts being towed by a tug came loose and rolled into, and penetrated, the fuselage of the 737, which was parked at a gate and being prepared to board passengers.				
Aug. 15	Doncaster, England	British Aerospace Jetstream 31	substantial	3 none
The left main landing gear collapsed when the Jetstream veered off the left side of the runway about eight seconds after touching down.				
Aug. 15	Bowie, Texas, U.S.	Cessna 414	destroyed	2 fatal
A witness said that the 414 pitched nose-down and rotated three times before striking the ground near the Bowie airport.				
Aug. 16	Grand Manan Island, New Brunswick, Canada	Piper Navajo	NA	2 fatal, 2 serious
The Navajo was returning from a night air ambulance flight to Saint John when it struck terrain while turning onto final approach. The pilot and a physician were killed; the copilot and a nurse were injured.				
Aug. 19	Northport, Alabama, U.S.	McDonnell Douglas 500	substantial	2 fatal
The crew was inspecting high-tension power lines for storm damage when the helicopter struck a shield wire between two towers and descended into a valley.				
Aug. 23	Mulume Munene, Democratic Republic of Congo	Let L410-UVP	destroyed	4 fatal
The aircraft crashed in mountainous terrain about 30 km (16 nm) from the departure airport during a cargo flight from Bukavu to Kama.				
Aug. 26	Mercaderes, Colombia	Cessna 208B	substantial	7 NA
No fatalities were reported in the forced landing of the Grand Caravan after the engine lost power during a flight from Cali to Tumaco.				
Aug. 27	Gardnerville, Nevada, U.S.	Robinson R22 Beta	substantial	1 serious, 1 minor
The passenger was seriously injured when the R22 descended into a ravine after striking four cables strung about 20 ft above a river.				
Aug. 27	Las Cruces, New Mexico, U.S.	Cessna 421C	destroyed	4 fatal
The airplane was misfueled with Jet A before it departed from Las Cruces for a medevac flight to Phoenix, Arizona. The pilot reported smoke coming from the right engine before the 421 crashed while returning to the airport.				
Aug. 28	Hemet, California, U.S.	Airbus AS350 B3	substantial	2 minor
During an instructional flight, the helicopter touched down hard and rolled over while being landed with a simulated governor failure.				
Aug. 30	Tamanrasset, Algeria	Antonov 12BK	destroyed	7 fatal
Visual meteorological conditions prevailed when the aircraft crashed in mountainous terrain shortly after departing from Tamanrasset for a cargo flight to Mali.				
Aug. 31	Kogatende, Tanzania	Fokker F-27	destroyed	3 fatal
The aircraft crashed in the Serengeti National Park about 20 minutes after departing from Mwanza, Tanzania, for a cargo flight to Kenya.				

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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