AeroSafety WORLD

TEM'S UNSPOKEN WORDS
Awareness of subtle trouble cues

AUDITING ON THE FRONTIER
World Food Programme's attack on risk

WIDESPREAD FATIGUE DAMAGE
New rules for aging aircraft

MAIN GEARBOX RUNS DRY
Rotor transmission's fatal failure

CHECK FLIGHT OVERHAUL

REDUCING THE RISK OF CHECK FLIGHTS

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

MARCH 2011

PROTECTING Safety Data

Over the past several years, Flight Safety Foundation has been pretty vocal on the broad topic of criminalization of human error. Things have been quiet on that front lately, so I thought I should provide an update. The focus of our recent efforts has been on the legal protection of safety information. Increasingly, voluntarily provided safety information is being used in court cases, sometimes even trivial cases, and surrendered to the general news media under freedom of information requests. We are not talking about the usual states with lax protections; we are talking about advanced aviation nations like Canada and the United Kingdom. These disclosures are not headline-grabbing events. They are quiet court rulings that don't get much notice. But that is what makes us nervous. It is one thing to see confidential information disclosed in the emotional turmoil following a major accident; it is another to see it being casually offered up by the courts in the normal course of business.

The judges in these cases point out correctly that there is no protection for this information under common law or legislation. Let me make this point clear: Even though your regulator may have agreed to protect the voluntary information and promised not to use it against the person who made the report, that promise has no bearing on anybody else who might want to use it. Just about anybody who argues in court that they have a need for that information will be provided access to it.

That is the battle we are fighting today. The good news is that we are not fighting alone. International Civil Aviation Organization is forming a group that will target that problem, and produce, hopefully, viable international standards regarding the protection of safety information. This group will include industry, labor organizations, prosecutors, attorneys and governments. Based on our long history on this issue, the Foundation has been invited to participate, and we will play a prominent role.

We quietly have been working on this issue for almost three years. The Foundation is not a lobbying group. But several years ago, the U.S. Congress asked us for advice on this issue as they formulated the new Federal Aviation Administration authorization bill. We provided advice that, we think, strikes the right balance between the needs of safety and justice. We suggested that the disclosure of all safety information — including flight data, voluntary reports, data from cockpit voice recorders and flight data recorders, and so forth — should only be allowed if the prosecution can convincingly show that a fair trial cannot be achieved without it. That is the highest legal test than can be put in place, but it still allows disclosure if there is no other way to achieve justice. We also suggested that if that stringent test is met, the information should be subject to the minimum possible disclosure, reviewed only in the judge's chambers. Beyond that, the information would remain sealed.

Having these protections placed in U.S. law would be quite an accomplishment, as well as providing a credible model for others to follow. We haven't made a big deal out of the effort because we didn't want to wake up the opposition, but now it is in the final throes of adoption. There is no guarantee what will come out of this. But let's hope for the best.

William R. Voss
President and CEO
Flight Safety Foundation

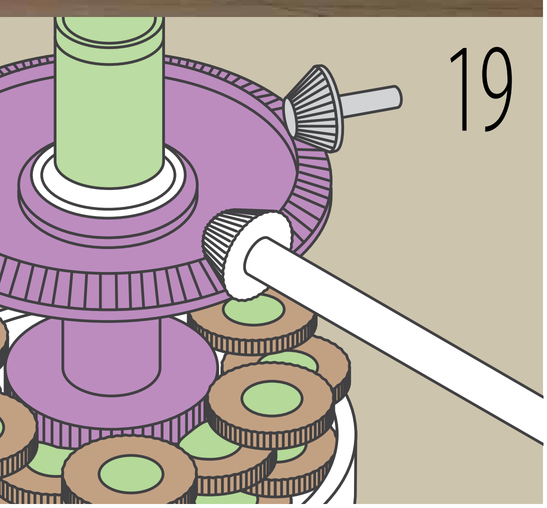
AeroSafetyWORLD

contents

March 2011 Vol 6 Issue 2

features

huh | hə | ■ interj. used to express surprise, disbelief, or confusion, or as an inquiry inviting affirmative reply



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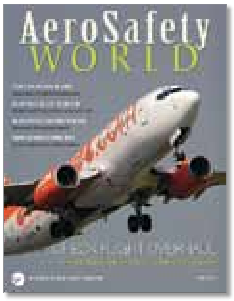

About the Cover
An easyJet 737 check flight nearly ended in tragedy.
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Share Your Knowledge

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 J.A. Donoghue, 801 N. Fairfax St., Suite 400, Alexandria, VA 22314-1774 USA or donoghue@flightsafety.org.

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Serving Aviation Safety Interests for More Than 60 Years

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

Member**Guide**

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MISDIRECTED Safety

An aviation safety event that doesn't harm people or equipment should be considered a learning experience, with, in the end, a positive outcome. A major exception to that rule is the odd event that alarms the public. When the public is alarmed, the general news media get agitated, which, in turn, motivates our political leaders into quick action that often misses the mark and sometimes is worse than doing nothing.

Recently, here in Washington, D.C., the public was alarmed when a night-shift tower controller at Ronald Reagan Washington National Airport (DCA) fell asleep and did not awake when two late flights called in expecting to be cleared to land. With advice from a controller at a nearby radar air traffic control (ATC) facility, and making radio calls in the blind as one would do at an uncontrolled airport, both aircraft landed without a problem.

It turned out that the sleeping controller was a supervisor who was pulling his fourth consecutive night shift. Readers of this magazine might remember Tom Anthony's story about such a shift, called "The Rattler" (*ASW*, 3/09, p. 19). The story can be found on the Foundation's Web site, <flightsafety.org>.

While the shifts the controller in question worked were not exactly the sequence Tom described, this statement from the story certainly seems to apply: "The real problem comes in when the acute sleep loss overlaps the major low point in the circadian rhythm. At that point, performance deteriorates to the point of being identical to someone who is legally drunk."

Make no mistake, an air traffic controller falling asleep on the job is not to be taken lightly, even if the average number of flights handled at DCA during that particular shift is around five. Not five per hour, five total; DCA has a highly restrictive noise curfew between 9:59 p.m. and 7:00 a.m. Still, let's try to fix this and talk about controller fatigue and fatigue countermeasures, maybe through schedule changes.

But this event rang the general public's alarm bell, with many passengers telling the agitated news media how lucky they feel to not have been on those flights, and how fearful they are that it could happen again. Pressed for instant solutions, Transportation Secretary Ray LaHood ordered that the DCA tower henceforth will have at least two controllers at all times. That ought to do it. Airplanes have two pilots and *they* never both go to sleep, right?

A few days later, the Federal Aviation Administration changed procedures by which flights are handed off between ATC facilities, adding a step to confirm that a conscious controller is manning the next sector.

This is not the first time in recent history that an alarmed and uninformed public pushed political leaders to adopt quick fixes.

Sadly, more than 80 years after air travel became widely available, the general public remains profoundly ignorant about aviation, viewing it with fear, suspicion and a distrust of those in the system. Due to this, a discouraging amount of the Foundation's efforts as a post-accident news media resource is invested in dispelling bogus theories and discrediting impossible solutions. However, as much as this might be regretted, along with political knee-jerk responses to public distress, there's little that can be done about it other than sticking to what we know is right, grinding away in our search for that next little bit of leverage in the perpetual war against risk in aviation.

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

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

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

APRIL 6–8 ➤ Workshop on the Launch of ICAO Universal Safety Oversight Audit Program Beyond 2010 and Continuous Monitoring Approach in Africa. International Centre of Excellence for Space & Aviation. Sandton, Republic of South Africa. <ratie@icesa.biz>, <www.icesa.biz/index.html>, +267 72.264.575.

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

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

MAY 2–6 ➤ Investigation Management Course. Southern California Safety Institute. Prague, Czech Republic. <Registrar@SCSI-INC.com>, <SCSI-INC.com>, +1 310.517.8844, ext. 104.

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

MAY 3–6 ➤ Aircraft Fire and Explosion Vulnerability and Protection Course. BlazeTech. Woburn, Massachusetts, U.S. Albert Moussa, <amoussa@blazetech.com>, <www.blazetech.com/firecourse.html>, +1 781.759.0700.

MAY 4–6 ➤ 7th International Aircraft Rescue Firefighting Conference and Exhibits. Aviation Fire Journal. Myrtle Beach, South Carolina, U.S. William Mulcahey, <avfirejournal@aol.com>, <www.aviationfirejournal.com>, +1 914.962.5185.

MAY 9–13 ➤ Human Factors for Accident Investigators Course. Southern California Safety Institute. Prague, Czech Republic. <Registrar@SCSI-INC.com>, <SCSI-INC.com>, +1 310.517.8844, ext. 104.

MAY 10–12 ➤ NextGen Ahead: Air Transportation Modernization Conference. *Aviation Week*. Washington, D.C. <www.aviationweek.com/events/current/nextgen/index.htm>.

MAY 10–20 ➤ Aircraft Systems Safety Management Course. (L/D)max Aviation. Dayton, Ohio, U.S. Sharon Morphew, <sharon.morphew@ldmaxaviation.com>, <www.ldmaxaviation.com/Courses/Systems_Safety_Courses/Aviation_System_Safety_Management_%28ASSM%29>, 877.455.3629, +1 805.285.3629.

MAY 16–19 ➤ Regional Airline Association (RAA) Annual Convention. RAA. Nashville, Tennessee, U.S. <raa@raa.org>, <www.raa.org/2011AnnualConvention/tabid/171/Default.aspx>, +1 202.367.1170.

MAY 16–20 ➤ Human Factors Investigation Course. (L/D)max Aviation. Torrance, California, U.S. Sharon Morphew, <sharon.morphew@ldmaxaviation.com>, <www.ldmaxaviation.com/Courses/Aircraft_Accident_Investigation_Courses/Human_Factors_Investigations_%28HFI%29>, 877.455.3629, +1 805.285.3629.

MAY 16–20 ➤ Safety Management Systems Complete Course. Southern California Safety Institute. Prague, Czech Republic. Mike Doiron, <mike.doiron@scsi-inc.com>, <www.scsi-inc.com/safety-management-systems-complete.php>.

MAY 16–20 ➤ Notification and Family Assistance Intensive Workshop and Live Exercise. Fireside Partners. New Castle, Delaware, U.S. <info@firesideteam.com>, <www.firesideteam.com/index.cfm?ref=60200&ref2=17>, +1 302.747.7127.

MAY 17–19 ➤ European Business Aviation Convention and Exhibition (EBACE). European Business Aviation Association and National Business Aviation Association. Geneva. Romain Martin, <rmartin@ebaa.org>, +32 2 766 0073; Donna Raphael, <draphael@nbaa.org>, +1 202.478.7760; <www.ebace.aero/2011>.

MAY 23–27 ➤ Investigation in Safety Management Systems Course. Southern California Safety Institute. Prague, Czech Republic. Mike Doiron, <mike.doiron@scsi-inc.com>, <www.scsi-inc.com/ISMS.php>.

MAY 23–27 ➤ Accident and Incident Investigation Course. ScandiAvia. Stockholm. Morten Kjellesvig, <morten@scandiavia.net>, <scandiavia.net/index.php/web/artikkel_kurs/investigation_sto_2011_01>, +47 91 18 41 82.

MAY 24–26 ➤ Global Runway Safety Symposium. Civil Air Navigation Services Organisation and International Civil Aviation Organization. Montreal. Details to be announced. <www.canso.org/cms/showpage.aspx?id=2118>.

MAY 24–27 ➤ Airmed Congress. Kent, Surrey and Sussex Air Ambulance, European HEMS and Air Ambulance Committee. Brighton, East Sussex, England. <info@airmed2011.com>, <www.airmed2011.com/>, +44 (0)1622 833833.

MAY 30–JUNE 1 ➤ Human Factors in Aviation Maintenance Course. Southern California Safety Institute. Prague, Czech Republic. Mike Doiron, <mike.doiron@scsi-inc.com>, <www.scsi-inc.com/HFAM.php>.

JUNE 14–16 ➤ Emergency Response Bootcamp. Fireside Partners. New Castle, Delaware, U.S. <info@firesideteam.com>, <www.firesideteam.com/index.cfm?ref=60200&ref2=16>, +1 302.747.7127.

JUNE 20–26 ➤ 49th International Paris Air Show. Salon International de l'Aeronautique et de l'Espace. Le Bourget, France. <www.paris-air-show.com>.

JUNE 27–28 ➤ Aviation Safety Management Systems Overview Workshop. ATC Vantage. Tampa, Florida, U.S. Theresa McCormick, <info@atcvantage.com>, <www.atcvantage.com/sms-workshop.html>, +1 727.410.4759.

JUNE 29 ➤ Transitioning to EASA Requirements for Operators. Baines Simmons. Chobham, Surrey, England. Zoe Martin, <zoe.martin@bainessimmons.com>, <www.bainessimmons.com/directory-course.php?product_id=134>, +44 (0)1276 855412.

JULY 14 ➤ Transitioning to EASA Requirements for Operators. Baines Simmons. Chobham, Surrey, England. Zoe Martin, <zoe.martin@bainessimmons.com>, <www.bainessimmons.com/directory-course.php?product_id=134>, +44 (0)1276 855412.

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

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

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

Safety News

ATM Goals

© Honeywell

Air traffic management (ATM) safety is improving but will require intensified effort to achieve the goals of the Single European Sky program, the Eurocontrol Safety Regulatory Commission (SRC) says.

In releasing its annual safety report for 2009, the SRC said that no ATM-related accidents were reported for aircraft weighing more than 2,250 kg (4,960 lb).

"The trend shows that the absolute number of accidents with an ATM contribution is decreasing," the report said.

The report also noted a slight decrease in runway incursion incidents and a decrease in the total number of level bust incidents reported, although the number of serious incidents increased slightly. In addition, the report said, "there was a definite increase in the number of reported airspace infringements, with more serious incidents reported, but the number of major incidents remained the same."

Jos Wilbrink, the 2010 SRC chairman, said, "One emerging issue is that although safety maturity in air navigation service providers is developing well, there is a lack of consistency in severity assessments. It is important that reports use the same standards so that reliable data can be established. The sharing of safety knowledge is fundamental in improving safety overall."

Research Agreement

The European Union (EU) and the U.S. Federal Aviation Administration (FAA) have agreed to work together on research to provide what the FAA called "seamless air traffic service" for aircraft flying between Europe and the United States.

Their agreement, signed in March in Budapest, Hungary, calls for research on "the interoperability of avionics, communication protocols and procedures, as well as operational methods" under the Next Generation Air Transportation System (NextGen) and its European counterpart, Single European Sky ATM (air traffic management) Research, known as SESAR.

Siim Kallas, European Commission vice president responsible for transport, who signed the agreement for the EU, said that, in another development, the EU and Eurocontrol had agreed to "explore a possible high-level cooperation agreement, thus consolidating the reform process of Eurocontrol, as well as the essential support provided by Eurocontrol to the implementation of [the Single European Sky], notably in its role as a performance review body and network manager for the [EU]."

Narrow Runways

Large aircraft will be required later this year to stop operating on runways in Australia that are narrower than the Australian Civil Aviation Safety Authority (CASA) standard.

Under current Civil Aviation Safety Regulations, large aircraft have been permitted to operate on runways that meet U.S. Federal Aviation Administration specifications. CASA says that beginning June 1, this practice will no longer be acceptable.

"This means that aerodrome operators must look at whether their runway widths meet the standards as set out in Part 139 of the Civil Aviation Safety Regulations, which is in accordance with International Civil Aviation Organization standards. In some cases, runways may have to be widened to accommodate aircraft that currently operate to an aerodrome."

CASA said that, for example, Boeing 737s are required by Australian regulations to use runways at least 45 m (148 ft) wide. Nevertheless, they have been permitted to use runways that are 30 m (98 ft) wide.

CASA said that airport operators that cannot meet the Australian standards must seek an exemption from the regulation. Operators that use narrow runways also must seek approval to continue their operations, CASA said.

Wikimedia

Weather Tower Warning

Citing three fatal accidents involving collisions of aircraft with unmarked meteorological evaluation towers (METs), the U.S. National Transportation Safety Board (NTSB) has issued a safety alert warning pilots of dangers associated with the towers.

U.S. National Oceanic and Atmospheric Administration

METs — many of which are only slightly shorter than 200 ft, the height at which the U.S. Federal Aviation Administration (FAA) requires obstruction markings — measure wind speed and direction during the development of wind farms (*ASW*, 11/10, p. 40).

METs typically are made from galvanized tubing with a diameter of 6–8 in (15–20 cm) and secured with guy wires installed at varying heights. Some of the structures, depending on their location, have been erected without notice to the aviation community, the NTSB said.

"Pilots have reported difficulty seeing METs from the air," the NTSB added. "METs could interfere with low-flying aircraft operations, including those involving helicopter emergency medical services, law enforcement, animal damage control, fish and wildlife, agriculture and aerial fire suppression."

Only two of the 50 states have taken action designed to reduce the risks presented by METs to aircraft, the NTSB said, noting that Wyoming requires all METS to be registered and marked so that they can be seen from a distance of 2,000 ft (610 m); the state also maintains an online database. South Dakota requires that METs be marked.

The FAA has issued a notice of proposed rulemaking that updates Advisory Circular 70/7460-1K with a recommendation that METs be marked. Nevertheless, the NTSB said that it is concerned that, because the FAA would not mandate the markings, many METs would be constructed without adequate markings or notice to aviators.

FOD Protection

Boeing should be required to develop a method of protecting the elevator power control unit input arm assembly on many 737s against damage from foreign object debris (FOD), the U.S. National Transportation Safety Board (NTSB) says.

The NTSB cited a June 14, 2009, incident in which a Tailwind Airlines 737-400 experienced an uncommanded pitch-up when it was about 20 ft above ground level during approach to Diyarbakir Airport in Turkey. The flight crew "performed a go-around maneuver and controlled the airplane's pitch with significant column force, full nose-down stabilizer trim, and thrust," the NTSB said. "During the second approach, the flight crew controlled the airplane and landed by inputting very forceful control column inputs to maintain pitch control."

The NTSB said that the two flight crewmembers received minor injuries during the go-around but did not provide details; none of the 159 passengers or cabin crewmembers was injured.

The NTSB determined that the uncommanded pitch-up was caused by FOD "lodged between the input arm assembly and the PCU [power control unit] housing" and credited the crew's immediate response with contributing to the survivability of the incident.

As a result of its investigation, the NTSB issued five safety recommendations to the U.S. Federal Aviation Administration (FAA), including its call for Boeing to be required to develop a way to protect against FOD damage to the input arm assembly on Boeing 737-300 through -500 series airplanes.

© Daniel Blok/Flickr

The FAA also should require operators of the affected airplanes to implement the modification developed by Boeing, require Boeing to redesign the elevator control system "such that a single-point jam will not restrict the movement of the elevator control system and prevent continued safe flight and landing," the NTSB said. Operators should then be required to implement the new design, the agency said.

In addition, the FAA said that Boeing should be required to develop "recovery strategies (for example, checklists, procedures or memory items) for pilots of 737 airplanes that do not have a mechanical override feature for a jammed elevator in the event of a full control deflection of the elevator system, and incorporate those strategies into pilot guidance."

Tailcone Icing

The U.S. National Transportation Safety Board (NTSB), citing three recent incidents in which Cessna 560XLs experienced a loss of rudder control associated with ice buildup inside the tailcone, has recommended that operators be required to take corrective action specified by the manufacturer.

The NTSB published a safety recommendation calling on the U.S. Federal Aviation Administration (FAA) to issue an airworthiness directive to require Cessna 560XL operators to comply with Cessna Service Letter 560XL-53-08.

The letter says that the problem can be corrected by drilling a 0.75-in (1.91-cm) hole in the airplane's bulkhead "slightly above the lower edge … [to] drain any water from the tailcone into the fuselage before the water level could become high enough to freeze around the rudder boost cables or pulleys." The letter also says operators should seal any drain holes in the tailcone.

The NTSB said it is investigating three incidents — each of which occurred in December 2010 — involving an ice buildup inside the tailcone. Investigators have found that ice that can freeze around the rudder boost cables and pulleys can interfere with their movement. No one was injured in the incidents, and all three airplanes landed safely.

In Other News …

The International Civil Aviation Organization, in collaboration with the International Federation of Air Line Pilots' Associations, has published the 2011–2012 edition of its *Emergency Response Guidance Manual* — a guide for flight crews and cabin crews dealing with aircraft incidents involving **dangerous goods**. … Nigeria's Accident Investigation Bureau has contracted with CAE Flightscape for a comprehensive **flight safety laboratory** to include CAE Flightscape Insight software, designed to analyze flight data. It will be the first laboratory of its kind in sub-Saharan Africa. … The U.S. Federal Aviation Administration has agreed to pay $4.2 million for the installation of automatic dependent surveillance-broadcast (ADS-B) avionics in up to 35 JetBlue Airbus A320s to enable satellite-based, **NextGen** flights from Boston and New York to the Caribbean beginning in 2012. The FAA said that under the agreement, it will "collect valuable NextGen data by observing and conducting real-time operational evaluations of ADS-B on revenue flights."

Corrections … An article in the September 2010 issue ("Back to Where We Began," p. 1) incorrectly stated the timing of an incident in China involving falsification of the records of more than 200 pilots. The falsifications were discovered in 2008, and the problem was corrected. … An article in the February 2011 issue ("SMS Swiss Style," p. 25) incorrectly stated the title of a Swiss official discussing the implementation of safety management systems. He is Peter Müller, safety analyst technical, Safety Risk Management, Swiss Federal Office of Civil Aviation (FOCA).

Capt. James C. Waugh

Capt. James C. Waugh, a retired airline pilot who served as chairman of Flight Safety Foundation in 1988 and 1989, died Feb. 24 after a long illness. He was 89.

Capt. Waugh, a native of Huntington, West Virginia, U.S., joined Pan American Airways' air ferries division — which supplemented the World War II air transport activities of the U.S. Navy and U.S. Army Air Corps — in 1942. After the war, he was a Naval Reserve officer until 1958.

During his years at Pan Am, he flew the Boeing 314, a four-engine flying boat, as well as a number of piston-engine airliners and jets. He was among the first to receive a type rating in the Boeing 747. He later held various management positions at the airline, including senior vice president, operations.

After retiring from Pan Am, he became chairman of Flight Safety Foundation. In 1995, the Foundation awarded him the *Aviation Week and Space Technology* Distinguished Service Award.

He is survived by his wife of 67 years, Mary Maxine Prockter Waugh; his children Barbara Waugh of Oakland, California, Jim Waugh of Greenwich, Connecticut, and Betsy Toro and Meg Koc, both of Cary, North Carolina; six grandchildren; and two great-grandchildren.

The family requested that, in lieu of flowers, donations be made to Flight Safety Foundation or to a favorite charity.

False Alerts

Older transponders are generating false short-term conflict alerts that have appeared on air traffic control (ATC) consoles, the Australian Transport Safety Bureau (ATSB) says.

The ATSB said that the false alerts have been detected by new terminal area radar equipment at Coolangatta and Melbourne. Similar new equipment is scheduled to be installed this year at several other major airports in Australia.

Mode A transponders work by emitting digital pulses that bear aircraft identification information. The pulses are transmitted "in response to the secondary surveillance radar used by [ATC] to identify all transponder-equipped aircraft," the ATSB said.

Compiled and edited by Linda Werfelman.

When Less Is More

BY PATRICK CHILES

Reduced-thrust takeoffs offer safety benefits, as well as economic benefits.

Engine and airframe manufacturers for decades have cited the direct relationship between engine wear and high exhaust gas temperature (EGT) in recommending that operators use less than maximum takeoff thrust whenever possible.

While the cost benefits of reduced-thrust takeoffs are thoroughly documented, the safety benefits are not as well understood.

Thus, there is a common perception that using reduced thrust is less safe than taking off with full-rated power. Undoubtedly, maximum

© Chris Sorensen Photography

Sample Takeoff Data

Outside Air Temperature	Maximum Takeoff Weight	V_1	V_R	V_2
35˚C	147,900 lb	129 kt	129 kt	136 kt
30˚C	153,000 lb	130 kt	130 kt	138 kt
20˚C	155,500 lb	131 kt	131 kt	139 kt
10˚C	157,000 lb	132 kt	132 kt	140 kt

V_1 = The maximum speed in the takeoff at which the pilot must take the first action (e.g., apply brakes, reduce thrust, deploy speed brakes) to stop the airplane within the accelerate-stop distance. It also is the minimum speed in the takeoff, following a failure of the critical engine at V_{EF}, at which the pilot can continue the takeoff and achieve the required height above the takeoff surface within the takeoff distance. (V_{EF} is the speed at which the critical engine is assumed during certification to fail during takeoff.)

V_R = Rotation speed

V_2 = Takeoff safety speed

Sources: Patrick Chiles, U.S. Federal Aviation Administration

Table 1

thrust will provide maximum takeoff performance. However, using reduced thrust does not mean that safety margins are reduced. There actually is a significant safety benefit: By increasing engine life, reduced-thrust takeoffs reduce the chances of engine failure.

A key factor in this concept is that turbine engines are guaranteed to provide maximum thrust at and below a specific ambient temperature — 30 degrees C for the CFM International CFM56-7B series, for example. At higher temperatures, maximum available thrust decreases because of decreased air density.

Typical runway-analysis tables, created either by the operator or by a qualified vendor, show a range of ambient temperatures and the maximum takeoff weights and the performance data (V-speeds) applicable to those temperatures (Table 1). In modern airplanes, takeoff thrust settings are computed by the flight management computer (FMC), based on programmed or pilot-selected temperatures or weights.

There are two methods for conducting reduced-thrust takeoffs: the fixed derate method and the flex thrust, or assumed temperature, method.

Fixed derate thrust settings are lower than the maximum flat-rated thrust setting for the engine. The CFM56-7B27, for example, has a maximum thrust rating of 27,300 lb (121 kN), with optional fixed derates at 22,000 lb (98 kN), 24,000 lb (107 kN) and 26,000 lb (116 kN). These settings are pre-programmed in the FMC and, if allowed by the operator, can be selected by the pilot when conditions permit.

The flex thrust/assumed temperature method employs an alternate thrust setting that is applicable to the highest ambient temperature at which the airplane could meet performance requirements at its actual takeoff weight.

Flex thrust essentially takes advantage of the spread between the actual weight at the actual temperature and whatever the maximum temperature for that weight would be. Assume, for example, that we are preparing for takeoff from an airport with an outside air temperature (OAT) of 10 degrees C. Our runway analysis data show that the maximum takeoff weight at this temperature is 157,000 lb (Table 1). But, because our aircraft weighs only 147,000 lb, we can move up the data columns until we find the maximum OAT for our actual weight, which is 35 degrees C.

This becomes our "assumed" temperature, which we enter into the FMC. In this case, the reduction in the takeoff thrust setting could be on the order of 3.5 percent N_1 (low-pressure rotor speed) — from 99.9 percent to 96.4 percent, which is set when takeoff/go-around power is selected.

The flex thrust/assumed temperature method also allows pilots to advance the thrust levers to achieve the full rated thrust setting at any stage of the takeoff, if necessary. This is not an option when using a fixed derate setting.

Effect of True Airspeed

Pilots who are skeptical about reduced-thrust takeoffs often sense that something very important is being taken away. However, there is absolutely no loss of any necessary performance margins involving field length, screen height,[1] climb or obstacle clearance. If the airplane's weight and power setting satisfied the certification standards at the higher temperature, then they certainly will do so at the lower temperature.

Although the takeoff speeds used by the flight crew are indicated airspeeds, actual performance is determined by true airspeed, which is a function of air density. Because we are operating at an actual temperature that is lower than the assumed maximum, true airspeed likewise will be lower.

Because of this true-airspeed effect, we enjoy a great deal of cushion between what the airplane must do and what it actually is doing. We are, in reality, using less runway and achieving a higher climb gradient, or obstacle-clearance margin, than if the ambient temperature was at the maximum for that same weight. Depending on conditions, the effect can be considerable — on the order of several hundred feet in field length. The benefit increases as the difference between the actual and the assumed temperatures increases.

Inside the Engine

Performance margins are not the entire story. Reduced-thrust takeoffs trade some excess capability for reduced engine wear. Operating temperatures, turbine speeds and overall stress levels are lower, and the engine is less likely to fail. This is especially important when you consider that the possibility of engine failure is the basis for all those takeoff performance margins in the first place.

The closely held studies by engine manufacturers are based primarily on fixed derate thrust data because operators typically do not report assumed temperature thrust data. However, equivalent temperature levels using assumed temperature techniques can be favorably compared to the results.

Component wear in the hot section, particularly the high-pressure turbine, can be dramatically improved. One available GE Aviation study of failure modes in the CF6-80 indicated that regular use of the maximum 25 percent fixed derate resulted in a near order-of-magnitude increase in cycles to failure — from 1,000-2,000 cycles to 5,000-10,000 cycles. This study identified thrust derate as the "most important factor in reducing turbine blade failures and deterioration."[2]

Reducing EGT has been tied directly to improved engine wear and time-on-wing maintenance intervals. EGT deterioration, a major factor in engine removal and overhaul, also has been shown to be retarded by reduced thrust. Related deterioration of fuel flow also is countered by reduced-thrust operations. According to the GE study, each 10 degrees C of EGT deterioration translates to a 1 percent fuel-flow deterioration. Limiting this effect has obvious advantages in maintaining a higher level of specific mileage for a given amount of on-board fuel.

Manufacturers approximate the effects of engine use against the engine's designed operating life through severity analysis, which considers the total picture of degraded performance, rotating parts life and parts deterioration and failure. Parameters like rotor speeds, internal temperatures and internal pressures are used to gauge the total severity. Analysis has shown that these parameters are directly affected by two factors: stage length and the level of reduced thrust used. The takeoff phase places the most stress on an engine and is thus weighted more heavily; however, other factors emerge during cruise on longer flights.[3] Thus, although any carrier will benefit, short-haul airlines that put several cycles a day on their aircraft would gain the most from a reduced-thrust policy.

Considering the extreme operating conditions of a turbine engine's hot section, limiting wear should be an obvious goal. Turbine blade fatigue, in particular, is directly affected by high centrifugal forces and vibration stresses, and these loads have a direct relationship to increased turbine inlet temperatures. A study performed by the China Civil Aviation Flight College found a 51 percent reduction in blade life after 3,500 hours at 870 degrees C, compared to a 35 percent loss when operating at 705 degrees C, and a near doubling of hot section life overall.[4]

Tradeoff

Apart from safety, there is the consideration of noise reduction in our environmentally sensitive culture. It stands to reason that an engine operating at lower thrust will create less noise. As noted previously, reduced thrust, actual-condition takeoff distance is less than the assumed-condition distance. It is not, however, less than the takeoff distance at full-rated power. So, while "sideline" noise may be improved, the longer takeoff distance and lower climb path actually may put the airplane closer to noise monitors and increase "in-line" decibel levels.

Reduced thrust operations are always a tradeoff. How, then, should we define "safety" in these terms? Is it safer to use the maximum allowable power setting or to back off and reduce our exposure to failure during the most engine-critical phase of flight? Ultimately, it is up to the pilot to decide.

Patrick Chiles is a member of the Flight Safety Foundation Corporate Advisory Committee and the Society of Aircraft Performance and Operations Engineers.

Notes

1. Screen height is a parameter used in certification to determine an airplane's accelerate-go performance. Minimum screen heights, or heights above the departure threshold, are 15 ft for a wet runway and 35 ft for a dry runway.
2. Stopkotte, Jack. "Minimizing Costs While Maintaining Performance Margins, Part 1 — Lowering Costs and Improving Reliability." GE Aircraft Engines, September 2003.
3. Ibid.
4. Chenghong, Yan. "Reduced Thrust Takeoff." International Council of the Aeronautical Sciences Congress, 2002.

After heavy maintenance, an aircraft usually must be flown to ensure that it was put back together properly.

Check Flight Checkup

FSF symposium focuses attention on functional check flight safety.

BY MARK LACAGNINA

Excitement and adventure are not on the typical line pilot's agenda. Standard-rate turns, smooth power and configuration changes, and staying comfortably within the "envelope" mark an airline pilot's professionalism. Sometimes, however, pilots are called upon to take aircraft to their limits, to demonstrate that normal and emergency systems are working properly, or to determine if everything was put back together correctly after the airplane was taken apart during heavy maintenance.

There is a bewildering variety of names for the types of ad hoc nonrevenue flights that aircraft operators perform, which include postmaintenance, airworthiness, aircraft-acceptance and end-of-lease check flights. However, a recent fatal accident and a rash of serious incidents have made one thing clear: The risks involved in these flight activities are higher than in normal operations.

This red flag prompted the industry to ask Flight Safety Foundation (FSF) to organize an international meeting to discuss the risks and how they can be reduced. "While exploring the issue with industry safety specialists, we found that there are not as many answers as there are questions, not the least of which was how to define the topic," said Jim Burin, FSF director of technical programs. "*Test flights* are not performed by operators but by manufacturers' test pilots. We're not talking about *check flights*, either, because check flights involve aircrew evaluation."

Ultimately, the term *functional check flight* was adopted by consensus of a steering team formed by Burin of specialists from Airbus, Boeing, Bombardier and Embraer.

Pivotal Question

For the 275 aviation safety specialists who came from 41 countries to attend the FSF Functional Check Flight Symposium in Vancouver, Canada, Feb. 8–9, there were many other questions to ponder: Are the crews who conduct such flights qualified to do so? What *are* the necessary qualifications? How do you train crewmembers for functional check flights? Are simulators adequate for the task? Are operators getting the information they need from the manufacturers? Are they getting useful guidance from the regulators? Do we need more regulations?

Do we need to perform functional check flights at all?

The resounding answer to that question — from the attendees and the speakers who represented manufacturers, regulators and operators[1] — was that this question must be asked before launching *any* functional check flight.

"Flight checking of aircraft, particularly older aircraft, often is driven by the maintenance manual," said keynote speaker David Morgan, chief pilot and general manager for Air New Zealand.

However, aircraft maintenance manuals (AMMs) often lack clarity, said Homero Montandon, a test pilot in the Airworthiness Branch of ANAC, the Brazilian national civil aviation agency. "AMMs should be more specific about the necessity to perform check flights after maintenance," he said.

Andre Tousignant, director of the Air Safety Investigation Office at Bombardier Aerospace, noted that few, if any, functional check flights are required by the AMMs for modern aircraft that have on-board troubleshooting and fault-reporting systems. The AMM for the Q400 requires only a trim check after an aileron is replaced. The AMM for the CRJs requires either a flight check *or* a ground check after an air-driven generator is repaired or replaced. "If a flight check is not required by the AMM, we see no need for it," he said.

This A320 crashed when the crew lost control while performing low-speed checks at low altitude.

Similarly, Joáo Carlos Braile and Fabrízio Sabioni Lourenço, who coordinate flight test activities at Embraer, noted that the AMM for the Embraer 145 requires a flight check for data acquisition, only. There are no requirements for check flights in the 170/190 AMMs, they said.

Unnecessary flight testing must be avoided, said Gary Meiser, chief pilot of production flight test at Boeing Commercial Airplanes. "We need to eliminate testing for testing's sake," he said. "We need to ask ourselves: Does it really need to be flown? Can it be done on the ground?"

Exemplifying one of the gray areas associated with this topic, the answers to Meiser's questions might be maybe and maybe not, according to Sel Laughter, flight test manager for United Airlines. Noting that United checks backup systems during postmaintenance flights, Laughter said, "A lot of times, they'll check OK in the hangar but not in the air."

Hard Lessons

In his keynote address, David Morgan recounted lessons learned during Air New Zealand's in-house investigation following the crash of an Airbus A320 in Perpignan, France, on Nov. 27, 2008. The accident occurred during an end-of-lease demonstration flight pending the return of the aircraft to Air New Zealand by XL Airways (*ASW*, 11/10, p. 22).

The official investigation by the French Bureau d'Enquêtes et d'Analyses found that the flight crew was not aware that the angle-of-attack sensors were blocked by ice — they lost control of the A320 while performing low-speed checks at low altitude. Among the factors that contributed to the accident, which killed all seven people aboard the aircraft, was the flight crew's lack of training and experience in performing functional check flights, and their inadequate coordination during the flight.

During its in-house investigation, Air New Zealand discovered that several other airlines were performing similar end-of-lease demonstration flights. "We found that the processes for these types of flights tend to be handed down from one chief test pilot to another," Morgan said. "With some airlines, the responsibility for these flights sets with those with the most gray hair; with other airlines, it sets with those with the most education."

Customer acceptance flight checklists, which usually are provided by manufacturers with the sale of a new aircraft, typically are adapted by operators for use in end-of-lease demonstration flights and other types of functional check flights. "Many operators are conducting functional check flights with checklists that are out of date," Morgan said. "They might not apply to changes made per service bulletins, for example." He called for more support from manufacturers in keeping checklists up-to-date.

The regulatory framework for functional check flights, too, is "less than optimal," he said. "Regulatory intervention could be quite useful. We need a more effective and consistent regulatory framework with a clearly defined set of rules to cover all nonrevenue flights."

Lessons from the Perpignan accident report and the airline's in-house investigation prompted Air New Zealand to "take a policy decision not to expose our crews to what we consider unacceptable risk when conducting end-of-lease and other ad hoc flights," Morgan said.

That policy subsequently was challenged by a set of end-of-lease demonstration procedures demanded by a leasing company. The airline found that some of the procedures posed unnecessary risk, but the leasing company contended that the procedures had served them well, so why change them? Although some compromises were reached, Air New Zealand refused to perform several systems checks that it believed could be performed adequately on the ground. "Aircraft systems or components should only be checked in the air if they cannot be checked on the ground," Morgan said.

Mark Lacagnina

Vancouver, site of the FSF Functional Check Flight Symposium.

Mark Lacagnina

Although the airline adhered to its safety policy, the leasing company did not relent. "The checks we refused to carry out were subsequently imposed on the delivery crew from the next airline," Morgan noted.

Simulator Infidelity

Morgan said that the in-house investigation also led Air New Zealand to question whether flight simulators realistically replicate the flight characteristics of an airplane flown close to or beyond the edge of its flight envelope.

According to Jean-Michel Roy, a test pilot for Airbus, they don't. "Simulators do not replicate the forces, vibrations and sounds often experienced in test flights," Roy said.

Simulator fidelity was found to be a factor in a functional check flight accident that occurred the night of Dec. 22, 1996. The crew of a Douglas DC-8 freighter, which had undergone major modifications and an extensive maintenance check, slowed the aircraft in clean configuration at 13,500 ft, just above a cloud deck, to record the airspeed at which the stick shaker, or stall-warning system, activated (*Accident Prevention*, 9/97). However, the system failed to activate, and the aircraft stalled at a slightly higher-than-expected airspeed, possibly because of ice accumulation and/or control misrigging, said the report by the U.S. National Transportation Safety Board (NTSB).

The pilot flying applied full aft control pressure when the DC-8 suddenly pitched nose-down. The aircraft then descended rapidly in a full stall and struck terrain near Narrows, Virginia, U.S., killing all three flight crewmembers and the three maintenance technicians who were aboard.

The NTSB report said that neither the pilot flying nor the pilot-in-command had experienced an actual stall in a DC-8, and the pilot flying's inappropriate control inputs likely were influenced by his training experience in a simulator that "developed a stable, nose-high, wings-level descent, with no tendency to pitch down in a stall break."

Beyond flight characteristics that might not be the same as those experienced in simulators, another factor to consider is that aircraft usually are substantially lighter than their normal operating weights during functional check flights, resulting in "handling qualities that may be different than what we are used to," said Harry Nelson, an experimental test pilot for Airbus.

'Hard Limits'

Several speakers emphasized the need for painstaking preparation for functional check flights. Among the factors to be considered are the time of day, weather conditions and the airspace in which the flight will be conducted.

Advance coordination with air traffic control (ATC) is important. "You must consider ATC as an integral part of a successful test flight," said Steve Smith, manager of flight technical services for Cathay Pacific Airlines.

"Maintenance partnership is critical," said Boeing's Meiser. "There must be open and honest dialogue."

Detailed briefings between flight crews and maintenance teams should be conducted before and after a functional check flight. Before flight, the crew should review the emergency procedures for each system and component that was involved in maintenance, said Bombardier's Tousignant.

Noting the infrequency of functional check flights at Spanair, Emilio Ranz, the airline's flight test department chief, said, "The lack of test flight proficiency is our biggest problem." The department copes with this by "writing everything down so that it can be used to review and prepare for the next flight test," he said. "We have to develop a checklist for each check because of the lack of proficiency." The department also maintains a detailed flight test operations manual.

"Plan the flight and fly your plan" was a message delivered repeatedly during the symposium. Improvisation, which was a major factor in the

Perpignan accident, is one of the greatest risks, said Walter Istchenko, chief of flight test for Transport Canada. "Crews may improvise and conduct maneuvers in inappropriate airspace and/or at an inappropriate time — for example, with high workload," he said.

Be "failure-minded" and have an escape plan when something goes wrong, suggested Harry Nelson. "If things don't look right, they probably aren't, so stop," he said.

Glenn Bradley, air operations check flight manager for easyJet, offered a good example involving an A320 post-maintenance check flight. The crew was performing a low-speed check when a pre-stall buffet occurred. "It was not working, so the pilot-in-command did the right thing: He stopped the test and got the aircraft on the ground," Bradley said. A subsequent review of recorded flight data showed that the angle-of-attack values being displayed were "frozen"; the problem disappeared after the gauges were replaced.

The policy at Cathay Pacific is that "if any one of the crew is uncomfortable with what is going on, that crewmember can call for a temporary halt in the operation," Smith said.

Nelson recommended that critical checks have "hard limits" labeled on the checklist as "DO NOT EXCEED."

"Knock-it-off limits" was the term used by Boeing's Meiser, who also stressed the importance of "stopping what you're doing when it starts going wrong."

Airbus School

Symposium attendees received a wealth of information on how to establish and staff a functional check flight organization. Choosing the right people is paramount, according to Harry Nelson. "I believe that you can have the best procedures, but if you have the wrong people, you will fail," he said. "I know people with 25,000 hours who have been doing the same things, flying the same routes, for years. They may not be the people you're looking for."

Among personal traits to look for are good communication and teamwork skills, inquisitiveness and patience, Nelson said. Among traits to be avoided are egoism, indecisiveness and impatience.

Although many operators perform in-house training, some also are sending check crews to the Technical Flight Familiarization Course offered monthly at Airbus training centers. The course comprises two days in ground school, two days in a flight simulator and one day in flight. During a question-and-answer session, Claude Lelaie, special adviser to the president and CEO of Airbus, pointed out that the goal is not to train operators' pilots to be "test pilots" but to train them to perform functional check flights safely. Since the course was begun in September 2009, 27 A320 crewmembers from six airlines have completed the training.

Standards vs. Regulations

Opinion was divided on whether the safety of functional check flights can be enhanced through increased regulation. While some participants said that well-founded and sensible regulation would help, others argued that the industry would benefit most by setting its own standards.

"We need to create some industry standards," said Delvin Young, chief pilot for flight test at American Airlines. "We, as airline operators, have to manage ourselves, or somebody else will."

Time is of the essence, said easyJet's Glenn Bradley. "These problems exist now, and we have to solve these problems now," he said. "We cannot wait for the regulators."

Nevertheless, calling attention to the recent accidents and serious incidents involving functional check flights, Didier Nicolle, chairman of the European Aviation Safety Agency (EASA) Flight Test Group, said, "We have a problem, and there is a positive need to do something in regulation."

Accordingly, EASA plans to take final action by the end of this year on a notice of proposed amendment (NPA) issued in August 2008 that seeks to define four categories of "flight testing," establish qualifications for pilots and flight test engineers involved in specific types of flight testing, and require operators to have a flight test operations manual, Nicolle said.

The first three categories include experimental, engineering and production flight testing activities typically performed by the manufacturers. Functional check flights likely fall in the fourth category, which will not include special crew qualifications.

The NPA noted that between 1990 and 2005, 30 airplane accidents, with 53 fatalities, and 15 helicopter accidents, with nine fatalities, occurred during flight testing activities.

At press time, the Foundation learned that three more fatal accidents, with 13 fatalities, recently have occurred — an Antonov 148 in Russia, a CASA 212 in Indonesia and a de Havilland Twin Otter in the United States.

Jim Burin and the functional check flight steering team members are considering ways to build upon the groundwork laid in Vancouver.

Note

1. The symposium presentations are available in the Aviation Safety Seminars section of the FSF Web site, <flightsafety.org>.

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A fatal S-92A crash prompts a TSB call for action to keep large transport helicopters running for at least 30 minutes without main gearbox oil.

BY LINDA WERFELMAN

Running on Empty

A "complex web" of factors, including a total loss of oil in the transmission's main gearbox (MGB), led to the fatal crash of a Cougar Helicopters Sikorsky S-92A in the Atlantic Ocean off Canada's east coast, the Transportation Safety Board of Canada (TSB) says.

The TSB supplemented its final report on the March 12, 2009, accident with safety recommendations calling for major changes in helicopter operations, including one provision to require S-92s and other large transport helicopters to be capable of operating for at least 30 minutes after a massive loss of MGB oil.

The accident helicopter crashed en route from St. John's, Newfoundland and Labrador, Canada, to the offshore Hibernia oil production platform. Both flight crewmembers and 15 of the 16 passengers drowned. One passenger, pulled from the water about 80 minutes after the accident, suffered serious injuries.

The helicopter departed from St. John's International Airport at 0917 local time and, at 0932, leveled off at 9,000 ft; the amended instrument flight plan estimated a 1040 arrival time at the oil rig (Figure 1, p. 20). At 0945, according to data from the flight data recorder (FDR), MGB oil pressure began decreasing. An amber "MGB OIL PRES" caution message illuminated and was followed almost immediately by a red "MGB OIL PRES" warning message, accompanied by the aural warning of "GEARBOX

Track of Accident Helicopter

Source: Transportation Safety Board of Canada

Figure 1

by saying he planned to level the helicopter at 1,000 ft, but the helicopter descended to 800 ft — to "provide approximately 300 ft of terrain clearance over the highest point of land on the direct track" to the St. John's airport and about 600 ft above the highest point near Cape Spear, the piece of land closest to the helicopter's position.

At 0952, in response to a question from the Cougar dispatcher, the crew said they believed a ditching was "possible" rather than "imminent" or "probable."

The report said that at 0955, "there were indications that something had just happened to the helicopter, and the captain made an immediate decision to ditch. At that point, power to the multipurpose flight recorder (MPFR) was interrupted. No additional abnormalities were verbalized by the flight crew prior to the [MPFR] power interruption to indicate what triggered the sudden decision to ditch the helicopter.

"At 0956, less than one minute after the captain advised the Cougar dispatch center that they were ditching and 11 minutes after the loss of MGB oil pressure, [the helicopter] struck the water in a slight right-bank, nose-high attitude."

The helicopter's emergency flotation system did not deploy, and the helicopter sank rapidly. Only two of the 16 passengers and two crewmembers exited the helicopter, and when an offshore patrol boat arrived at the accident site at 1012, its crew saw two people and two life rafts floating on the water. One person waved at

PRESSURE … GEARBOX PRESSURE." The crew began checklist procedures, and by 0945, MGB oil pressure had decreased to less than 5 psi, down from the normal range of between 45 and 70 psi.

"The combination of the red 'MGB OIL PRES' warning message … and MGB oil pressure below 5 psi … constituted a 'land immediately' condition, as per the S-92A Rotorcraft Flight Manual," the report said, noting that the captain declared an emergency and requested clearance from the Gander area control center (ACC) to return to St. John's.

ACC began issuing radar vectors, and seconds later, after the pilots turned the helicopter back toward the airport — 54 nm (100 km) to the west — they began a descent. At 0947, MGB oil pressure was 0 psi. The pilots discussed emergency preparations with ACC and the company dispatcher, and at 0951, the first officer said that the helicopter was in a "land immediately" condition. The captain responded the aircraft, but the second "appeared to be face-down in the water," the report said.

At 1037, a Cougar search-and-rescue helicopter departed St. John's for the accident site; at 1055, the helicopter arrived at the site, and 20 minutes later, the survivor was pulled from the water. Soon afterward, a second search-and-rescue helicopter recovered the second passenger, who by that time apparently had died, the report said.

Much of the wreckage was located later in March, in waters about 169 m (554 ft) deep, and recovered.

'Very Visible' Safety Program

The captain, with 5,997 flight hours, including 1,061 hours in S-92s, had an airline transport pilot license for helicopters; type ratings in the Bell 206 and 212, Robinson R22, Eurocopter AS 332 and AS 350, and S-92A; and an instrument rating.

He began work for Cougar Helicopters as an AS 332 first officer in January 2005, and in September 2006, was qualified as an S-92A first officer; he upgraded to captain in September 2007. He completed a pilot proficiency check in January 2009.

The 2,854-hour first officer — a veteran of 24 years in the Canadian Forces — had 94 hours in type, and type ratings in S-61s, in addition to S-92As. He also had an instrument rating. During his military service, he served for 11 years as a Sikorsky CH-124 Sea King pilot, with "extensive experience in the offshore environment," the report said, noting that he was "routinely exposed to ditching training, annually conducting landings on the water to condition personnel for a ditching situation."

He began work for Cougar Helicopters in April 2008 and completed the S-92A initial conversion course the following month.

In the days preceding the accident, neither pilot had exceeded flight and duty time limits.

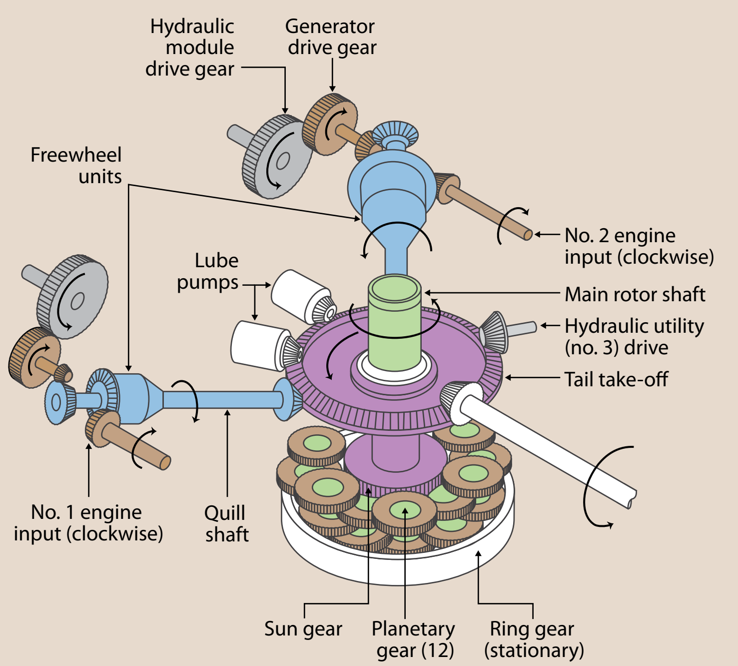
Cougar Helicopters was established in 1986 and, in 1990, began transporting workers to offshore oil platforms. The company estimates that worldwide, 97 percent of its flying time involves overwater operations. The report described Cougar Helicopters as being proactive in developing internal safety programs and noted that it was the first helicopter company in North America to receive ISO 9001:2000 certification, which later was upgraded to ISO 9001:2008.[1]

"The safety program at Cougar Helicopters is very visible and all the employees of the company, from the owner on down, actively promote safety in all its activities," the report said, citing the corporate "just culture" and the company's implementation of a safety management system, although it is not required by regulations to have one.

The helicopter was manufactured in 2006 and had total airframe time of 2,194 hours and 1,773 cycles. It was configured for two crewmembers and up to 17 passengers. The helicopter was certified and equipped as specified by regulations, and maintenance records did not indicate that there were any problems before the accident flight.

The MGB is part of the helicopter's main transmission assembly (Figure 2). The oil filter bowl in the accident helicopter was attached to

Main Gearbox



Source: Transportation Safety Board of Canada

Figure 2

the MGB housing with "three equally spaced titanium alloy stud and self-locking nut assemblies," the report said. Manufacturers select the types of fasteners to be used, and Sikorsky chose titanium alloy studs "because these had been used successfully on other Sikorsky products. … Also, Sikorsky declared that there was no reported history of in-service titanium stud failures."

The oil filter bowl fasteners included anodized titanium alloy studs, silver-plated steel nuts and cadmium-plated steel washers. Anodizing and plating are used to make parts more resistant to corrosion, wear and galling — defined in the report as a type of wear in which material is "removed or displaced from a surface"; titanium and titanium alloys are prone to galling, the report said.

'While attempting to ditch, the helicopter struck the water and sank rapidly.'

MGB operations require the prescribed amount and quality of lubricating oil to reduce friction between contacting surfaces and prevent the components from overheating. An insufficient amount of oil typically results in increased oil temperature.

Maintenance records indicated that Cougar Helicopters changed oil filters in its S-92As about every 220 hours — more frequently than the aircraft maintenance manual's requirement of 500 hours or, in some cases, 1,000 hours. The change intervals were consistent with the S-92A worldwide fleet average and resulted from operators' attempts to avoid the clogging of an oil filter element and the associated overheating of the oil. The report noted, however, that the more frequent oil filter changes also required more frequent removals of the MGB hardware.

Data Gap

The helicopter's MPFR recorded cockpit audio data as well as flight data. The device stopped recording about 44 seconds before the crash and resumed about 1.7 seconds before impact.

There was no indication of a problem that would have caused this abnormal operation of the MPFR.

In normal operations, a helicopter's two primary alternating current (AC) generators supply power to the MPFR. An auxiliary power unit (APU) and generator provide power during emergencies and when the main rotor speed (N_r) decreases below 80 percent. Switching from one power source to another sometimes leads to a brief power interruption, the report said.

The investigation found that, before recording was interrupted, power was provided by the primary AC generators. Then, according to MPFR data, N_r decreased to about 80 percent; after recording resumed, the APU generator supplied power.

"The lack of FDR and CVR [cockpit voice recorder] information during the latter part of the accident flight hampered the investigation team's ability to obtain an accurate understanding of the final seconds of the event and could have prevented the timely identification of safety-significant issues," the report said.

Other data, including those from flight control computers, electronic engine controls and the enhanced ground proximity warning system, were used to reconstruct a portion of the flight profile. They indicated that, in the final seconds of flight, the helicopter had descended at a rate between 2,300 fpm and 5,100 fpm and struck the water with "high downward velocity" that broke apart the passenger cabin and floor.

Investigation

Investigators determined that the oil loss resulted in the failure of the tail-rotor take-off pinion, which in turn led to a loss of drive to the tail rotor and a subsequent autorotative descent. "While attempting to ditch, the helicopter struck the water and sank rapidly," the report said.

'Extremely Remote'

The report noted that the U.S. Federal Aviation Administration (FAA) had strengthened helicopter certification requirements in the 1980s, calling for helicopters to be equipped with gearboxes that were able to operate for 30 minutes after a massive oil loss — unless an equipment failure was considered to be "extremely remote." In that case, the FAA did not require the manufacturer to demonstrate compliance with the 30-minute requirement.

"Neither Sikorsky nor the FAA considered the possibility that the MGB oil filter bowl attachment system could fail," the report said. "On this basis, the FAA certified the S-92A, even though it had failed the initial loss of lubricant testing. By focusing on the 'extremely remote' concept, both the FAA and Sikorsky lost sight of the purpose of this rule."

Transport Canada (TC) subsequently accepted the FAA's certification.

Earlier Incident

The report also cited a July 2008 incident in which the crew of an S-92A en route to Broome, Western Australia, from an offshore oil facility conducted an emergency landing after receiving warnings of low MGB oil pressure. None of the 16 people in the helicopter was injured, and the helicopter was not damaged in the incident.

Records indicated that the MGB in the Australian helicopter had been removed and reinstalled 17 times during the aircraft's 1,233 flight hours, and that about 58 flight hours before the incident, an MGB oil filter bowl mounting stud had fractured during the removal process. Although it was initially suspected that the incident resulted from a temporary repair, Sikorsky later told S-92A operators to give "extra attention … to the condition and torque of filter bowl fasteners," and in September 2008, said that the titanium studs should be replaced with steel studs.

In October 2008, Sikorsky stopped using titanium studs in new S-92As and said that failed titanium studs in helicopters already in service should be replaced with steel studs; the following month, a revision of the aircraft maintenance manual (AMM) described mandatory inspection procedures for detecting damaged MGB mounting stud threads; and in January 2009, an alert service bulletin was issued requiring the replacements within 1,250 flight hours or one year.

Sikorsky asked operators to return the titanium studs that were removed, and "all of these studs, as well as the studs recovered from the occurrence helicopter and the other Cougar helicopters, had different severities of galling, which would be consistent with a difference in the number of times the nut was installed and removed," the report said.

The report said that Cougar Helicopters "did not effectively implement the mandatory maintenance procedures in … AMM Revision 13, and therefore, damaged studs on the filter bowl assembly were not detected or replaced."

After release of the TSB report, relatives of crash victims asked the Canadian minister of transport to investigate the S-92's certification, arguing that TC "never should have certified as airworthy a helicopter that could not fly for at least 30 minutes after the complete loss of MGB oil" and "should have responded in 2008 after learning about the 'Achilles heel' of the S-92 MGB: titanium studs prone to failure."

Recommendations

The report cited dozens of safety actions taken in the aftermath of the accident by regulatory authorities, the manufacturer and the operator, including an FAA directive to replace all S-92A MGB oil filter bowl titanium studs with steel studs, the development by Cougar Helicopters of a descent profile in the event of MGB oil pressure loss and the company's upgrade of flight crew attire for overwater flights.

In addition, the TSB issued four safety recommendations, including one that called on the FAA, TC and the European Aviation Safety Agency to "remove the 'extremely remote' provision from the rule requiring 30 minutes of safe operation following the loss of [MGB] lubricant for all newly constructed Category A[2] transport helicopters and, after a phase-in period, for all existing ones."

The TSB also recommended that the FAA "assess the adequacy of the 30-minute [MGB] run-dry requirement," noting that, if a flight crew ditches a helicopter in "hostile waters, such as those off the Canadian east coast, the occupants are at considerable risk." Many offshore energy facilities are more than a two-hour flight from land, the TSB said.

In addition, the TSB recommended TC action to prohibit Category A transport helicopters from engaging in overwater commercial operations "when the sea state will not permit safe ditching and successful evacuation."

TC also should require supplemental underwater breathing devices "for all occupants of helicopters involved in overwater flights who are required to wear a PTSS [passenger transportation suit system], designed to protect against hypothermia and help keep its wearer afloat," the TSB said. Existing regulations require helicopter passengers to wear a PTSS during extended flights over cold water.

This article is based on TSB aviation investigation report A09A0016, Main Gearbox Malfunction/Collision With Water; Cougar Helicopters Inc; Sikorsky S-92A, C-GZCH; St. John's, Newfoundland and Labrador, 35 NM E; 12 March 2009.

Notes

1. ISO 9001 is the set of standards, developed by the International Organization for Standardization, for an internationally recognized quality management system.
2. "Category A" transport category rotorcraft are multiengine rotorcraft designed to assure adequate performance capability for safe flight in case of an engine failure.

It is no secret that Africa presents the most daunting challenge in the world to aviation safety; accident rates continue to reflect that reality. However, over the past decade, there has been a new stabilizing force in the region.

To most aviation professionals, the operating environment faced by the World Food Programme (WFP) and its partner agencies of the United Nations Humanitarian Air Service (UNHAS) is as alien as another planet. All of the terms are familiar, but nearly everything else about WFP operations is … different, sometimes startling so.

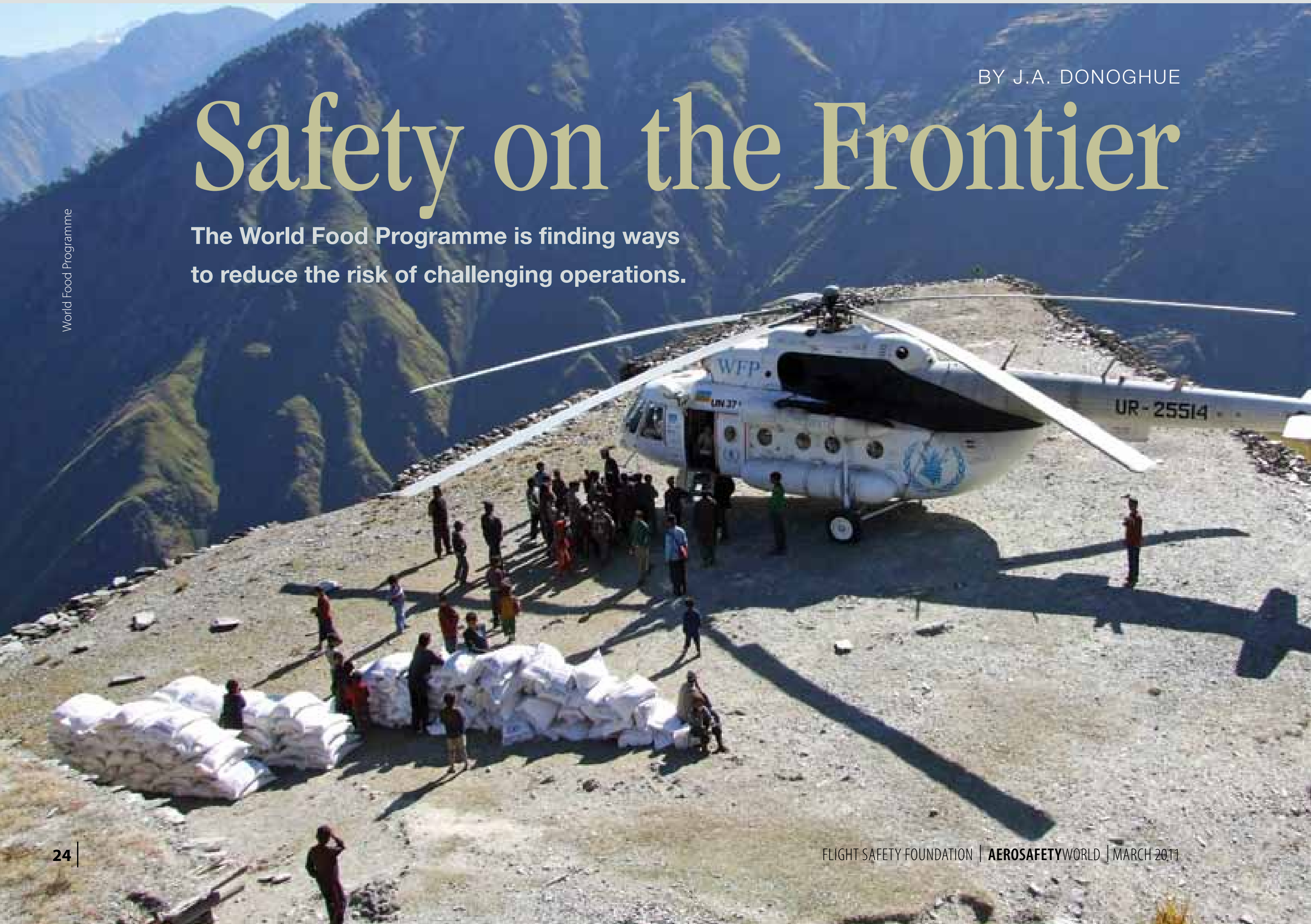
The entity bringing order and an elevated level of safety to these operations on the frontiers of aviation is the WFP's Aviation Safety Unit (ASU), headquartered in Rome but with regional offices in Sharjah, United Arab Emirates; Nairobi, Kenya; and Johannesburg, South Africa. Through a series of audits, regulator reviews, training and oversight of its own operations, the WFP has set a new standard for operations in underdeveloped areas.

In the early days of U.N. relief efforts involving wide-scale use of contracted aviation assets, says Conny Akerstrom, ASU's Nairobi-based aviation safety officer, the contracting arm of the WFP stopped its inquiry into an aviation operator's fitness when an air operator's certificate (AOC) was produced. This light-touch involvement in safety began changing in 1999, after a WFP-chartered ATR 42-300 struck high terrain while in the clouds on radar vectors from a newly opened air traffic control facility at Pristina, Kosovo. The aircraft had an inoperable ground proximity warning system. All 24 aboard died (*Accident Prevention*, 10/2000).

BY J.A. DONOGHUE

Safety on the Frontier

The World Food Programme is finding ways to reduce the risk of challenging operations.



World Food Programme

WFP, FSF Partner

The United Nations (U.N.) World Food Programme (WFP) and Flight Safety Foundation (FSF), after several years of informal collaboration, in February signed a memorandum of understanding formalizing the partnership between the Foundation and one of the world's largest humanitarian organizations.

Speaking earlier this year at the FSF European Aviation Safety Seminar in Istanbul, Turkey, Conny Akerstrom, WFP aviation safety officer based in the organization's East African Aviation Safety Office in Nairobi, Kenya, said, "It is a true pleasure to announce on behalf of the United Nations WFP the new and exciting partnership we have entered with Flight Safety Foundation, one of the most respected flight safety organizations in the world. This partnership will include many levels of valuable support for the WFP aviation department, which will directly enhance the safety of U.N. Humanitarian Air Services operations.

"As our safety and aviation officers work directly with air operators in many remote regions, this partnership will also ensure that the Foundation's important safety initiatives will reach those operators and improve their safety standards as well.

"WFP takes the need to continuously improve our standards and promote aviation safety very seriously. Even though we have not had any fatal passenger aircraft accidents in the past 10 years, we are still looking for ways to constantly improve our safety standards, and one new important avenue is this partnership with the Foundation," Akerstrom said.

In addition to the Foundation providing briefings for WFP operators on the *Approach and Landing Accident Reduction (ALAR) Tool Kit*, and the donation of hundreds of ALAR Tool Kits to the WFP, William R. Voss, Foundation president and chief executive officer, said the WFP also was enlisted in the Basic Aviation Risk Standard (BARS) program. Developed initially to provide mining and drilling businesses a common audit standard for aviation service providers, BARS is similar in concept to the WFP operator audit program. Akerstrom said that the WFP is considering how BARS audits can be integrated into the WFP audit registry.

— JD

Akerstrom and Voss

J.A. Donoghue

At that time, WFP activities were ramping up, trying to come to grips with the desperate needs of large populations going hungry due to disasters, both natural and manmade. In response to WFP accidents, the U.N. asked the International Civil Aviation Organization (ICAO) to take a look at U.N. aviation activities, Akerstrom said. That audit resulted in two recommendations, one that the WFP logistics office set up a separate aviation contracting unit and the second that led to the establishment of the ASU.

The safety unit began operations in 2002 with Afghanistan relief efforts, but it wasn't until 2004 that its existing structure took shape, "and we started the real work," Akerstrom said. At the headquarters in Rome, the ASU is led by Cesar Arroyo.

The WFP safety officers quickly learned that "the [abilities of the national] civil aviation authorities (CAA) is the main problem we have; if they did their job, we wouldn't have to do so much," Akerstrom said.

And the unit does quite a lot. The ASU established a registry of audited contractors. They conducted 121 audits last year, with two safety officers spending five to eight days on each full audit, looking at an operator's training, maintenance and flight operations procedures. After that initial audit, a program of continued surveillance is maintained. "Every two years, we do a full audit," Akerstrom said. "When we have some findings, we go back and review. We like to see every operator every six

Arroyo

J.A. Donoghue

months," more often if there are open issues, or to perform a spot check, he added.

Then they track events in the field in several ways, some of which involve the UNHAS on-site manager of the specific relief effort, ASU drop-in checks and extensive use of reports using the European Coordination Centre for Accident and Incident Reporting Systems (ECCAIRS). All reports of accidents, incidents and events are handled with a no-fault, just culture approach, seeking to fix a problem rather than punish an offender.

The ASU and its registry are used by all of the UNHAS agencies, including the U.N. High Commissioner for Refugees, the U.N. Children's Fund (UNICEF) and the U.N. Development Program. The U.N. branch providing transportation for U.N. peacekeeping forces has its own safety office in New York, but it uses the

WFP flight crews use hand-drawn airport diagrams depicting obstructions, wildlife and other hazards.


AWK Airworks (Kenya) Ltd.

DAILY VOYAGE REPORT FORM

BASE: WAU	CAPT: BILL L. / F/O: DENIS M	DATE: 06 MA / 2010
A/C REG: 5Y NLM	A/C TYPE: C208	CALL SIGN: UN CO 8AW

ROUTE/COMMENTS:

N↑ • TAMBURA AIRSTRIP •

20

OVERGROWN GRASS

02

TREES OVER GROWN

• THRESHOLD 02/20 HAS OVERGROWN SHRUBS AND GRASS NEEDS TO BE CLEARED.

• EXTREME CAUTION TO BE EXERCISED AT THIS AIRSTRIP !! PEOPLE AND ANIMALS CROSSING THE AIRSTRIP AT ALL TIMES. NO CROWD CONTROL WHATSOEVER.

• RUNWAY TO BE CLOSED UNTIL ABOVE ISSUES ARE ADDRESSED.

COPY TO UN

CAPTAIN SIGNATURE

© Jim Farrell

same standards as the WFP — the U.N. Common Aviation Safety Standards, Akerstrom said.

Although an aviation operator from Canada might be hauling food and people around in Kenya or Somalia, the WFP "tries to use as many African operators as possible," Akerstrom said. "It is easier to get them into the operation faster, it builds local expertise and it builds the local economy." When disasters strike anywhere in the world, such as the 2010 earthquake in Haiti or Japan's multiple disasters, the WFP turns to its registry to get going as quickly as possible.

The WFP is a very active agency. In 2010, WFP used an average of 54 aircraft per month and during the year, transported more than 350,000 passengers and 14,000 tonnes (15,428 tons) of cargo in 19 country operations. The East Africa Region of the WFP contracted fleet alone encompasses 30 aircraft, including Boeing 737s, Ilyushin Il-76s, de Havilland Dash 8s, a couple of regional jets, five Mil Mi-8 helicopters and a clutch of Cessna Caravans; most are based in south Sudan and Darfur.

Keeping close tabs on events, the East African Region of the WFP counted 114 occurrences and 75 hazard reports in the last half of 2010; there are 135 open hazards in the region, 24 of them considered significant. There were no accidents in the period; however, five serious incidents — two involving non-WFP contracted aircraft — and 35 significant incidents were recorded.

"The number of serious incidents has decreased, but we want the number of reports to increase," allowing for more comprehensive searching for hazard precursors, Akerstrom said. He added that analysis of the reports is kept at the local level.

The two most troubling categories of incidents are air traffic control (ATC), with marginal infrastructure falling further behind rapidly expanding air traffic, and the broad category called "airfield conditions and control." This includes farmers digging irrigation ditches across runways, but also involves the number of people and animals wandering on the runways. In this area of the world, goats constitute a significant safety hazard, although camels, wild pigs, gazelles, cattle and donkeys all present problems. Imagine starting your takeoff roll in a Dornier 328 Jet and having to veer around a wild pig.

The weak ATC issue is one reason that WFP highly recommends that its aircraft have a functional traffic-alert and collision avoidance system (TCAS II), adding, "PCAS (Portable Collision Avoidance System) is not an acceptable substitute."

Official airport documentation is nearly nonexistent in the regions where the WFP flies, so the organization requires that its operators create their own maps of route infrastructure and airports. Some of these begin as crew-produced hand-drawn diagrams similar to those that, from their beginnings in the earliest days of commercial aviation, evolved into the comprehensive documents we see today. These drawings are copied and passed around, noting hazards such as trees, animals and high terrain. Eventually, diagrams of some of the busier airports are more professionally rendered, with a more familiar information format, and widely distributed.

The WFP also requires that operators institute its real-time flight following system with Internet access so all aircraft can be tracked all of the time. As Arroyo said in 2009 when he accepted the Flight Safety Foundation President's Citation on behalf of the WFP, "Every single aircraft is equipped with a satellite tracking system, TCAS, and EGPWS [Enhanced Ground Proximity Warning System], even in small planes such as Cessna Caravans. Pilots are proud to be properly trained, and aircraft maintenance is done by appropriately authorized maintenance organizations."

The weakness — or even functional existence — of many CAAs is one of the reasons the old WFP practice of simply checking for an AOC and assuming the best was doomed to failure. "In some countries, you don't have to do anything to get an AOC," Akerstrom said. "You can operate a [Boeing] 737 on a 60-day waiver. We've gone to the CAA and asked to see records on an operator to find they have no data, despite having issued an AOC. Sometimes the CAA will inspect, but they don't write a report," so there's nothing to research, he said. WFP has learned that the relative strength or weakness of a CAA can be easily seen when they audit that nation's operators.

In a manner of looking at the situation, the expression "a rising tide lifts all boats" applies perfectly to the WFP experience; a small, dedicated group of aviation safety professionals, using existing techniques and standards and adapting them to fit the circumstances, has lifted African safety values. And, as more and more operators adopt WFP practices, the higher all of the boats will rise.

WFP Volunteer Opportunities

The partnership between Flight Safety Foundation (FSF) and the U.N. World Food Programme (WFP) will offer some unique volunteer opportunities for members of the aviation safety community. The Aviation Safety Unit (ASU) of the WFP needs volunteers to contribute time, expertise and knowledge to various programs and projects throughout the year. The primary needs are:

- Speakers at WFP aviation workshops, especially specialists in helicopter operations, approach and landing accident reduction, controlled flight into terrain and safety data management;
- Data analysts to interpret WFP operational safety risk environment data;
- Trainers in crew resource management and human factors, for both crew and corporate staff;
- Accident investigators; and,
- Specialists in ATC operations.

These categories may vary in scope and need, according to time and circumstances.

If you have an interest in volunteering your time with the ASU, your information will be kept on file and the Foundation and/or the ASU will contact you on an as-needed basis. Please email information about your qualifications, along with a résumé, to Susan Lausch, FSF director of development, at <lausch@flightsafety.org>. You can make a tax-deductible, charitable contribution through the Foundation to support WFP activities. Contact Lausch for more information or contribute via the FSF Web site at <flightsafety.org/donate>.

FSF President and CEO William R. Voss welcomed the new formal relationship "so that the community of aviation safety experts in the Foundation can have an opportunity to volunteer their assistance to this organization doing this most difficult work under the most difficult of conditions."

— Susan Lausch

BY WAYNE ROSENKRANS

Seat Belt Signs

Serious injuries during turbulence influence the FAA's latest advice.

Turbulence is the leading cause of in-flight injuries involving American air carriers, based on a recent review of data by analysts within the U.S. Federal Aviation Administration (FAA) Flight Standards Service. Without detailing three cited incidents, the FAA has reminded the air carrier industry — via an *Information For Operators (InFO)* bulletin — of the need to adhere to standard operating procedures (SOPs). Turbulence encounters with injuries were described during 2010, however, in the agency's Accident/Incident Data System and in last year's final report by the U.S. National Transportation Safety Board (NTSB) about a 2009 accident.

The NTSB report describes an encounter involving an Airbus A320-232 operated by JetBlue Airways (*ASW*, 7/10, p. 57). Two passengers — one not wearing a seat belt and the other in a lavatory — suffered serious injuries, and two passengers received minor injuries. The aircraft was descending through 12,500 ft when it flew through a small cumulus cloud. "The captain had made a passenger announcement during initial descent and prior to the turbulence encounter, emphasizing the need for passengers to take their seats and fasten their seat belts when the seat belt sign was illuminated," the report said. "Additionally, a flight attendant [had] made a public [address] announcement when the seat belt sign was illuminated. The seat belt sign had been illuminated since 19,000 ft (about four minutes prior [to the encounter]), and the airplane was not flying through any precipitation. The captain had also instructed the flight attendants via intercom to sit down a few minutes prior to the turbulence encounter."

Incidents With Injuries

On July 20, 2010, near Denver, 13 passengers and four flight attendants were injured when a United Airlines Boeing 777-200 encountered severe turbulence and diverted for medical assistance. The FAA's report said, "Ten minutes prior to the [turbulence] encounter, the [flight] crew turned on seat belt signs, made an announcement and had flight attendants be seated. In an area of light precipitation indicated on the radar, the flight encountered a four-second severe turbulence event of plus/minus 1 g [one times standard gravitational acceleration]."

On July 16, 2010, near Birmingham, Alabama, the flight crew of an unspecified airliner type operated by Shuttle America encountered severe turbulence, causing a minor injury to one flight attendant. "The captain requested an immediate turn but was unable to avoid penetrating the storm cell during the turn," the report said.

"The crew reported first entering an area of extreme precipitation at Flight

Level [FL] 370, followed by severe turbulence, autopilot disengagement and subsequent loss of control after inadvertently entering the storm cell."

On Feb. 27, 2010, near Redmond, Oregon, an unspecified airliner type operated by Horizon Air encountered severe turbulence at FL 230, resulting in one passenger receiving injuries for which emergency medical technicians advised seeing a physician. The seat belt sign was illuminated. "The [flight crew] reported the turbulence occurred two or three times in a period lasting 30-45 seconds," the FAA report said. "The pilot reported a loss of 1,500 ft in altitude. … One passenger released her seat belt after the initial occurrence to retrieve her purse, which had fallen into the aisle. When the second turbulence happened, she hit her head on the overhead bins, and then hit her chest on the armrest."

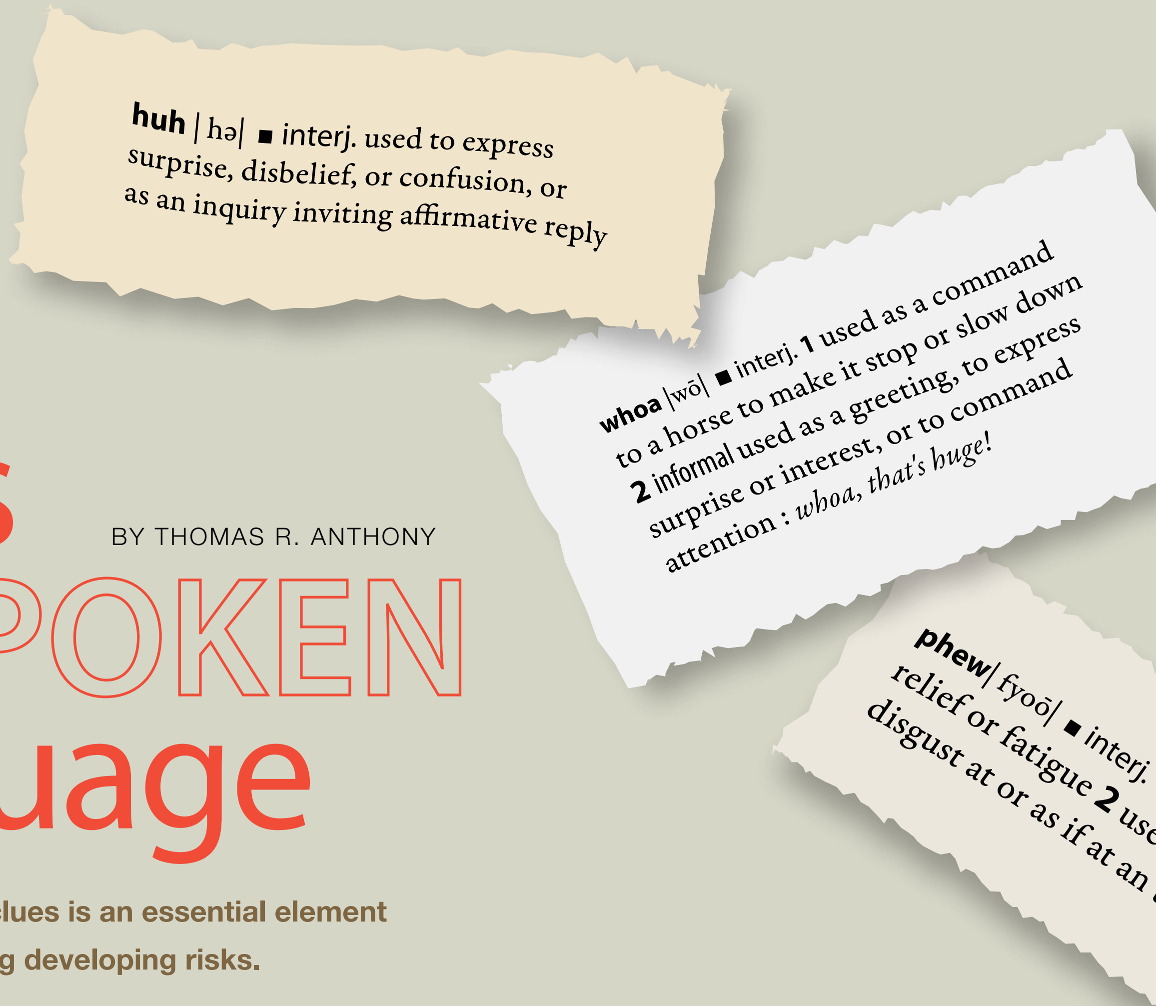
The bulletin also urges airlines to stress the relevant FAA requirements for enforcing passenger compliance with seat belt signs and related crewmember instructions.

Turbulence Countermeasures

Tactics fall into categories of preflight planning, in-flight situational awareness, postflight debriefing and encounter reporting. The FAA said the following tactics deserve emphasis:

- Pilots should obtain current turbulence reports from their weather service.
- Passengers who ignore crewmember instructions to fasten seat belts should receive a written warning, such as a small card that says, "Turbulence Happens – Click it, don't risk it."
- Flight attendant training should include scenarios to practice quick response, managing service carts, and improved communication including commands such as "Turbulence! Tighten seat belts."
- Dispatchers should proactively provide "ride reports," and pilots consistently should share knowledge of forecast turbulence with flight attendants and passengers in time for adjustments to cabin service.
- All crewmembers should adhere to SOPs regarding announcements on night flights and remind passengers to keep their seat belts visible.
- Crewmembers should adapt their announcements to specific facts about turbulence severity and "the approximate time that the seatbelt sign will stay illuminated."
- If severe turbulence is encountered, the flight crew should instruct the cabin crew to follow up with cabin checks of the effects.
- The cabin crew should "caution passengers that they should not attempt to open overhead bins when the seat belt sign is illuminated."
- Cabin crewmembers should monitor long lines forming around a lavatory, especially in light of the turbulence-injury threat.
- Cabin crews should employ visual aids such as seat belt extenders or briefing cards, and point to seat belt signs during oral announcements and while checking compliance.
- Flight attendants should adapt communication for special passengers such as those who speak a different language; people who are elderly, deaf or hearing impaired or have limited mobility; and those traveling with small children.

Except where noted, this article is based on "Seat Belt Use and Passenger Injuries in Turbulence," InFO *no. 11001, published by the FAA on Jan. 6, 2011.*



TEM's UNSPOKEN Language

BY THOMAS R. ANTHONY

Acting on subtle trouble clues is an essential element in the process of defeating developing risks.

There is an unspoken language, although sometimes it ripens into discussion, associated with the threat and error management (TEM) process. It is a simple language of just three "words." Commonly known and widely used, these words have a connection to the world of TEM that has gone unnoticed. The three words are: *Huh?, Whoa!* and *Phew!*

From the aviation safety perspective, the word *Huh?* is the most important; the others flow from it. There are two common usages of the word *Huh*. The first is "*Huh*. I didn't know that." The second is "*Huh?* I wonder what that is."

For the purposes of TEM, we are only interested in the second. So why are we interested? Because this word is an identifier of a potential threat or hazard. We utter *Huh?* when something doesn't make sense, when we hear a sound or experience a sensation that we cannot explain, or observe something that we didn't expect.

Huh? is an involuntary word. Something has happened, and we can't figure out what it is. The occurrence may not be dramatic enough to demand our immediate attention, but in the world of aviation safety, the word *Huh?* should not be ignored. Like a piece of yarn tied to the shroud of a sailboat, it is a telltale, an indicator that something changed, perhaps for the worse.

Huh? is an indicator that a threat or a hazard may be present. While not a red flag, it is often a yellow flag that requires our attention, or a warning to proceed with caution. As aviation professionals, everything should make sense to us. When something doesn't, the reason needs to be found.

When things don't make sense, the minimum action is to vocalize and identify the situation in a question: "That frequency change doesn't make sense" or, "Why would they assign that

runway?" Recognition and vocalization drags the *Huh?* moment out of the realm of a "vague sense of unease" and places it squarely on the table for resolution or confirmation by ourselves and others.

At the very least, vocalizing the *Huh?* starts the process of cautionary mitigation — "I guess we should look at this a little closer," or "I guess we should confirm that frequency." In a way, *Huh?* serves as a probabilistic risk assessment, another good reason that verbalizing such a condition to others can help mitigate and manage the associated threat or hazard. Upon the announcement of the word *Huh?* there exists at least some cognitive processing of whether this new thing represents a high level of risk, launching a proactive risk assessment that seeks to complete the risk matrix in real time, followed by mitigation development.

Why is this important? Often, when performing a demanding operation or task, our attention is focused on a single thing, or a set or sequence of things. The temptation is to continue with the attention-demanding task until it's completed. But in doing so, we may ignore the relatively undemanding— at least immediately — circumstance that has generated the *Huh?* feeling. This myopic task fixation would, of course, be the wrong response. Similarly, another wrong response is: "Oh, it's probably nothing," without investigation. Ignoring the *Huh?* can be as detrimental as excessive attention to a singular task.

So where do these *Huh?* sensations come from, and why are they important? Sigmund Freud, often called the father of psychoanalysis, explains the mind in terms of three levels of awareness: the conscious, the subconscious and the preconscious. He distinguishes the preconscious from the subconscious as follows:

> *[There exist] two kinds of unconscious — one which is easily, under frequently occurring circumstances, transformed into something conscious, and another with which this transformation is difficult and takes place only subject to a considerable expenditure of effort or possibly never at all. … We call the unconscious which is only latent and thus easily becomes conscious, the 'preconscious' and retain the term 'unconscious' for the other.*[1]

When we perform a demanding task that requires our complete attention, we are operating at the conscious level. We are not aware of everything that is stored in our memory, since everything that can be recalled is the preconscious. I believe that the *Huh?* phenomenon is the recognition that something doesn't make sense on the preconscious level.

The preconscious comprises all of the experiences and lessons we have logged. For aviation professionals, this represents a significant mental database. So, while we are not aware in the present moment of all that we have learned, that information is stored in our preconscious, just out of sight, so to speak. It is similar to the phenomenon of a difficult-to-remember name popping into our mind, that event indicating there was processing going on at the preconscious level. It is this preconscious processing that is responsible, I believe, for the *Huh?* phenomenon. We ignore the *Huh?*s at our peril.

People have recognized this phenomenon over the ages. Family members are advised to "sleep on it" before making any big decisions. Why is this good advice? It allows us to use the lessons, information and values that are in the preconscious, which are not immediately available to us while we are talking with the salesman at the used-car lot.

The Second Word

The second word in the unspoken language of TEM is "*Whoa!*" While punctuation is dependent upon context, the word *Whoa* is almost always followed by an exclamation point, as in "*Whoa!* What the heck was that?"

Whoa! is a relatively simple word compared to *Huh?* Its importance in the world of aviation safety is that it is the word that may follow when the first unspoken word (*Huh?*) is ignored. While we call it a word, it is better described as a spontaneous utterance, a class of speech given a special status in the eyes of the law of the United

Whoa!

This is a proactive risk management process in real time.

States. As with many legal concepts, there is a Latin term for spontaneous utterance; it is *res gestae*. The spontaneity of such utterances is judged to be of such genuineness that they may be reported by others and taken as evidence in a court of law.

So what does that mean to us? Like *Huh?* the word *Whoa!* is an automatic verbal signal. It is the immediate and automatic recognition that a threat or hazard condition exists or has just existed. It lacks, however, a complete element of cognizance of what the hazard really is, as in the earlier "*Whoa!* What was that?"

The Third Word

The third word of the unspoken language is *Phew!*, the natural follow-on to *Whoa!* It is uttered after the threat or hazard has passed, and it reflects a certain degree of understanding of the threat or likelihood and the severity of the threat or hazard condition, and indeed the acceptable outcome of the risk event. In most cases of *Phew!*, the likelihood was close to 100 percent, and the appreciation of this is clear and inescapable. In this sense, *Phew!* functions as a rapid risk assessment of a historical threat or hazard — a verbal, determinate risk assessment process, including outcome.

While there is often very little that can be done following the utterance of *Whoa!, Phew!* (like its cousin *Huh?*) presents very real opportunities for significant safety action. Like *Huh?*, however, we ignore the *Phew!* utterance at our peril. Unless the *Phew!* moment is followed by analysis of what caused it, as well as a mitigation of those causes, a sort of real-time root cause analysis, the original hazards that started the *Huh?, Whoa!, Phew!* chain remain unchecked. The absolutely wrong response to *Phew!* is: "*Phew!* That was close, but I'll be fine from now on." The correct response is: "I've got to figure out why that happened and change something."

Words in Action

Cmdr. Chris Nutter, in his previous career as a U.S. Navy A-7/FA-18 pilot, recounts the following story: He and a wingman were blazing southbound on a low-level training route in the Panamint Valley desert of California. With things happening very quickly, Chris sensed a *Huh?*, followed immediately by a significant deceleration. Immediately, he heard his wingman announce over the radio, "*Whoa!*"

Nutter responded "What do you mean, *Whoa*?"

The wingman answered quickly: "Yeah, you just lost about 6 ft of your tailpipe," a confirmation of the condition that prompted *Huh?* As the aircraft lost most of its thrust and was rapidly losing airspeed, Nutter traded the speed for altitude for either a one-time shot at essentially a no-thrust landing or positioning the aircraft to allow a controlled ejection in a safe area. In the end, Nutter landed safely at China Lake, a Navy airport.

Nutter, now Capt. Nutter with Alaska Airlines and a University of Southern California (USC) aviation safety management instructor, adds: "Effective threat management techniques can include a conscious awareness of the secret words, and a crew agreement that when they arise, they are verbalized and addressed by the crew."

This is a proactive risk management process in real time. But, by the time *Whoa!* happens, the crew is committed to managing either an error or hazard that now demands immediate attention and mitigation, and deliberate action to restore reduced risk levels. In some tragic accidents, while there may have been a *Huh?* there may not have been sufficient time between *Whoa!* and impact to resolve the situation.

These three unspoken words are an effective articulation of the need for real-time risk management, with direct relevance to modern safety management. The word *Huh?* validates what many pilots for many years have said when "something doesn't feel quite right." Often, things are not right, indeed, and the operation needs attention — identification, mitigation and resolution. Recognition of the "*Huh?*" and implementing appropriate risk management are real, effective methods of assuring operational safety.

Another Word

A careful reading of Nutter's incident reveals that his *Huh? Whoa!* sequence did not end in *Phew!* It ended in something akin to "*Oh, Jeez,*" "*Darn*" or a more salty expletive. The reason that these types of words are not included in our TEM lexicon is that they take us outside the realm of threat and error management. They belong instead to the realm of crisis management, emergency response or recovery. If we fail to control the threat or hazard early, to some extent we may become controlled by it.

Other Examples

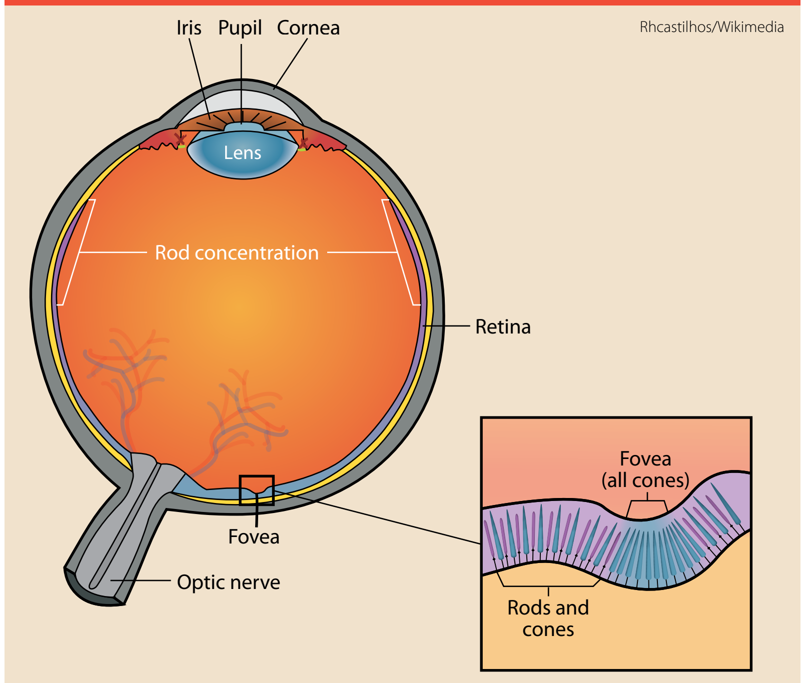
Dr. Gregg Bendrick, a U.S. National Aeronautics and Space Administration flight surgeon and an instructor in the USC Aviation Safety Program, notes that the human eye possesses mechanisms that function in a way very similar to the *Huh? Whoa! Phew!* model.

The retina of the human eye contains two types of sensory elements: rods and cones. The cones — so named because of their conical shape — are concentrated in the center of the retina. The rods — also named because of their shape — are dispersed over the wider area of the retina with a much lower level of concentration. The cones process visual information for our central vision. The central vision is what we see and are consciously aware of.

On the other hand, the rods process information of the peripheral vision. In effect, the rods — the peripheral vision — act as a light and motion detector, as well as a basic horizon indicator (Figure 1). We can "see" things via this peripheral vision but may not be consciously aware of them. The peripheral vision helps with our overall spatial orientation, and when a light or relevant motion "catches our eye," our brain redirects the eyes to focus the central (cone) vision onto the item of interest. That is, the item is now brought to our conscious awareness.

The rods, and therefore the peripheral portion of vision, also combine with input from the vestibular structures of the brain that help control balance. This duality of vision also allows us to walk while focusing our central vision on things like reading a newspaper or viewing an iPod. We may not be conscious of the walking function, nor the general surface of the walkway ahead, but it is being subconsciously processed. The rods, however, possess a very important *Huh?*-like function. They sense movement and environmental differences, and they act automatically to direct the central vision to focus on the item identified to need further attention. In a sense, it is a physiological TEM function.

The Eye's Data Collection Mechanics



Source: Thomas R. Anthony

Figure 1

Understanding a little more about rods and cones gives further insight into their distinct but dependent function. The concentrated cones that feed our central vision are able to make acute discriminations among objects, so that's where the eye's best vision can be found, 20/20 or better. Visual image acuity for peripheral vision via the retinal rods is limited to 20/60 at best. Similarly, cones can distinguish the full color spectrum, while rods can detect only a single green-blue color.

This central vision/conscious mind, peripheral vision/unconscious mind duality explains

'The airplane is talking to you. Better listen.'

the "invisible gorilla" phenomenon that many of us have witnessed when watching the popular video used to demonstrate selective vision. Students are told to count the number of times a basketball is passed among members of a white-uniformed team. The video is played, and the white team passes the ball about 20 times. While the ball-passing activity takes place, a person dressed in a gorilla suit walks among the players. After the video is played, the instructor asks how many people saw the gorilla and is often met with the question "What gorilla?" from a large portion of the class. Insight into the dual functions of the eye lets us understand that the invisible gorilla phenomenon is not just a matter of attention but is also a matter of physiology as well.

This rod-based peripheral detection capability is a physiological component of the unspoken word *Huh?*, and it highlights how important it is to consciously risk-manage our *Huh?* events.

Useful Lessons

The first lesson is to understand that the *Huh?* phenomenon is an indicator that a threat or hazard may exist. The fact that we aren't able immediately to determine what created the *Huh?* effect is not important. Capt. Guy Woolman of Southwest Airlines describes the *Huh?* feeling associated with an unusual sound as: "The airplane is talking to you. Better listen."

It is important to understand that the *Huh?* phenomenon is a result of the fact that the mind, like the eye, is not conscious of all that it knows at all times. We experience this from time to time when we cannot immediately recall a name. Trying harder seldom gets us closer to remembering. However, when we set the task aside and think about something else, the memory often pops up like a cork on the surface of a pond. Our mind has been working on the problem unconsciously — or subconsciously, I don't know which. The conscious mind is not always the most direct link to remembering. But the important thing is to recognize that this is the way the mind sometimes works.

As Nutter says, the most important step after *Huh?* is to verbalize the concern and then seek additional information.

Questionable Words

Certain phrases are often associated with a less than productive approach to TEM. Among them are:

- "I can handle this." This is often associated with the recognition of an increased hazard level with no accompanying mitigation other than increased concentration of the type that can cause us to miss the gorilla.
- "Gulp." This is associated with recognition of an increased hazard environment and no mitigating measures.
- "… No matter what." This gives permission to all who hear it to depart from standard operating procedures (SOPs), regulations and established safety standards in order to meet a single threat or hazard. It is inherently a hazard-creating statement, and is not easily withdrawn.
- "Hey, watch this," or "I bet you've never seen this before." These are phrases that almost certainly precede a hazardous act, an intentional noncompliance with SOPs, regulations and established safety standards, and within another frame of reference are a significant contributor to the automobile insurance rates charged for teenaged males.

So, follow through in examining the *Huh?*s encountered and pay attention to what the *Whoa!*s and *Phew!*s tell us about what just happened; these are processes that are at the heart of TEM.

Capt. Chris Nutter contributed to this story.

Thomas R. Anthony is director of the Aviation Safety and Security Program at the Viterbi School of Engineering, University of Southern California.

Notes

1. Freud, Sigmund. *New Introductory Lectures on Psychoanalysis* (1932).

BY ROBERT B. BARNES

Paths to Proficiency

A new organization aims to provide a global pilot training best practices clearinghouse.

There are as many ways to teach flying as there are good instructors. And each of these good instructors has developed special ways to guide students toward becoming safe and competent pilots instead of simply accumulating hours to satisfy a minimum standard. Until now, it has been too hard to share such personal techniques beyond the local flight line for the benefit of all instructors.

The International Association of Flight Training Professionals (IAFTP) has been organized to facilitate the identification, recognition and timely communication of demonstrable global pilot training best practices.

IAFTP has evolved from a three-year, online discussion of pilot training practices by more than 300 aviation professionals. During this discussion, the concept of pilot training best practices often surfaced.

However, it was quickly discovered that more than 25 aviation safety organizations worldwide currently use the term "best practices" when describing their individual training initiatives. Unfortunately, it also became apparent that there is no consistent definition of this term.

It has been suggested that the phrase "best practices" implies a collection of standards, procedures and techniques that are used by pilot training organizations to achieve specific outcomes. Another perspective suggests that a best practice is not a standard, since a standard is the desired proficiency — rather, a best practice should be considered the best way to achieve a specific standard.

Of course, including the word "best" implies that there is some form of evaluation and rating system for pilot training practices. However, there is no such process and, therefore, every organization has used its own internal experience to determine its "best" way to help students achieve the desired proficiency. In reality, what is called a best practice today is only a local organizational practice.

While today's best practices may be defined within the scope of a local organization, the term is still used globally, even in the absence of a neutral base for reference and evaluation. The implications of this are significant — unless a specific training practice is known to be widely used and is documented to be effective, it should not be described as a best practice. It is simply a training practice or technique, nothing more.

Global Clearinghouse Established

The idea of creating an organization to provide a global pilot training best practices clearinghouse was first introduced publicly at the World Aviation Training Conference and Trade Show in April 2010, and IAFTP was incorporated in January 2011.

IAFTP members are flight training professionals directly involved in the conduct or support of pilot training activities; the organization's singular goal is to work toward improving the competency of all pilots — in airline, air taxi, business and general aviation — to enhance overall aviation safety.

It is important to note that IAFTP's focus is not to establish standards, create a certification body or attempt to influence regulators. It is to provide a credible, independent and international clearinghouse for pilot training best practices that have been developed by flight training professionals to respond to individual pilot or operator needs.

Organizing Training Practices

As discussed, unless a specific training practice is known to be widely used and is documented to be effective, it should not be described as a "best practice." Therefore, IAFTP will use this hierarchy of terms to organize pilot training practices:

- **Personal technique** for accomplishing task proficiency — an instructor may have several;
- **Personal best practice** — the instructor's most effective technique for achieving specific task proficiency;
- **Local best practice** — used by an unofficial group of instructors or a local training organization;
- **Regional best practices** — used and/or officially designated by a recognized standards body in a region, such as North America, Europe, or Asia; and,
- **Industry standard best practices** — identified by a recognized international standards body as globally applicable.

Collecting Training Practices

The heart of this international clearinghouse will be the IAFTP Web site, <IAFTP.org>.

Each month, the public area of the IAFTP Web site will feature an article focusing on a high priority pilot training topic. An introductory section written by a subject matter expert will establish the link between that topic and pilot training best practices. This introduction will then be used to develop three personal perspectives: how a flight training organization approaches this topic, how an instructor teaches this topic and how a student reacts to the learning experience.

Monthly articles will include such topics as upset recovery, loss of control in flight, runway incursions and excursions, level busts, communications, crew resource management, loss of separation, and safety management systems. Reader comments will be encouraged.

Each monthly training article will thereby provide a focus for collecting instructor practices to be processed as potential best practices through a members-only IAFTP Pilot Training Best Practices Forum and later posting to the IAFTP Pilot Training Best Practices Portal on the SKYbrary site, <SKYbrary.aero>.

SKYbrary is a "wiki" resource site created by Eurocontrol, the International Civil Aviation Organization, Flight Safety Foundation and other organizations to be a freely available, comprehensive online source of aviation safety information. It was launched in May 2008, with a goal to capture authoritative aviation industry information and create cumulative knowledge, especially about critical safety issues.

William R. Voss, president and CEO of Flight Safety Foundation, recently said, "Having been involved in its creation, I can say without reservation that SKYbrary is an unparalleled tool in the world of aviation safety."

Announced in February of this year, the IAFTP Pilot Training Best Practices Portal on SKYbrary will provide free access to pilot training practices that have been collected from around the world and peer-reviewed by pilot training professionals.

Robert B. Barnes is president of IAFTP.

Culminating years of work aimed at preventing aging airliners from being flown with widespread fatigue damage (WFD), the U.S. Federal Aviation Administration (FAA) has issued a rule requiring the development of an inspection program for transport category airplanes.[1]

The FAA's final rule governing the inspections took effect Jan. 14. It gives design approval holders between 18 months and five years, depending on the airplane, to develop inspection programs. Operators then have an additional 2½ to six years to implement the inspection requirements.

A framework assembled by the Taiwan Aviation Safety Council holds wreckage from a China Airlines Boeing 747 that crashed near Taipei in 2003, killing 225. Investigators found extensive fatigue damage in the fuselage.

BY LINDA WERFELMAN

Crackdown on Fatigue

The FAA aims for new inspection programs to keep airplanes with widespread fatigue damage out of the air.

The campaign to address the problem of WFD began in the aftermath of an April 28, 1988, accident in which an Aloha Airlines Boeing 737-200 experienced an explosive decompression and separation of an 18-ft (5-m) section of the upper portion of the cabin fuselage (see "There Was Blue Sky," p. 39).[2]

The U.S. National Traffic Safety Board blamed the accident on the failure of the airline's maintenance program to detect "significant disbonding and fatigue damage" that led to the failure of a lap joint and the subsequent separation of the upper section of fuselage. The safety recommendations generated by the accident investigation set in motion the years-long effort to develop protections against WFD.

The FAA characterized the problem as increasingly likely as the airplane ages.

Over the years, the NTSB has investigated a number of accidents and incidents involving airliners with WFD (see "Airplanes Damaged by WFD," p. 40), and the FAA has issued about 100 airworthiness directives intended to address WFD.

Defining the Terms

WFD is defined by the FAA as the "simultaneous presence of fatigue cracks at multiple structural locations that are of sufficient size and density that the structure will no longer meet the residual strength requirements of [U.S. Federal Aviation Regulations] Section 25.571(b)," which discusses damage tolerance evaluations.

WFD is largely a result of the repeated pressurization and depressurization of airplanes during years of flight. In the final rule, the FAA characterized the problem as "increasingly likely as the airplane ages, and … certain if the airplane is operated long enough."

WFD is difficult to detect because when the cracks first form, they are very small; eventually, however, they grow quickly and join together, possibly causing structural failure before they are detected in an inspection.

The FAA characterized as "fortuitous" that many cases of WFD have been discovered by workers performing routine aircraft maintenance.

"Cracks have been found by workers while stripping and painting an airplane," the FAA said in the final rule. "Cracks have also been found by mechanics conducting unrelated inspections of skin anomalies on the external fuselage; further investigation revealed multiple cracks in stringers and circumferential joints."

In other cases, however, fatigue cracking has gone unnoticed, and "undetected multiple site damage in wing or fuselage structure has eventually led to catastrophic failure of the structure in flight," the FAA said.

Two Types

WFD takes one of two forms:

- Multiple site damage is defined by the FAA as "the simultaneous presence of fatigue cracks at multiple locations that grow together in the same structural element, such as a large skin panel or lap joint."

- Multiple element damage is "the simultaneous presence of fatigue cracks in similar adjacent structural elements, such as frames or stringers."

In some instances, both types of WFD occur at the same time.

'Broad Safety Net'

Summarizing the comments submitted after the rule was proposed in 2006, the FAA noted that some operators and aviation organizations questioned the need for the new rule, arguing that it was not justified in terms of safety.

The FAA said that some had noted that the Aloha Airlines accident was the last major accident in the United States to be attributed to WFD — and that the NTSB had concluded that WFD was a contributing factor rather than the sole factor in the accident.

Boeing commented, however, that the rule would "cast a broad safety net on airframe structural performance for those types of details the industry has determined may be susceptible to

Continued on p. 40

'There Was Blue Sky'

The in-flight structural failure of an Aloha Airlines Boeing 737-200 during an April 28, 1988, flight from Hilo, Hawaii, U.S., to Honolulu is widely described as the defining event in the development of programs to address issues associated with aging aircraft.

The airplane had accumulated 89,680 flight cycles, and 35,496 flight hours, when the accident occurred — an explosive decompression and the separation of an 18-ft (5-m) section of the upper cabin fuselage — from the main cabin entrance door aft.

Of the 95 people in the airplane, one flight attendant was swept out of the airplane and presumably killed. Another flight attendant and seven passengers were seriously injured.

The final report on the accident by the U.S. National Transportation Safety Board (NTSB) noted that the two pilots had said that they heard a loud clap or "whooshing," followed by the sound of wind behind them and that the captain had said that, when he looked back, he saw that the cockpit entry door was gone and "there was blue sky where the first-class ceiling had been."[1]

He said that the airplane rolled slightly left and right and that the controls felt "loose" as he began the emergency descent to Kahului Airport on the Hawaiian island of Maui, using hand signals to communicate with the first officer because of the continuing roar of the wind. He stopped the airplane on the runway, where the cabin crew conducted an emergency evacuation.

Afterward, one passenger said that, as she boarded the airplane, she had seen a longitudinal fuselage crack located, the report said, "in the upper row of rivets along the S-10L lap joint, about halfway between the cabin door and the edge of the jet bridge hood." The passenger had not mentioned her observation to the crew or to ground personnel.

A post-accident examination of the airplane revealed that the fuselage skin had separated along a line that followed the upper rivet line.

The NTSB cited as the probable cause of the accident "the failure of the Aloha Airlines maintenance program to detect the presence of significant disbonding and fatigue damage which ultimately led to failure of the lap joint at S-10L and the separation of the fuselage upper lobe."

Among the contributing factors identified by the NTSB were "the failure of Aloha Airlines management to supervise properly its maintenance force" and "the failure of the FAA [U.S. Federal Aviation Administration] to evaluate properly the Aloha Airlines maintenance program and to assess the airline's inspection and quality control deficiencies."

—LW

Note

1. NTSB. Aircraft Accident Report NTSB/AAR-89/03, *Aloha Airlines, Flight 243, Boeing 737-200, N73711; Near Maui, Hawaii; April 28, 1988*.

WFD," pave the way for establishing safe operational limits and prescribe maintenance actions to help avert WFD in airplanes that have not yet reached those limits.

Airbus added its support for the "intent … to address the potential risks of [WFD] by requiring that appropriate maintenance requirements be imposed to preclude aircraft operations in the presence of [WFD]."

The FAA characterized the rule as "essential to prevent future accidents or incidents."

The agency added that "the potential for catastrophic structural failure is significant."

In the past, manufacturers developed "some level of understanding of structural fatigue characteristics up to the design service goal, but not beyond it," the FAA said. "A significant number of airplanes being operated currently have already accumulated a number of flight cycles or flight hours greater than the original design service goal. As the existing fleet continues to age, the number of such airplanes will increase."

The FAA noted that airplane structural fatigue characteristics are understood "only up to a certain point consistent with the analyses performed and the amount of testing accomplished." Airplanes should not be operated beyond that point because "in the absence of intervention, the likelihood of WFD increases with the airplane's time in service."

The FAA noted that some airlines had said in their public comments that existing programs — including elements of the Aging Aircraft Program, established after the Aloha Airlines accident — served the same purposes as an airplane inspection program designed specifically to identify WFD. Nevertheless, the FAA said that the existing programs were intended to address structural degradation in specific aircraft and not to focus on WFD. This new rule, however, specifically addresses WFD, and the programs that will be implemented as a result of the rule are intended to be the last element of the Aging Aircraft Program, the FAA said.

The agency said that maintenance programs typically include inspections to detect "obvious damage and irregularities," but "WFD, by

Airplanes Damaged by WFD

In its final rule, the U.S. Federal Aviation Administration (FAA) discussed about a dozen cases since the 1988 Aloha Airlines accident involving widespread fatigue damage (WFD) in transport category airplanes, including:

- The discovery, during maintenance in 1998, of two cracks growing from beneath a Boeing 727 lap joint. "Disassembly of the joint revealed a 20-in [51-cm] hidden crack from multiple site damage on the lower row of rivet holes in the inner skin," the FAA said.
- The discovery in July 2003 of cracking along a lap joint in a 737. The FAA described "extensive multiple site damage with up to 10 in [25 cm] of local link-up of cracks in one area."
- The discovery in June 2003 of cracking of the aft pressure bulkhead on a McDonnell Douglas DC-9 following a rapid decompression at 25,000 ft. A subsequent inspection found multiple site damage and "extensive link-up of cracks," the FAA said.
- An investigation that blamed fatigue cracks in the right wing of a Lockheed C-130A for the August 1994 in-flight separation of the wing as the airplane was responding to a forest fire near Pearblossom, California, U.S. Similar cracks were blamed for the in-flight separation of the wing of another firefighting C-130A in June 2002 near Walker, California, the FAA said.
- The discovery, during maintenance in 2005, of missing skin fasteners in the upper deck area of a 747. The subsequent inspection revealed that the fuselage frame was severed. Substantial cracking was found in two adjacent fuselage frames.
- Testing, service experience and analysis of an Airbus A300 in 2002 revealed cracking in adjacent fuselage frames. The FAA said the fatigue cracks "could result in multiple element damage."

— LW

its nature, is usually hidden and not readily detectable."

Specifics of the Rule

The new rule applies to turbine-powered transport category airplanes with a maximum takeoff gross weight of more than 75,000 lb (34,020 kg) that are operated under U.S. Federal Aviation Regulations Part 121 or Part 129 and have type certificates issued after Jan. 1, 1958. It also applies to all transport category airplanes that will be certificated in the future, regardless of their maximum takeoff gross weight or how they are operated. Some 4,198 U.S.-registered airplanes are affected by the rule, the FAA said.

The rule requires design approval holders to "evaluate the structural configuration of each model for which they hold a type certificate to determine its susceptibility to WFD and, if it is susceptible, to determine that WFD would not occur before the proposed LOV" — the "limit of validity" — the number of flight hours or flight cycles that an airplane can be operated before undergoing mandatory inspections for fatigue damage.

Design approval holders and operators also would be required to incorporate into their maintenance programs an LOV for the affected airplanes. The rule includes an option for extending an LOV, with maintenance actions designed to support the extension. No airplane could be operated beyond its extended LOV, the FAA said.

Determining an LOV

The rule says the evaluation of an LOV must be based on test evidence — described as data from full-scale fatigue testing, either of the entire airplane or of major sections of the airplane or both — and analysis — including fatigue and damage tolerance analyses. New airplane models pending approval should undergo testing to produce data on all structural parts of an airplane that are susceptible to WFD, the rule says.

The test data for some older airplanes may involve only the fuselage, the rule says.

"This is because the pressurized fuselage has been considered to be the most fatigue-critical part of the airplane," the rule says. "The wing and empennage have typically been considered less critical, and, as a result, relevant test data may not exist. However, for these same airplane models, significant service experience does exist."

Because of the availability of data, the rule says that, for these airplanes, the FAA would accept a combination of data from test evidence and analysis, along with service experience to show compliance with the rule.

"For example, in the case of one [of the earlier] airplane models, significant numbers of airplanes both in service and in storage have accumulated flight cycles in excess of the design service goal," the rule says. "For this model, there is significant existing test evidence for the fuselage but very little for the wing. In this case, the FAA expects that demonstrating freedom from WFD for the wing would be based primarily on service experience; for the fuselage, it would be based primarily on service experience and test evidence."

In the rule, the FAA established "default LOVs" for dozens of airplane models; for most, the default LOV was the same as the model's previously established design and extended service goal. For example, the default LOV for Airbus A319-series airplanes is 48,000 flight cycles/60,000 flight hours. The design and extended service goal also is 48,000 flight cycles; the goal is not expressed in flight hours.

The FAA estimated the benefits of implementing the rule at $4.8 million and the cost at $3.6 million.

The FAA said it is working with the European Aviation Safety Agency, which currently is developing rules to address WFD, and other national aviation authorities to harmonize WFD regulations.

'WFD, by its nature, is usually hidden and not readily detectable.'

Notes

1. FAA. "Aging Airplane Program: Widespread Fatigue Damage." *Federal Register* Volume 75 (Nov. 15, 2010): 69745–69789.

2. NTSB. Aircraft Accident Report NTSB/AAR-89/03, *Aloha Airlines, Flight 243, Boeing 737-200, N73711; Near Maui, Hawaii; April 28, 1988.*

A flight crew's landing on a taxiway prompts calls to enhance ASDE-X, airport lighting and ATC communication.

BY WAYNE ROSENKRANS

New proposals to augment airport surface detection equipment, model X (ASDE-X), and tighten airfield lighting practices have lengthened the list of safety recommendations inspired by a nighttime taxiway-landing incident. The landing involved a Boeing 767-300ER at Hartsfield-Jackson Atlanta International Airport (ATL), recalls the U.S. National Transportation Safety Board (NTSB). No injuries or aircraft damage occurred at 0605 local time on Oct. 19, 2009, when the Delta Air Lines flight being handled as a medical emergency — and initially cleared to land on Runway 27L — was cleared by air traffic control (ATC) to land on Runway 27R, a runway usually assigned for departures.

One minute and 40 seconds after accepting the side-step approach, the flight crew landed on Taxiway M, 200 ft (61 m) north of and parallel to the runway. The weather for the airport, reported at 0552, included calm winds and clear sky with visibility of 10 mi (16 km).

Having explained in October 2010 the human factors of pilot fatigue and the incapacitation of one of the three pilots on this flight (*ASW,* 12/10–1/11, p. 59), the NTSB turned in its March 2011 safety recommendation letter to the potential for airport infrastructure and ATC to exacerbate or mitigate a flight crew's errors and misperceptions. The safety recommendation letter emphasizes "non-causal aspects of this incident that present opportunities to improve ATC detection of potential taxiway landings and management of taxiway light settings."

The probable cause of this incident, which occurred after a 9.5-hour flight from Rio de Janeiro, Brazil, to Atlanta, was: "The flight crew's failure to identify the correct landing surface due to fatigue. Contributing to the cause of the incident were the flight crew's decision to accept a late runway change; the unavailability of the approach light system and the instrument landing system [ILS] for the runway of intended landing; and the combination of numerous taxiway signs and intermixing of light technologies on the taxiway."

The captain and first officer had been based at this airport for five years and eight years, respectively, and told

Omoo at en.wikipedia

Blue Edge Lights

NTSB investigators that they had difficulty recalling more than one previous experience of landing on Runway 27R. The captain said that in assessing risks after one pilot had become incapacitated, he had wanted to have available to the crew all possible "aids and resources from inside and outside the cockpit."

When the aircraft was on the ILS Runway 27L approach near the final approach fix, the local controller offered the side-step to the closer Runway 27R. "[The captain, intending to expedite the gate arrival,] said they had the parameters, and since they were an emergency, he decided to accept it and asked the first officer to set up the approach for 27R," the NTSB said. "[He] said he looked up and saw the edge lights, 'locked in' on the precision approach path indicator [PAPI] lights because he did not have the glide slope [or flight director], and followed them in. … [He said,] 'I glanced at the centerline lights for alignment information. I continued to focus on the PAPI until short final, at which point I looked ahead, aligned the aircraft and started to flare.' … He said when the main wheels touched down and he was in reverse [thrust], he realized the edge lights were blue, not white, and at that point 'it was too late [to go around].'" The captain said that he had not requested that ATC turn on the approach lights for Runway 27R because he believed that he already had identified that runway.

Multiple visual cues could have misguided the captain to align with Taxiway M instead of Runway 27R while on final approach, however, the NTSB said. "These cues included numerous taxiway signs along the sides of Taxiway M which, from the air, appeared to be white and could be perceived as runway edge lights. In addition, the blue light-emitting diode (LED) lights used on the eastern end of Taxiway M [Figure 1, p. 44] were perceived to be brighter than the adjacent incandescent lights on the airfield, and the alternating yellow and green lights in the ILS critical area [of Taxiway M] provided the appearance of a runway centerline.

© ADB Airfield Solutions (LED in-pavement fixture on ATL taxiway edge)

"Observations made from the flight deck during [four post-incident 767 approaches flown to recreate the appearance of relevant airfield lighting] indicated that when the lights were set to the same levels as were encountered by the incident crew, from about DEPOT intersection [the final approach fix for ILS Runway 27L], the Runway 27R centerline lights were not identifiable and the Taxiway M centerline lights were more prominent. When established on final, the taxiway signs were more visible than Runway 27R edge lights. At about 500 ft above ground level, the runway centerline lights were barely visible and it appeared that some lights may have been out. The color of the blue taxiway edge lights became distinguishable at about 500 ft above ground level while on approach."

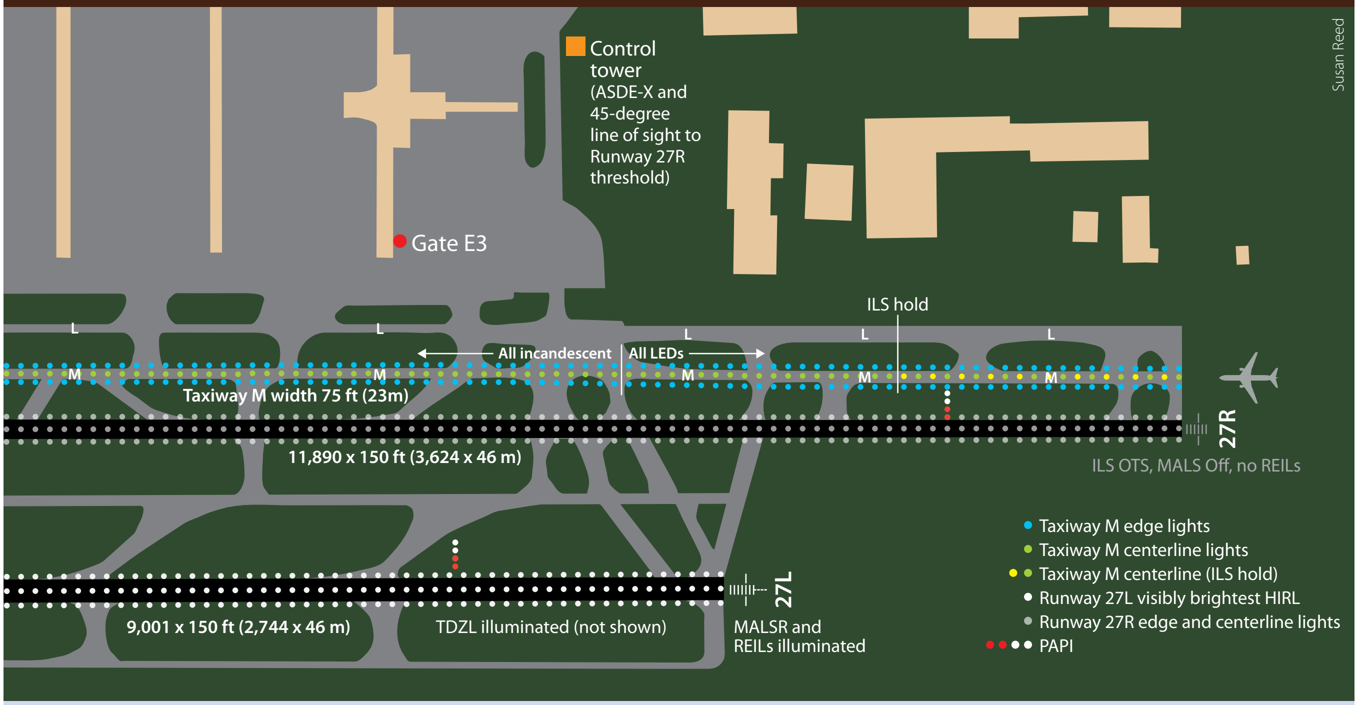
Observations by flight test lighting-evaluation participants were recorded, including: "Taxiway signs are very enticing to the eye. … At about 2,500 ft, the runway [27R] is virtually invisible and green lights being seen are the taxiway lights. … When 1 DME [1.0 nm (1.8 km) slant range on distance measuring equipment] from DEPOT, the taxiway appeared to be the runway."

Airfield Lighting Practices

The incident local controller told investigators that ATL airfield lighting presets periodically were re-selected according to time of day and visibility criteria, and that "[ATC] never changed the intensity of the lights unless a pilot requested it."

The investigation revealed that local controllers' ability to operate taxiway and runway lights from the touch-screen panel in the tower and the airport's lighting-intensity preset options did not conform to FAA standards and/or guidance. Among unrecognized

Context of Inadvertent Night Visual Landing on ATL Taxiway M



ASDE-X = airport surface detection equipment, model X; ATL = Hartsfield-Jackson Atlanta International Airport; HIRL = high-intensity runway lights; ILS = instrument landing system; LEDs = light-emitting diodes; MALS = medium-intensity approach lighting system; MALSR = MALS with runway alignment indicator lights; OTS = out of service; PAPI = precision approach path indicator; REILs = runway end identifier lights; TDZL = touchdown zone lights

Note: The flight crew conducted the ILS Runway 27L approach with a side-step maneuver to Runway 27R but landed on Taxiway M. The maneuver began from the altitude of 2,800 ft at the final approach fix about 5.4 nm (10 km) from the 27L threshold.

Source: U.S. National Transportation Safety Board

Figure 1

problems, the system did not provide controllers with accurate intensity information for all preset lighting, and controllers were unaware of these discrepancies, the NTSB said.

"The edge and centerline lights for Runway 27R were set to step 1 [the correct minimum intensity, as the FAA specifies during nighttime visibility of more than 5 mi (8 km)] at the time of the incident, the edge lights for Taxiway M were set to the maximum settings [that is, step 3 on the east and west ends and step 5 in the mid-section instead of the FAA-specified step 1 for all edge lights], and Taxiway M centerline lights were set to step 2 [instead of the FAA-specified step 1 for the east and west ends and step 3 for the mid-section]."[1,2]

An airport maintenance supervisor noted that management had directed that the nighttime appearance of the north and south sides of the airport be uniform, and also had increased the centerline preset for Taxiway M to step 2 "to compensate for the difference in the output level of the LED and the incandescent lighting," the NTSB said.

Notably, one observer in the tower during the lighting-evaluation flight also saw this, saying, "The taxiway edge lights for the entire airport were much brighter than the runway lights, which made it a challenge in identifying the runway lights among the taxiway lights."

The NTSB's latest safety recommendations call for advisory circular (AC) revisions clarifying that airport operators should inform air traffic managers of such changes. The NTSB also proposed amending FAA Order 7210.3, "Facility Operation and Administration," to direct that "at airports with air traffic control towers equipped with airport lighting control panels that do not provide direct indication of airport lighting intensities, the air traffic manager annually reviews and compares, with the airport operator, the preset selection settings configured in the tower lighting control system to verify that they comply with FAA requirements."

FAA officials in 2009 told the NTSB that a forthcoming AC restricting mixing of LED and incandescent lighting was not prompted by a safety concern but rather by "pilot perception of the lights being different [in brightness and color]" and pilots' preference for consistent lights on the same movement surface although "LEDs only appear brighter in clear visibility due to chromaticity and saturated color." New limitations on mixing light source technologies were addressed with the September 2010 release of AC 150/5340-30E, "Design and Installation Details for Airport Visual Aids."

ATC Surveillance

The latest recommendations also propose that the FAA study and, if feasible, enhance ASDE-X (*ASW*, 9/08, p. 46). The NTSB already has obtained a preliminary technical review by the manufacturer. "Sensis [Corp.] found that software modifications could possibly enable ASDE-X to detect a potential taxiway landing at ATL at a distance of up to 0.75 m [1.2 km] from the runway threshold and 15 seconds from touchdown and provide an alert to controllers," the agency said. "A more thorough evaluation of the system should be conducted to determine whether ASDE-X logic can be modified systemwide to detect … improper operations such as landings on taxiways."

Despite good prevailing visibility during the incident, the controller and supervisor who were observing the arrival did not recognize the widebody passenger jet's misalignment because of the 45-degree viewing angle from the tower to the threshold of Runway 27R and the east end of Taxiway M, and the airplane lights intermittently blending with city lights. The controller told investigators that the distance between this runway and taxiway was a factor.

"He also stated that, as [the aircraft] approached Runway 27R for landing, he checked the ASDE-X display and saw that the system's safety logic bars were raised, which indicated to him that the aircraft was lined up to land on Runway 27R," the NTSB said. "In addition, no alerts were being emitted by the ASDE-X, which indicated to the controller that the runway was clear of other traffic and that it was safe to land. … The ASDE-X's verification of the aircraft's position relative to the runway, combined with the visual uncertainty, provided a false confidence that the aircraft was lined up for Runway 27R."

Human Factors

Lack of information from ATC to the crew about some of the risk factors involved in landing on Runway 27R was cited by the NTSB and by a written submission by the Air Line Pilots Association, International (ALPA).

The flight crewmembers, who had briefed the other approaches that they had been assigned or that they had expected, lacked sufficient time to brief the approach to Runway 27R. They were "not aware that the approach light system [which was turned off to accommodate airport construction] and the ILS [which normally was not turned on except when rare arrivals were at or outside the outer marker] were not available to aid in identifying that runway," the NTSB said. After this incident, ATL tower management implemented a standard operating procedure for local controllers to notify flight crews about the status of the approach light system and ILS.

During interactions with the local controller, however, the incident flight crew did not advise ATC that the airfield lighting was a problem or express any reluctance to side-step from Runway 27L, although this runway had the advantages of a full complement of approach and runway lighting, including runway end identifier lights and touchdown zone lighting, and a functioning ILS already set up as the backup to visual navigation.

"At approximately 0603, the local controller asked [the flight crew,] 'Do you have Runway 27R in sight, and would you like to land on it?' the NTSB said. "[The crew] responded, '27R is in sight and we would love to land on it.'" The controller told investigators that he offered the side-step because "the aircraft had a medical emergency on board and Runway 27R would eliminate excessive taxi time because it is closer to the ramp area." Only a few side-steps were conducted per day, and medical emergencies were a common reason.

ALPA's interpretation of the incident also cited failures to communicate about the difficulties actually occurring. "While air traffic controllers at ATL were trying to provide assistance to the inbound emergency aircraft, their actions created more workload for the flight crew," ALPA said. "Controllers should be aware of the briefings that have to take place with each runway change." The pilot union also recommended that the FAA's ATC policy order instruct controllers to "provide pilots during last-minute runway changes … any NOTAMs [notices to airmen] relevant to that runway (e.g., lighting and navaid [navigation aid] out of service)."

Notes

1. The FAA's only exceptions to standard settings for airfield lighting are situations in which an ATC facility directive has specified other settings or times to meet local conditions, a pilot has requested different settings, or a controller deems different settings to be necessary and those settings are not contrary to pilot request.
2. On a three-step system, the intensity is 100, 30 or 10 percent of the maximum 6.6 amps. On a five-step system, the intensity options are 100, 80, 60, 40 and 20 percent of the maximum 6.6 amps.

© IWS Predictive Technologies

BY WAYNE ROSENKRANS

Vibration monitoring preempts emission of smoke and burning odors by airplane cooling fans.

Great Shakes

Pilots confronting smoke and burning odor (SBO), a frequent reason for aircraft diversions, gain a decision-making advantage if electric cooling fans can be ruled out as the source, a U.S. manufacturer of cooling fan monitors has concluded. The advantage derives from vibration-sensing technology introduced about eight years ago to automatically detect symptoms of incipient fan failure and shut down the fan to prevent an SBO event in the first place, says Joseph Barclay, president and CEO of IWS Predictive Technologies.

Measuring temperature — the long-established method of protecting fans from a variety of hazardous conditions — has not proved effective in detecting the worn, rough, inadequately lubricated or "dry" fan impeller bearings responsible for a high proportion of all SBO events reported by airlines (Figure 1), Barclay said. His company basically adds a new type of predictive sensor that supplements conventional means of protecting the fans with thermal sensor–relay switches embedded in motor windings.

The typical cooling fan has a rotating impeller with bearings, rotating blades and blade-tip design that will allow interference between the blade tips and fan housing/frame if the condition of bearings deteriorates sufficiently. Company documents summarize the root cause: "Fan bearings fail often as a result of lubricant loss from high stress or high temperature conditions. Ultimately, this can result in bearing cage failure. Cage failure allows unbalanced rotation of the fan, causing fan blade tips or rotors to rub against the fan fixed assemblies [housing/frame]. This occurs at high speeds — some fans rotate in excess of 12,000 rpm — allowing friction to produce smoke and odor." The fan continuously feeds smoke/odor into the cabin or flight deck without a failure warning or indication of cause to the flight crew.

The IWS Predictive Technologies solution requires mounting a vibration monitoring unit (VMU) on the top or

The blue vibration monitoring unit includes an accelerometer and proprietary algorithms to analyze fan vibration signatures, balance and other parameters.

side of the fan housing using a bracket, vibration-transmitting feet and band-type clamps, and external cables for power and communication with the aircraft environmental control system. A VMU measures about 2 by 2 by 5 in (5 by 5 by 13 cm), and the largest eligible aircraft have eight or nine cooling fans.

The applicable supplemental type certificates (STCs) today allow VMU integration with specific types of cooling fans aboard the Boeing 747-400, 757-200/300, 767-200/300/400 and 777-200/300 series. They are fitted, per regulator approvals, to fans used for avionics equipment supply and exhaust; upper/lower cabin air recirculation; gasper; galley chiller boost/exhaust; and crew rest area ventilation. The company's first application for Airbus-related STCs, currently in the final approval stages, is expected to allow VMUs for avionics fans on the A318/A319/A320/A321 aircraft series.

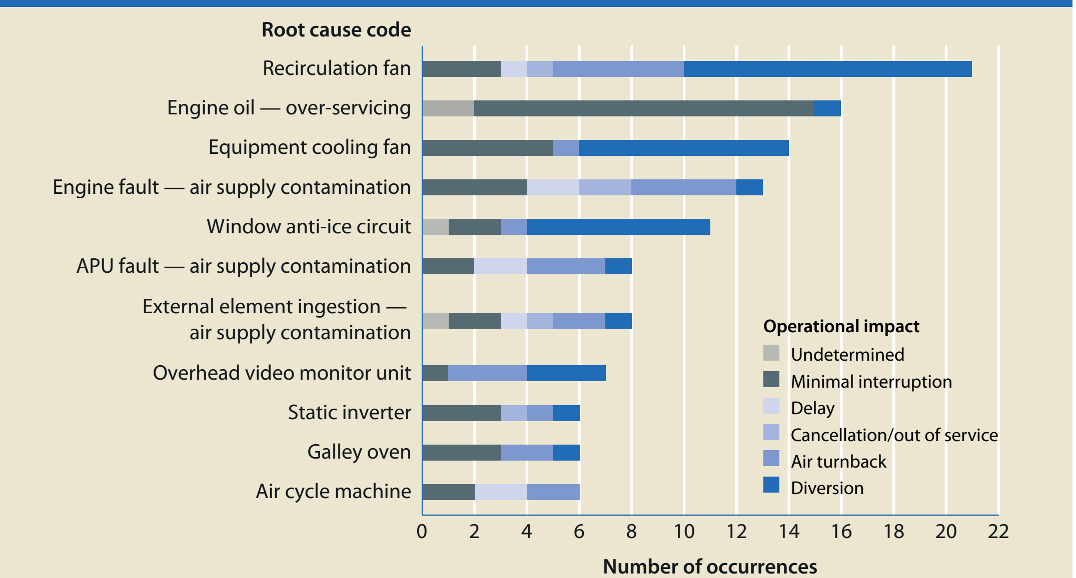
As of March 2011, 12 airlines operate airplanes equipped with about 3,500 VMUs. "Before VMUs were added, one of our customers averaged one SBO event every 12,000 flights from fans," Barclay said. "Since they began installing these monitors in 2003, we know that among the equipped aircraft, their equipped fans have completed more than 1 million flights without a single SBO event."

He therefore expects flight crews to rely on this technology to rule out their VMU-equipped cooling fans as a smoke source as part of making timely decisions. "The flight crew can know 100 percent that the SBO is not a fan-induced event," he said. "Smoke from the fan itself is harmless, but when the flight crew is flying an aircraft without VMUs and does not know where the smoke/burning odor is coming from, they are left trying to troubleshoot the system" — ideally following a checklist that conforms to the latest industrywide consensus on pilot responses to smoke/fire/fumes.

VMU logic also can identify some safety-critical failures at the aircraft system level, revealing information likely to be missed by routine maintenance checks, Barclay said. The worst-case scenario is a malfunctioning fan that overheats in flight but continues running until a "catastrophic, critical meltdown-type condition" and an in-flight fire, he said. Diagnostics provided by the VMU after fan shutdowns also help ensure that the unit's programmed relays function properly to preclude unwarranted fan shutdowns.

To read an enhanced version of this story, go to <flightsafety.org/aerosafety-world-magazine/march-2011/great-shakes>.

Smoke and Burning Odor Events, Boeing 757, July 2004–August 2008



APU = auxiliary power unit

Note: Since 2004, Boeing Commercial Airplanes has studied events in which "human senses detect a condition inside the pressurized area of an airplane that may result in a conclusion that there is a potentially dangerous ignition source or atmospheric contamination present that needs immediate corrective action." Human detections of automated alarms were excluded, and "airplane on ground" was not among operational impacts. These study results are for one airplane model.

Reprinted from *AERO* magazine courtesy of The Boeing Company

Figure 1

BY RICK DARBY

Business Jet Paradox

Over a 10-year period, U.K. operators had the highest reportable accident rate but the lowest serious incident rate.

During 2000–2009, business jets had the highest reportable accident rate and fatal accident rate among all large airplanes used in public transport in the United Kingdom.[1] However, the trend has turned around in recent years, with the reportable accident rate for business jets lower than those for otherwise-classified jets and turboprops in the three-year subset ending in 2009. The data are reported by the U.K. Civil Aviation Authority (CAA) in a comprehensive study of the 10-year period.[2]

A total of 113 reportable accidents occurred, the report says. In descending order of percentage of accidents, they were categorized as "ramp incident" — about 35 percent — and "abnormal runway contact/runway excursion" — slightly less than 25 percent, followed by "aircraft technical malfunction/failure," "loss of control," "ground conflict including runway incursion," "other" and "in-flight fire/smoke/fumes."

"Three accidents involved fatalities to aircraft occupants, with a total of five fatalities," the report says. "One accident involved a third-party fatality." The data included 15 serious injuries and 44 minor injuries.

The reportable accident rate for all these aircraft classes during the study period was 9.8 per million flights, with a fatal accident rate of 0.3 per million flights (Table 1).[3] Three-year moving averages show a downward trend for both rates, with the reportable accident rate at its lowest for the subset of years ending in 2009.[4]

Business jets during the study period had a reportable accident rate of 19.4 per million flights, nearly double that for all large airplane classes. The business jet fatal accident rate of 9.7 per million flights was about 32 times the 0.3 rate for all large airplane classes.

Yet, looking at reportable accident three-year moving averages for jets, turboprops and business jets, a different picture emerges (Figure 1). All three showed a trend of declining rates, but the most prominent was business jets. For the subset years ending in 2007, 2008 and 2009, the business jet rate improved more than the other classes. For

U.K. Reportable and Fatal Accident Rates, by Aircraft Class, 2000–2009

Class of aircraft	Reportable accident rate (per million flights)	Fatal accident rate (per million flights)	Reportable accident rate (per million hours)	Fatal accident rate (per million hours)
Business Jet	19.4	9.7	14.1	7.1
Jet	9.1	0.0	3.4	0.0
Piston	0.0	0.0	0.0	0.0
Turboprop	15.5	1.0	16.0	1.1
All classes of aircraft	9.8	0.3	4.2	0.1

Note: Rates are for airplanes in public transport with a maximum total weight greater than 5,700 kg/12,500 lb.

Source: U.K. Civil Aviation Authority

Table 1

the subset years ending in 2009, the fatal accident rate was also at its lowest in the study period.

The 2000–2009 period also included 179 serious incidents, of which "aircraft technical failure/malfunction" was the most common type, followed by "in-flight fire/smoke/fumes."[5] In contrast to the accidents, business jets had the lowest serious incident rate — 9.7 per million flights — of the three airplane classes (Table 2). The comparable rate for jets was 14.9, for turboprops 20.1, with the overall rate for all classes 15.7.

As with fatal accident and reportable accident rates, the serious incident rate for business jets decreased in the latter part of the study period and was at its lowest for the three-year subsets ending in 2007 through 2009 (Figure 2).

The study examined data for U.K.-registered or -operated helicopters in public transport operations from 2000 to 2009.

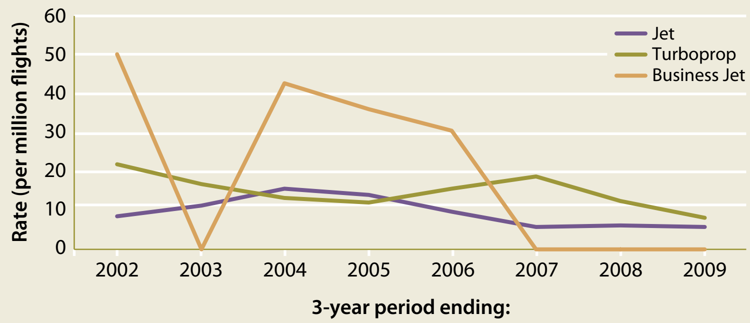
"The reportable accident rate was 8.3 per million flights and the fatal accident rate was 1.1 per million flights," the report says. There were 22 reportable accidents and three fatal accidents, with a toll of 34 fatalities.

The CAA divided helicopter public transport into three categories for analysis: "emergency services," "offshore" and "other." Emergency services operations comprise emergency medical services, police support, and search and rescue. The offshore category consists of passenger and cargo flights to oil and gas extraction or drilling platforms in the North Sea or Irish Sea. "The 'other' category comprises land-based passenger and cargo operations, but is predominantly passenger flights," the report says. Helicopters involved in the "other" operations had no fatal accidents and one reportable accident in the 2000–2009 period.

Based on the three-year moving average, the fatal accident rate remained fairly steady in the 2000–2009 span (Figure 3, p. 50). Reportable accident averages in the same time frame varied more, reaching a peak with the subset ending in 2002 and a low with the subset ending in 2005.

The trend for offshore helicopter fatal and reportable accident rates also bottomed out in the subset ending in 2005 (Figure 4, p. 50). For

Trends in U.K. Reportable Accidents, Three-Year Moving Averages, by Aircraft Class



Note: Rates are for airplanes in public transport with a maximum total weight greater than 5,700 kg/12,500 lb.

Source: U.K. Civil Aviation Authority

Figure 1

U.K. Serious Incident Rates, by Aircraft Class, 2000–2009

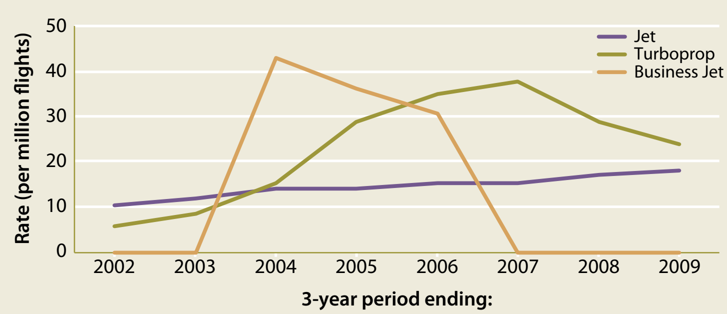
Class of aircraft	Serious incident rate (per million flights)	Serious incident rate (per million hours)
Jet	14.9	5.7
Turboprop	20.1	20.8
Business Jet	9.7	7.1
All classes of aircraft	15.7	6.7

Note: Rates are for airplanes in public transport with a maximum total weight greater than 5,700 kg/12,500 lb.

Source: U.K. Civil Aviation Authority

Table 2

Trends in U.K. Serious Incidents, Three-Year Moving Averages, by Aircraft Class



Note: Rates are for airplanes in public transport with a maximum total weight greater than 5,700 kg/12,500 lb.

Source: U.K. Civil Aviation Authority

Figure 2

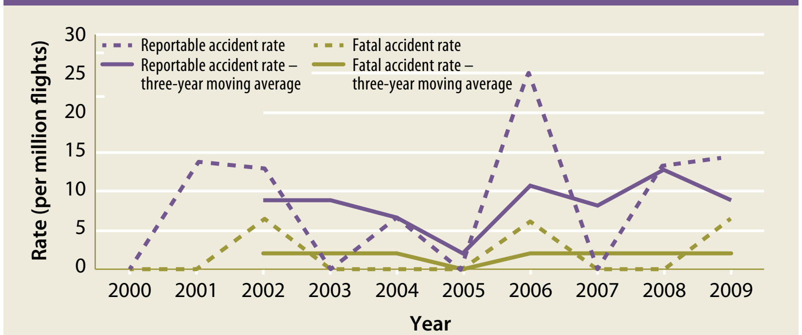
U.K. Reportable and Fatal Accident Rates, Helicopters, 2000–2009

Note: Data are for all U.K. public transport helicopters.

Source: U.K. Civil Aviation Authority

Figure 3

U.K. Reportable and Fatal Accident Rates, Offshore Helicopters, 2000–2009

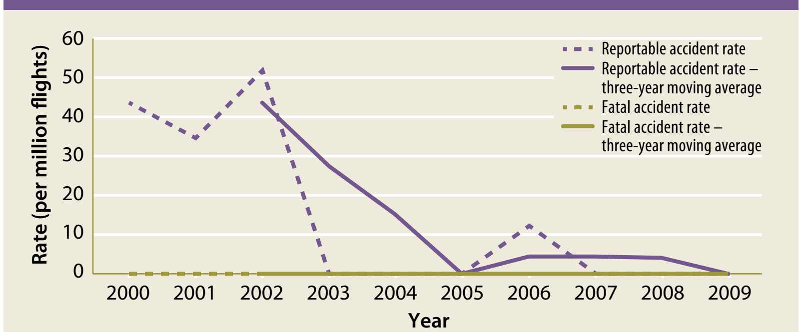


Note: Data are for all U.K. public transport offshore helicopters.

Source: U.K. Civil Aviation Authority

Figure 4

U.K. Reportable and Fatal Accident Rates, Emergency Services Helicopters, 2000–2009



Note: Data are for all U.K. public transport emergency services helicopters.

Source: U.K. Civil Aviation Authority

Figure 5

emergency services helicopters, the three-year moving average for reportable accidents decreased sharply from the subset ending in 2002 to the subset ending in 2005, and again bottomed out in the subset ending in 2009 (Figure 5). There were no emergency services operations fatal accidents.

For 2000–2009, the reportable accident rate for emergency services helicopters was 11.3 per million flights, 36 percent above the 8.3 for all helicopters studied. At 8.5 reportable accidents per million flights, the offshore helicopter category, with a fatal accident rate of 2.0 per million flights, also exceeded the rate for all helicopters studied.

U.K. public transport helicopters were involved in 12 serious incidents in the 10-year period, all but one of which involved twin-turbine helicopters.

The study considered data related to the safety of U.K. airspace and aerodromes, regardless of the country of registration. "ATC [air traffic control] occurrences" include runway incursions, altitude deviations, loss of separation, airspace infringements, ATC engineering problems and communication difficulties. "The involvement of ATC in an occurrence does not imply that ATC were at fault or even the cause of the occurrence," the report says.

In U.K. airspace during the study period, there were 401 high-severity ATC occurrences, representing 1.6 percent of all ATC occurrences.[6] Of those high-severity ATC occurrences, 82 percent were in uncontrolled airspace, 13 percent in controlled airspace and the others in airspace whose type was unknown.

"Airspace infringement," "altitude deviation" and "loss of separation" were the most frequent types of ATC occurrence reported (Figure 6).

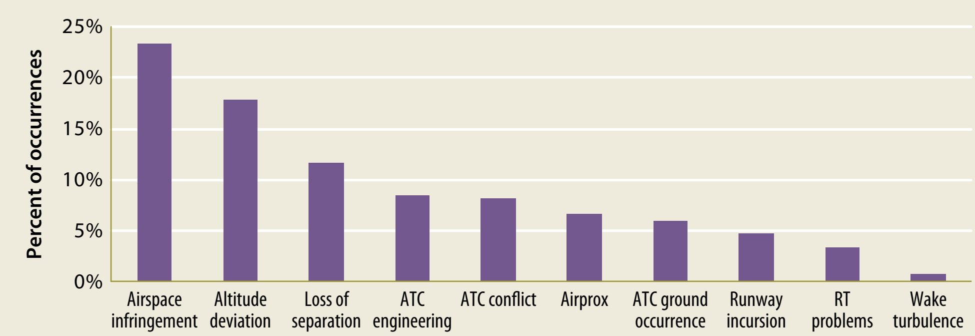
The study examined occurrences at U.K.-licensed aerodromes and involved civil aircraft. Such occurrences, the report says, may involve "an aerodrome's infrastructure, or personnel working at the aerodrome … ." Security breaches are excluded except for "people or non-airport vehicles entering an aerodrome unescorted," which can present a safety hazard.

Between 2000 and 2006, there were about 6,400 aerodrome occurrences. Their three-year moving average climbed steadily after 2002. Among the occurrences were 48 graded as high-severity, for which the three-year moving average bottomed out in 2006 (Figure 7).

"Ramp incidents" accounted for 33 percent of aerodrome occurrences, followed by "loading errors" at 14 percent and "runway obstruction/damage," also at 14 percent.

Aircraft registered in or operated by countries outside the U.K. were involved in 199 reportable accidents in 2000–2008, including 21 fatal accidents resulting in 44 fatalities, the report says. About 22 percent involved public transport aircraft. No fatal accidents involving non-U.K.-registered public transport aircraft in U.K. airspace occurred during the study period, although there was one large-aircraft fatal accident involving a privately operated Bombardier CL-600.

U.K. Air Traffic Control Occurrences, by Type, 2000–2009



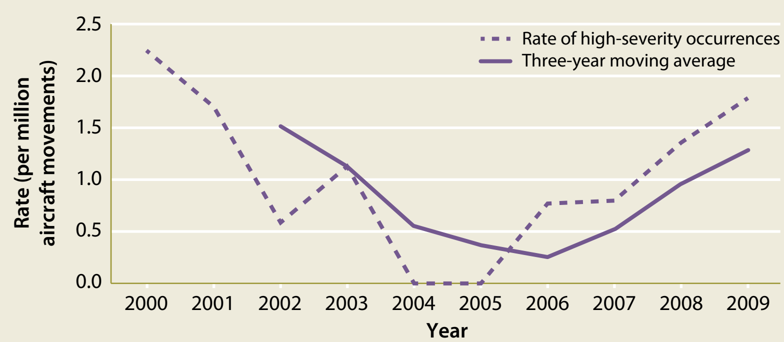
ATC = air traffic control; RT = radiotelephony

Note: Occurrences are derived from the Mandatory Occurrence Reporting Scheme database. Categories can overlap.

Source: U.K. Civil Aviation Authority

Figure 6

Rate of High-Severity Occurrences, U.K. Licensed Aerodromes, 2000–2009



Note: Occurrences are derived from the Mandatory Occurrence Reporting Scheme database.

Source: U.K. Civil Aviation Authority

Figure 7

Notes

1. The CAA's criterion for a reportable accident is derived from the definition of "accident" in International Civil Aviation Organization Annex 13, *Investigation of Air Accidents and Incidents*. The data include U.K.-registered or -operated public transport aircraft both in the U.K. and elsewhere. "Public transport" includes operations involving passenger carrying, cargo, ambulance, police support or search and rescue. Large airplanes are those with a maximum total weight of more than 5,700 kg/12,500 lb.

2. "UK Safety Performance, Volume 1." CAP 800, January 2011. Available via the Internet at <www.caa.co.uk/application.aspx?catid=33&pagetype=65&appid=11&mode=detail&id=4410>.

3. Events are classified as reportable accidents and serious incidents by the U.K. Air Accidents Investigation Branch, independently of the CAA.

4. The moving average is a line connecting the averages of subsets within a full data set to indicate a trend rather than shorter-term fluctuations.

5. A "serious incident" is defined as "an incident involving circumstances indicating that an accident nearly occurred."

6. The CAA grades severity of occurrences on a scale from A, high, to E, non-significant. ATC occurrence severity depends on factors such as the proximity of the aircraft involved and the ability of the pilot or controller to correct the situation. Occurrences are considered to be high severity if they have been assigned an A or B grade.

Cracking the Microburst Code

Meteorology confronts a mysterious threat to flight safety.

BY RICK DARBY

BOOKS

From 'Adverse Winds' to Microbursts

Warnings: The True Story of How Science Tamed the Weather

Smith, Mike. Austin, Texas, U.S.: Greenleaf Book Group Press, 2010. 304 pp. Photographs.

Mark Twain's quip that everyone talks about the weather but no one does anything about it has been made obsolete by today's meteorology, to aviation safety's great benefit.

Mike Smith, himself a meteorologist, has been involved for most of his career with measuring and forecasting extreme weather to enhance safety. Despite minuscule financing compared with that for cancer research, heart disease research and traffic safety innovations, meteorology has resulted in "a far more impressive reduction of deaths," Smith says.

The annual death rate from tornadoes in the United States has decreased from three per million people in the 1920s to 0.068 per million in 2006 through 2009, he says. Weather science's influence on aviation safety is also significant.

"From 1964 to 1985, a number of microburst-related plane crashes in the United States killed hundreds of people at a time," he says. "Today, this type of fatal airline accident has practically been eliminated. From 1986 to 2008, the number of microburst fatalities in the United States was 37, a decrease of 93 percent, in spite of a near doubling of airline flights during this period."

But the path to prediction and avoidance of microbursts was anything but smooth.

Smith credits meteorologist Ted Fujita with pioneering many of the methods used today in storm analysis and prediction.

"Without Fujita's techniques, increasing our knowledge of thunderstorms and similar small-size meteorological events during the 1950s, 1960s, 1970s and 1980s would have been nearly impossible," Smith says. "He had a creative perspective and a mind that viewed the world in four dimensions, the north/south dimension, the east/west dimension, vertical dimension (altitude) and time. … To perform his analysis, Fujita almost single-handedly created the art of meteorological photogrammetry [measuring by photography]. He triangulated the photographs from different locations in order to track the evolution of the storm's features."

Smith cites, as an example of the prevailing attitude in aviation at the time, the accident involving Eastern Air Lines [EA] Flight 66 at John F. Kennedy International Airport (JFK), New York, in June 1975:

"Reports to the JFK control tower from an aircraft awaiting takeoff that it was being buffeted by the storm's high winds were disregarded by the air traffic controllers and, thus, not relayed to the aircraft on approach. Another airplane landing ahead of EA 66 barely avoided crashing. The flight crew of EA 66 knew there was bad weather ahead — it was visible on their on-board radar — but pressed on anyway. One hundred and twelve people were killed."

The U.S. National Transportation Safety Board (NTSB) determined the probable cause to be "the aircraft's encounter with adverse winds associated with a very strong thunderstorm located astride the ILS [instrument landing system] localizer course, which resulted in a high descent rate into the non-frangible approach light towers." Smith comments, "To most people in aviation, the NTSB is the final word, and the NTSB believed the cause of the accident to be 'adverse winds.' And it was — sort of."

But the probable cause was not the sort of adverse winds the NTSB had in mind, Smith says. Fujita, called in to investigate the Flight 66 crash, "conducted a detailed study of the 11 aircraft that landed safely ahead of EA 66. He studied the weather, the radar and flight paths, and he talked with the surviving crews."

That led to a new and unorthodox theory, described in a 1977 paper by Fujita and Horace Byers, describing a previously unknown weather phenomenon they called a downburst — "a rapidly sinking column of air that originated in a thunderstorm and then spread out, and accelerated when it reached the ground," Smith says. "As the air spread out, it could reach speeds of 70 mph [113 kph] or more. A pilot flying through the sinking air, with its rapid change in wind speeds and directions, would be severely challenged to keep control of the plane."

Other meteorologists were unconvinced or expressed outright disbelief. No one had seen or recorded such a downburst. Fujita persevered in his research and identified "a smaller, more intense form of downburst he named a 'microburst.' Yet even as Fujita's body of evidence grew, many in both the meteorological and aviation communities remained deeply skeptical."

'Yet even as Fujita's body of evidence grew, many in both the meteorological and aviation communities remained deeply skeptical.'

Smith himself, along with a companion in "storm chasing," helped provide additional evidence in the form of what he describes as "the first microburst ever photographed," near Wichita, Kansas, U.S. The photo is included in the book.

"Downbursts were further confirmed by Project NIMROD (Northern Illinois Meteorological Research on Downbursts), conducted in the Chicago area around O'Hare International Airport," Smith says.

The Flight 66 accident helped motivate the U.S. Federal Aviation Administration (FAA) to begin installing the low level wind shear alert system (LLWAS) at U.S. airports.

The issue of downbursts and microbursts received renewed attention 10 years later with the fatal accident involving Delta Air Lines Flight 191 at Dallas/Fort Worth International Airport in August 1985.

Flight 191, a Lockheed L-1011, was on final approach. The cockpit voice recorder recorded the first officer, the pilot flying, saying, "Stuff is moving in." The captain, the monitoring pilot, radioed to the tower, "Delta One-Ninety-One heavy, out here in the rain. Feels good."

Smith says, "Now under the cloud base, the crew could see what appeared to be a light rain shower between them and the runway. Other planes were flying through the shower and landing normally. But once Delta 191 entered the rain shower, all hell broke loose." Soon the ground-proximity warning system was generating its "whoop whoop pull up" automated voice message. The captain called for a go-around, but it was too late to avert the accident. The aircraft touched down a mile short of the runway, bounced, touched down three more times, skidded, and struck a large water storage tank. The jet fuel ignited.

"The microburst, a phenomenon that many meteorologists said did not exist, had claimed another commercial jetliner and 137 lives," says Smith. He notes that airport weather instruments measured winds gusting to 100 mph (161 kph) at the eastern runways, while the west side runways were dry, with partial sunshine.

Once again, Fujita was invited to investigate the accident. Smith says, "Fujita himself flew over the airport, surveyed the on-site instrumentation from a cherry picker [boom lift], photographed the exact location of the anemometer [wind speed sensor] and wind vane, and collected every scrap of data he could. With Fujita, one never knew which type of data might turn out to be crucial.

'Almost instantly, the plane went from being too high to nose-diving toward the ground.'

"In addition to the data collected by the instrumentation at the airport, Fujita collected weather satellite imagery, radar data, eyewitness reports, and data from the cockpit voice recorder and flight data recorder. Once he had all of the data, he began to weave it into a coherent picture."

As Smith describes it, the picture looked like this:

"As the L-1011 neared the north end of the runway, it gradually slowed and descended along the glideslope. When the plane initially encountered the microburst, the leading edge of the wind struck the aircraft. … Delta 191 encountered high winds and rising air. This increased the speed of the aircraft and lifted it above the descending trajectory it was supposed to follow.

"This is where the insidious nature of the microburst presents itself. Almost instantly, the plane went from being too high to nose-diving toward the ground. As it reached the south half of the microburst, the wind direction shifted from out of the south (a headwind) to the north (a tailwind), causing an instant drop in airspeed and even more sink."

The book devotes a chapter about the controversy — including a lawsuit brought by the captain's widow against the FAA and the National Weather Service (NWS) — to why Flight 191 was flying an approach in a thunderstorm at all when "just about everyone on the east side of the airport — traffic controllers, pilots preparing to take off, the crew of Delta 191 and the airport weather observer — had all seen the storm."

The NWS was legally charged with the responsibility for providing weather information to the FAA, which in turn passed it on to controllers and pilots. Smith says that the hand-off worked better in theory than in practice at the time.

National weather radar charts were sent from Kansas City, Missouri, but were not received by airports or air traffic controllers until nearly an hour after the radar observations had been made, a delay that can be like a century for aviation purposes. Local NWS radar facilities were often located not only outside airports, but outside the cities they served, to provide better advance warning of approaching storms and reduce clutter on the radar screens. The NWS radar for the Dallas–Fort Worth area was in Stephenville, about 50 mi (80 km) from the airport.

"The data from that radar [were] fed to two NWS facilities in Fort Worth: the Fort Worth forecast office, located in the federal building downtown, and the NWS Center Weather Service Unit (CWSU) inside the FAA's air route traffic control center near the Dallas/Fort Worth airport," Smith says.

Among other problems, "the NWS radar technician in Stephenville was at dinner, away from the radar console, when the microburst-producing thunderstorm developed just north of Dallas/Fort Worth International [Airport]. Right after he finished eating, he helped launch the evening weather balloon, leaving the radar still unmanned. He did not return to the radar until 6:00 p.m. At 6:04, two minutes before the crash, he telephoned the Fort Worth downtown office to inform it of the storm near the airport. The 6:04 p.m. call came too late to allow a warning to have been issued because … it took the NWS office six to 10 minutes to prepare an aviation weather warning for the Dallas/Fort Worth control tower."

In short, "there was … no real mechanism to *instantly* convey a threat directly to aircraft," Smith says. "This faulty system is one that continues, to some extent, even today."

But progress has been made in mitigating the danger from microbursts and wind shear. "The NWS, recognizing that the split radar/warning responsibility contributed to some of the worst failures in its history, changed its entire forecast structure in the 1990s so that radar data and warning responsibility were co-located 100 percent of the time," Smith says. "Much follow-on work based around Fujita's research began in order to train pilots how to avoid microbursts, and if they were to inadvertently fly into microburst wind shear, how to escape it (if possible)."

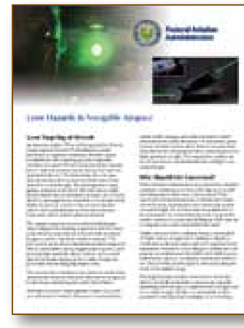
The FAA contracted with an industry advisory group to create the *Windshear Training Aid* and established wind shear training requirements for U.S. Federal Aviation Regulations Part 121 and Part 135 operators.

The last crash attributed to a microburst was U.S. Airways Flight 1016 at Charlotte, North Carolina, U.S., in July 1994. Smith says, "Given the ever-increasing number of people and planes in the air, the number of lives saved due to Fujita's pioneering research that eventually led to implementation of microburst avoidance procedures in the United States is well over 2,000, not to mention the hundreds of millions of dollars of aircraft losses prevented."

REPORTS

Look Away

Laser Hazards in Navigable Airspace



U.S. Federal Aviation Administration (FAA) Civil Aerospace Medical Institute (CAMI). AM-400-10/3. Available from CAMI, Shipping Clerk, AAM-400, P.O. Box 25082, Oklahoma City, OK 73125 U.S.A. Also available via the Internet at <www.faa.gov/pilots/safety/pilotsafetybrochures/media/laser_hazards_web.pdf>. 2010.

The FAA has recorded more than 3,000 reports of aircraft targeted by laser beams. While aeromedical researchers work to understand the physiological aspects of laser beams on vision (*ASW*, 12/10–1/11, p. 50), CAMI has issued this brochure to explain the nature of the threat to pilots and recommend actions to minimize the effects of a laser beam striking the cockpit.

Among the recommendations are these:

- "When operating in a known or suspected laser environment, the non-flying pilot should be prepared to take control of the aircraft";
- "Check aircraft configuration and (if available) consider engaging the autopilot to maintain the established flight path";
- "Use the fuselage of the aircraft to block the laser beam by climbing or turning away";
- "Inform Air Traffic Control of the situation. Include location/direction of the beam, your present location, altitude, etc."; and,
- "Turn up the cockpit lights to minimize any further illumination effects."

Faulty Altimeter Spurs Near Collision

An Airbus nearly overran a wayward Pilatus.

BY MARK LACAGNINA

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

JETS

Leak Affected Altitude Indication

Airbus A318, Pilatus PC-12. No damage. No injuries.

The A318 pilots apparently were head down, preparing for their arrival at Bordeaux, France, the morning of June 2, 2010, when they felt a strange motion — similar to slow roll oscillations of about five degrees — that lasted for about 5 seconds. "Seeing nothing abnormal on their primary flight displays, they carried on with the preparation for the arrival," said the report by the French Bureau d'Enquêtes et d'Analyses.

When the oscillations began again, the copilot suspected wake turbulence and looked through the windshield. "He was then in visual contact with an airplane that was very close, slightly above and to the right," the report said. "He disconnected the autopilot and made a pitch-down input to the left, keeping in constant visual contact with the other airplane while passing."

The Airbus descended about 200 ft during the avoidance maneuver, and the copilot checked his traffic-alert and collision avoidance system (TCAS) display to ensure that there were no other aircraft below. "He saw a white diamond symbol on the TCAS, indicating an airplane [was] 2,000 feet below, without realizing at that time that it was in fact the airplane that he had just passed," the report said.

The A318 had overtaken and had passed slightly below a Pilatus PC-12, which also was on a southwesterly heading. The minimum separation between the two airplanes could not be determined from recorded air traffic control (ATC) radar data, but "the crews estimated that the separation was between 15 and 30 m [49 and 98 ft] horizontally and about 100 ft vertically," the report said.

The near collision occurred at Flight Level (FL) 290 (approximately 29,000 ft) in day visual meteorological conditions (VMC) near Aurillac, France. The airspeed difference between the two airplanes was about 170 kt.

The Pilatus was on a ferry flight to San Sebastian, Spain, from Buochs, Switzerland, where an annual maintenance check had been performed. Although the airplane was certified for single-pilot operation, it had two sets of flight instruments. The pilot was flying from the left seat and was accompanied by a passenger who held a commercial pilot license.

They had noticed during departure from Buochs that there was a slight variation in the indications on the two altimeters. "A return to the departure aerodrome was considered, but the meteorological conditions at that field were mediocre," the report said. "In addition, the aerodrome was in a mountainous region … and a return to the field was risky since the crew didn't know which altimeter to depend on. It was also decided to continue the flight because the forecast meteorological conditions in cruise and at the destination were very good."

The difference between the altimeter indications increased as the airplane climbed to the assigned cruise altitude, FL 270. The pilot and the passenger-pilot also noticed an increasing difference in the readings on the two airspeed indicators. The pilot leveled the airplane when the no. 1 altimeter, on his side of the panel, indicated FL 270; the no. 2 altimeter indicated FL 290. The airspeed indications were 90 kt and 160 kt, respectively.

The pilot reported the altimeter discrepancy to ATC and asked the controller to confirm the PC-12's altitude. The controller replied that the altitude indicated on his radar display — as well as on the display being used by a military ATC specialist at the same facility — was FL 270.

However, the altitudes shown on the controllers' displays corresponded with the Mode C data transmitted by the airplane's transponder, which unknowingly was receiving the erroneous air data that also were being provided to the no. 1 altimeter.

The near collision occurred about 10 minutes after the controller advised the PC-12 pilot of the altitude readout. The incident was reported to ATC by the pilots of both airplanes. The conflict had not been detected by the A318's TCAS or by the controller's short term conflict alert system because of the PC-12's erroneous Mode C data, which showed the airplane at FL 270 while the A318 was shown, correctly, at FL 290.

Realizing that the no. 1 altimeter was reading 2,000 ft low, the PC-12 pilot requested a descent to a lower altitude with less traffic and used the no. 2 altimeter and the no. 2 airspeed indicator for the remainder of the flight.

The fault was traced to a leak in a connector between the cabin differential pressure indicator and a static pressure line for the altimeter, airspeed indicator and vertical speed indicator on the left side of the panel. The leak was caused by a slightly deformed tube that flexed in flight, allowing pressurized cabin air to enter the static line. "Due to this, as soon as the cabin was pressurized, the instruments on the pilot's side indicated an altitude and a speed that were lower than they were in reality," the report said.

The static line had been disconnected and reconnected for a transponder test during the annual maintenance check. "This manipulation is made tricky due to the limited space and the presence of an electrical plug near the pipes," the report said. "At the end of this test, the static circuit is subjected to an impermeability test. In this case, the test did not reveal a leak. … No other failure of this type has been reported to the manufacturer on a fleet of more than 1,000 PC-12s in service in the world, with over 3 million flight hours."

'Severe Shake' Hurts Flight Attendants

Boeing 777-200. No damage. Two serious injuries.

Inbound from Paris, the 777 was descending through 30,600 ft, to land in Narita, Japan, when it encountered jetstream winds the morning of March 5, 2009. The rapid and substantial changes in wind direction and velocity caused the aircraft to pitch nose-down. Indicated airspeed was nearing the operating limit and the descent rate had reached 4,900 fpm when the first officer, the pilot flying, reacted by moving the thrust levers to idle and abruptly pulling back on the control column, said the report by the Japan Transport Safety Board.

The steward said that he 'strongly hit against the ceiling.'

The first officer's control input and the turbulence from the jetstream caused a "severe shake" of the aircraft, the report said. Four flight attendants in the aft galley were thrown into the air and fell on the floor. Two of the flight attendants — a purser and a steward — sustained compression fractures of vertebrae. The purser's injuries occurred when the chief purser fell on top of her. The steward said that he "strongly hit against the ceiling and then fell down on the floor on my lower back." None of the other 275 people aboard the aircraft was hurt.

The report said that the accident occurred in clear air and that there had been no forecast or pilot reports of turbulence in the area. The pilot-in-command said that the turbulence was "like a mountain wave. It was a slow movement, and there was no large up thrust." The first officer recalled two movements: "The slow and deep movement increased the speed of the aircraft, and the other movement was that the aircraft was suddenly shaken. The shake, itself, was not a strong one, but the amplitude was large."

Flaps Fail on Approach

Raytheon Premier 1. Substantial damage. One minor injury.

The aircraft had been flown from Delhi, India, to Jodhpur for a maintenance inspection on March 18, 2008. The next morning, it departed from Jodhpur for a 20-minute charter flight with five passengers to Udaipur. The flight encountered turbulence but no anomalies until the flight crew attempted to extend the flaps 10 degrees during a visual approach to Runway 26 at the Udaipur airport, said the report by the Indian Directorate General of Civil Aviation.

The flaps did not respond, and the crew received a "FLAP FAIL" message. They conducted the checklist for a no-flap landing and received clearance to land from ATC. The controller noted that the prevailing wind was from 230 degrees at 10 kt.

'The pilot decided to continue instead of making a go-around.'

The checklist for a no-flap landing requires that 20 kt be added to the normal reference approach speed of 114 kt, and the pilot had told the copilot to set the airspeed bugs to 135 kt. "However, the pilot approached with a higher speed," the report said. The aircraft was on final approach when the copilot called out an airspeed of 149 kt and the terrain awareness and warning system (TAWS) issued two "GLIDESLOPE" warnings. "The pilot decided to continue landing with the speed higher than the assigned speed instead of making a go-around," the report said.

The Premier touched down hard just short of the touchdown zone on the dry, 7,500-ft (2,286-m) runway and bounced. Rubber deposits on the runway indicated that the wheel brakes were applied heavily after the second touchdown. After rolling about 150 ft (46 m), both main landing gear tires burst — the right tire, first. The aircraft then gradually veered off the right side of the runway, about 2,200 ft (671 m) from the threshold, rolled about 90 ft (27 m) and struck the airport boundary wall. "Airport fire services immediately reached the site and rescued all persons on board," the report said. The copilot sustained minor injuries; the passengers and the pilot were not hurt.

Liftoff Into Lapwings

Boeing 737-300. Substantial damage. No injuries.

The commander, the pilot monitoring, said that just as he called "V_1" during takeoff from Runway 09 at Ireland West Airport in County Mayo the afternoon of Oct. 19, 2009, a flock of birds rose from the edge of the runway. The 737 struck the birds when the commander called "rotate."

"The commander stated that there were a few bangs on the nose of the aircraft and that the flight crew saw numerous birds going down either side of the aircraft," said the report by the Irish Air Accident Investigation Unit. The left engine was substantially damaged and the right engine sustained minor damage when they ingested some of the birds.

The vibration indications for the left engine increased as the crew continued to climb straight ahead. "The cabin crew reported unusual smells in the cabin and significant vibrations on the left side of the aircraft," the report said.

The commander reported the bird strike to ATC and diverted the flight to Shannon Airport. "The aircraft climbed to FL 160 en route to [Shannon]," the report said. "The crew kept both engines operating and made a normal approach and landing." None of the 127 passengers and five crewmembers was injured.

Several fan blades in the left engine were found bent and distorted. Two fan blades in the right engine also were found distorted, and a portion of the nacelle fan duct acoustic panel was missing. Five pieces of metal, identified as the missing acoustic panel, were found on the departure runway. The fire crew at Ireland West Airport estimated that 30 to 40 birds had been involved in the accident. The birds were identified as lapwings — wading birds that weigh 150–300 g (5–11 oz).

Four bird patrols had been conducted at Ireland West Airport the morning of the incident. No bird activity was observed during the patrols or during the departure of an A320 six minutes before the 737's departure. Thus, "a bird patrol was not deemed to be necessary prior to the incident flight," the report said. "The duty controller expressed surprise that the strike had occurred, as there had been no previous observed or reported bird activity on the aerodrome that day."

After the incident, the airport ATC manual, which had provided discretion in requesting bird patrols before the arrival or departure of scheduled or jet aircraft, was revised to require bird patrols before such operations.

Gear Damaged by Tire Chocks

Dassault Falcon 20C. Substantial damage. No injuries.

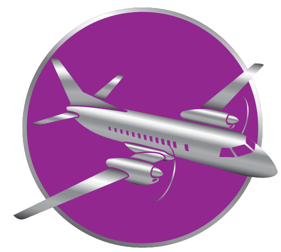
Witnesses saw one of the pilots remove a chock from the nose landing gear tire and place the chock on the ramp. The pilot, who was preparing the Falcon for a flight from Eagle, Colorado, U.S., to Chihuahua, Mexico, the afternoon of Jan. 8, 2010, did not remove the chock from the left main landing gear tire, however.

One witness heard the engines spool up to high power as the Falcon began to taxi and saw the left main tire roll over its chock and then the chock that had been removed from the nose gear tire, said the report by the U.S. National Transportation Safety Board (NTSB).

The airport manager told investigators that the left main landing gear tire burst during the takeoff roll. The captain said he thought that the right tire, not the left tire, had failed. "In addition, he stated that the malfunction occurred at the 120-kt mark, that there were no anomalies with the airplane's braking systems and that he simply could not stop on the remaining runway," the report said.

The Falcon overran the runway into deep snow, causing both main landing gear to collapse and the right wing to buckle. The five passengers and the pilots escaped injury. An examination of the airplane by a U.S. Federal Aviation Administration inspector revealed that both main tires had failed and that there was a "crease or shallow laceration that went across the tire tread on the left main landing gear tire," the report said.

TURBOPROPS



'In and Out of Some Clouds'

Rockwell 690B. Destroyed. Three fatalities.

The pilot was conducting a visual flight rules (VFR) charter flight from Tortola, British Virgin Islands, to San Juan, Puerto Rico, where his two passengers were to connect with an international airline flight the afternoon of Dec. 3, 2008. The NTSB report said that the airplane departed late from Tortola and the pilot "may have felt pressured" to expedite the flight to San Juan.

VMC, with 10 mi (16 km) visibility and a few clouds at 3,000 ft, prevailed in San Juan. As the Turbo Commander neared the airport, ATC stopped receiving its altitude readout. This likely was because the airplane was descending at a rate that the ATC radar data processing system assessed as excessive and possibly incorrect, the report said. The groundspeed readout was 250 kt.

The controller asked the pilot to report his altitude, and the pilot replied that he was descending through 3,200 ft. "Because aircraft operating in VFR flight are not required to comply with minimum instrument altitudes, aircraft receiving VFR radar services are not automatically afforded minimum safe altitude warning services except by pilot request," the report said.

The controller advised that the minimum vectoring altitude was 5,500 ft in the area and asked the pilot if he was maintaining VFR flight. The pilot replied, "We are in and out of some clouds right now." A few seconds later, the airplane struck a mountain at 2,310 ft about 14 nm (26 km) southeast of the airport. Witnesses said that the mountain was obscured by fog and rain.

Problems Plague Positioning Flight

Dornier 328-100. Minor damage. No injuries.

The pilots had been hired to ferry the aircraft from a storage facility in Dundee, Scotland, to a maintenance base in Oberpfaffenhofen, Germany, the afternoon of Sept. 23, 2009.

Maintenance had been performed in Dundee to prepare the Dornier for the ferry flight, but the aircraft had been flown only once in the past 21 months, from a storage facility in Aberdeen to Dundee, said the report by the U.K. Air Accidents Investigation Branch.

"The preflight procedures included an extensive inspection of the aircraft documentation; an external inspection, during which the commander noted that both engines' oil levels were just below full; and a ground run," the report said.

The crew did not effectively communicate their intentions in English to ATC.

Shortly after takeoff, the "RH ALT" (right alternator) warning light illuminated. The pilots had begun to conduct the corresponding checklist when the commander noticed that oil pressure in the left engine was fluctuating. "While the crew were discussing the fluctuating oil pressure, the red left engine oil pressure warning illuminated," the report said.

The crew declared an emergency and notified ATC that they were returning to Dundee. The commander then decided to shut down the left engine. The copilot was about to retard the left power lever when the commander noticed that oil pressure in the right engine was fluctuating. "The crew stopped the left-engine shutdown drills, and the commander asked the copilot to request radar vectors to the nearest suitable airfield," the report said.

Noting that Russian was the native language of both pilots, the report said that the crew did not effectively communicate their intentions in English to ATC. The copilot apparently believed that he was requesting vectors to the nearest airport when he told the controller, "We are having problems with two engines, and it's the shortest way to the field." The controller believed that he was asking for vectors to Dundee.

The pilots then spotted an airport ahead and believed that it was the one to which they were being vectored. When they reported the field in sight, the controller advised that it was RAF Leuchars and that Dundee was 10 nm (18 km) farther ahead. The controller then asked if they needed to land at RAF Leuchars. Believing that the controller was offering an alternative to the airport they had in sight, the crew replied, "Negative." The controller again advised that they were flying toward RAF Leuchars, not Dundee, and the crew replied, "Roger."

However, the airport traffic controller at RAF Leuchars saw the Dornier approaching and cleared the runway. The pilots landed the aircraft without further incident.

Examination of the engines revealed that corrosion had prevented their air-switching valves from opening. The valves control the flow of bleed air that is used to provide a pressurized supply of oil to the engine bearings. The failure of the valves to open had caused the bearing cavities to become overpressurized and engine oil to be discharged from the engines through the breather and vent systems.

Unapproved Part Cited in Gear Collapse

Beech King Air A90. Substantial damage. No injuries.

Maintenance performed on the King Air to prepare it for sale included several servicings of the left main landing gear in an attempt to prevent the shock absorber, or strut, assembly from losing pressure. "The strut was then inflated to a 6-in [15-cm] extension, which was about twice the recommended extension," the NTSB report said. "After this last inflation, the strut did not lose pressure."

The report said that, in an attempt to compress the overextended strut, the left wing tanks were refueled and the right wing tanks were left nearly empty for a maintenance test flight at

DeKalb, Illinois, U.S., the afternoon of March 2, 2010. The primary purpose of the test flight was to check throttle adjustments and engine performance.

"Upon completion of the flight, the pilot returned to the departure airport, where he attempted a landing with a left quartering tail wind and with the airplane flaps fully retracted," the report said. The left main landing gear collapsed after touchdown, and the airplane veered off the left side of the runway. The pilot and the passenger, who held pilot and mechanic certificates, escaped injury.

Examination of the airplane revealed that the strut assembly was designed for use in a Beech Queen Air and was not approved for installation on the King Air. The report said that the probable causes of the accident were "the company's improper maintenance practices and the pilot's decision to take off with an overextended landing gear strut."

PISTON AIRPLANES

Ice Factors in a Hard Landing

Cessna 402B. Substantial damage. No injuries.

The 402 encountered moderate icing conditions shortly after departing from Sioux City, Iowa, U.S., for a cargo flight to Aberdeen, South Dakota, the morning of March 10, 2009. The pilot activated the airplane's ice-protection systems and received clearance from ATC to climb to 12,000 ft, which was above the cloud tops.

"The pilot noted that the unprotected areas of the wings and windshield were still contaminated with ice when he initiated the descent into [Aberdeen]," the NTSB report said. The airport was reporting winds from 360 degrees at 22 kt, gusting to 30 kt; 1 mi (1,600 m) visibility in light snow and mist; a few clouds at 600 ft; a broken ceiling at 1,400 ft; and a 2,300-ft overcast.

"The unprotected areas of the airplane continued to accrue ice while [the pilot was] being vectored to join the instrument landing system (ILS) approach to Runway 31," the report said. "The runway was partially obscured by blowing snow due to a strong crosswind."

The windshield was covered with ice, except for a narrow section protected by a heated plate, and the pilot had difficulty aligning the 402 with the runway. The airplane crossed the threshold at 120 kt, entered a high sink rate and landed hard, damaging the right wing and engine nacelle. The pilot was not hurt.

Examination of the airplane showed that there was no appreciable ice on the protected surfaces but that 1.0 to 1.5 in (2.5 to 3.8 cm) of ice had accumulated on the unprotected surfaces. The report said that the ice accumulation and the strong, gusting crosswind were factors in the accident.

Lights Out at Alternate Airport

Piper Chieftain. No damage. No injuries.

Before departing from Mackay, Queensland, Australia, for a charter flight with five passengers to Clermont, about 240 km (130 nm) southwest, the night of Feb. 25, 2010, the pilot-in-command (PIC) filed Mackay as an alternate airport because of forecast thunderstorm activity at Clermont.

The flight crew conducted a global positioning system (GPS) approach to Clermont but were unable to land. "Having insufficient fuel for a further approach, the flight crew advised [ATC] that they were conducting a weather diversion back to Mackay," said the report by the Australian Transport Safety Bureau (ATSB).

However, visibility at Mackay had decreased to 300 m (1,000 ft), and two airliners were holding over the airport, waiting for conditions to improve. The PIC decided to divert to Proserpine, about 90 km (49 nm) north of Mackay. He asked ATC to arrange for someone to be at the airport, to ensure that the runway lights were on. The controller replied, "There is no one on the ground at Proserpine," and told the crew that the radio frequency for the pilot-controlled light system at the airport was 120.6 MHz. This frequency, however, was no longer valid; it had been changed to 126.7 MHz 10 days earlier.

The crew, who were familiar with the airport, conducted an unspecified instrument approach but were unable to activate the runway lights. The Chieftain's fuel supply was critical, and the crew maneuvered to land with reference to lights on an airport parking lot and moonlight reflecting off the wet runway. The PIC "positioned the aircraft to align with what he thought was the approximate runway centerline [while] the copilot monitored and called the aircraft's altitude," the report said. "The runway threshold marking came into view, and the PIC landed the aircraft."

HELICOPTERS

Wrench Left on Rotor Head

Eurocopter AS 350-B3. Substantial damage. No injuries.

A pilot and two maintenance technicians boarded the helicopter to perform a functional check flight following balancing of the main rotor blades in Parker, Arizona, U.S., the morning of March 16, 2010. The occupants heard a bang when main rotor speed reached 100 percent and felt vibrations as the helicopter was lifted into a hover. Believing that further blade balancing was required, the pilot landed the helicopter, the NTSB report said.

While preparing to continue their work, the mechanics could not find the wrench that they had used to secure a bolt on top of the rotor head. Examination of the helicopter revealed that the wrench had been left on the rotor head and had become dislodged during the flight, damaging a main rotor blade, the tail boom and the lower vertical stabilizer.

Winch Cable Strikes Ship's Mast

Bell 412. No damage. Two serious injuries.

The helicopter was on an emergency medical services flight to evacuate an ill crewmember from a container ship 132 km (71 nm) from Horn Island, Queensland, Australia, the afternoon of Nov. 9, 2009. The flight crew had been told that there was no suitable landing area on the ship and that they would have to use the helicopter's winch to pick up the patient from the ship's forecastle.

The pilot established a hover about 10 m (33 ft) over the forecastle, and the winch operator began to lower a rescue crew officer and a paramedic to the deck. However, the pilot then lost sight of the ship, and the helicopter began to drift backward.

"Despite assistance from the winch operator to re-establish the hover, the pilot was unable to arrest the helicopter's movement," the ATSB report said. "The winch cable became fouled on the foremast while the helicopter continued to drift rearward." The winch cable snapped, and the two crewmembers fell about 6 m (20 ft) onto the ship's deck.

The paramedic was winched aboard another helicopter about two hours later, and the patient and the rescue crew officer were transported to a hospital by a boat.

Coke Obstructs Engine Oil Passages

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

The helicopter was descending into a canyon during an air tour flight with six passengers near Peach Springs, Arizona, U.S., on March 3, 2009, when the pilot heard a loud pop and noticed that main rotor speed was decreasing. He then conducted an autorotative landing in an open area.

The NTSB report said that a bearing in the Honeywell LTS101 engine had seized because of oil starvation. The oil passages had been blocked by coke, a solid residue that remains when oil is overheated and evaporates.

In January 2009, the engine manufacturer had published a bulletin recommending that the engine be run at idle for two minutes before shutdown and then motored for 10 seconds after shutdown to prevent coke buildup.

The operator had instructed its pilots to comply with the recommended pre-shutdown procedure but not the post-shutdown procedure "due to concerns about depletion of oil in the engine oil reservoir," the report said. Investigators were unable to determine if noncompliance with the recommended post-shutdown procedure contributed to the bearing failure.

Preliminary Reports, January 2011

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Jan. 1	Surgut, Russia	Tupolev 154B-2	destroyed	3 fatal, 121 NA
	During start-up, a fire erupted in the Tu-154's right engine and spread to a fuel tank. Three occupants died, and about 39 were injured.			
Jan. 1	Orange, Massachusetts, U.S.	Cessna 310F	substantial	1 fatal, 1 minor
	Witnesses saw the 310 flying low before it struck trees and crashed, killing the passenger, during a visual approach in night VMC.			
Jan. 3	Maple Creek, Saskatchewan, Canada	Beech King Air B200	substantial	3 none
	The King Air was on an air ambulance flight when it veered off the runway during landing.			
Jan. 3	New Stuyahok, Alaska, U.S.	Beech E18S	substantial	1 none
	The cargo airplane struck rising terrain when the pilot attempted to go around after touching down on an ice-covered runway.			
Jan. 5	Birmingham, Alabama, U.S.	Beech 58P Baron	destroyed	1 fatal
	The Baron crashed in a residential area during an attempted go-around from a night ILS approach with 2 mi (3,200 m) visibility and a 300-ft overcast.			
Jan. 5	Asheboro, North Carolina, U.S.	Cessna 340A	substantial	1 none
	The owner was conducting a high-speed run to test the engines after maintenance when the 340 overran the runway.			
Jan. 6	Kipnuk, Alaska, U.S.	Cessna 208B	substantial	6 none
	The captain said that he landed long to avoid a bump on the runway. The Caravan then overran the snow- and ice-covered runway, and struck a ditch.			
Jan. 6	Springfield, Illinois, U.S.	Learjet 35A	destroyed	2 minor, 4 none
	The Learjet veered off the runway after the landing gear collapsed during a hard touchdown.			
Jan. 7	Montpellier, France	Beech King Air B200	substantial	4 minor
	The flight crew returned to the airport after the electrical system failed during initial climb in IMC. The landing gear collapsed on touchdown.			
Jan. 7	Riyadh, Saudi Arabia	Aerospatiale AS 265N	destroyed	4 fatal
	The Dauphin helicopter crashed shortly after departing from Riyadh for an emergency medical services flight.			
Jan. 7	Macapo, Venezuela	Partenavia 68C	destroyed	5 fatal, 1 serious
	The airplane crashed during a forced landing after its fuel supply was exhausted.			
Jan. 9	Orumiyeh, Iran	Boeing 727-200	destroyed	79 fatal, 26 serious
	Visibility was 800 m (1/2 mi) in snow when the 727 struck terrain 8 km (4 nm) from the runway during approach.			
Jan. 10	Kuching, Malaysia	Airbus A320-216	substantial	129 NA
	No fatalities were reported when the A320 veered off the runway while landing in heavy rain.			
Jan. 14	Goiânia, Brazil	Beech King Air B200	destroyed	6 fatal
	The King Air struck a hill during a night approach in low visibility and heavy rain.			
Jan. 16	Edmonton, Alberta, Canada	Beech King Air B200	substantial	1 NA, 4 none
	One occupant was injured when the King Air slid off the runway while landing during an air ambulance flight.			
Jan. 17	St. Thomas, U.S. Virgin Islands	Convair 340-71	substantial	2 none
	The crew shut down the left engine and returned to the airport after a fire erupted on departure for a cargo flight. The Convair veered off the runway during landing.			
Jan. 19	Chicago, Illinois, U.S.	Cessna Citation X	substantial	1 minor, 1 none
	The Citation slid off the runway while landing at Waukegan Regional Airport.			
Jan. 20	Santa Clara, Ecuador	de Havilland DHC-6-300	destroyed	6 fatal
	The Twin Otter struck terrain about 15 minutes after departing from Shell-Mera Airport for a relief supply flight to Tena.			
Jan. 28	Patrimônio Regina, Brazil	Beech 58 Baron	destroyed	3 fatal
	The Baron crashed in a rural town shortly after departing from Londrina Airport for a charter flight.			
Jan. 31	Waterman's Peak, Arizona, U.S.	McDonnell Douglas 369FF	substantial	1 fatal, 2 serious, 1 minor
	The pilot was killed when the survey helicopter crashed during an attempted pinnacle landing.			

NA = not available

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

Selected Smoke, Fire and Fumes Events in the United States, December 2010–February 2011

Event Date	Flight Phase	Airport	Classification	Event sub-classification	Aircraft	Operator
Dec. 6	Takeoff	—	Burning odor in cockpit	Unscheduled landing	Boeing 737	Continental Airlines
A burning odor was noticed in the cockpit and cabin, and at the same time hydraulic B system pressure dropped from 80 percent to 42 percent, during takeoff and climbout. The odor dissipated somewhat on approach.						
Dec. 12	Approach	—	Smoke in cockpit	Emergency and priority ATC handling	Bombardier DHC-8	Colgan Air
The aircraft crew was just released from a holding pattern when the first officer noticed smoke in the vicinity of his overhead light. The captain also saw the smoke and noticed an acrid odor. The lavatory smoke detector activated. The captain called a flight attendant and she reported that there was no visible fire, but the cabin looked foggy. The crew declared an emergency and received priority handling from air traffic control. The aircraft was landed within a few minutes. By the time the aircraft landed, the smoke and acrid odor had subsided.						
Dec. 16	Cruise	—	Light smoke and oil odor in cockpit	Emergency and diversion	Bombardier DHC-8	—
Several minutes after departure, the crew reported indications of light smoke and oil odor in the cockpit. The crew followed in-flight emergency procedures. The pilot declared an emergency and diverted to the nearest airport.						
Dec. 29	Taxi/ground hold	Detroit (DTW)	Smoke in cockpit	Passenger evacuation	Bombardier CL-600	Express Airlines
While the aircraft was parked at the gate, the auxiliary power unit (APU) performed an auto-shutdown. The flight crew smelled smoke and saw it emerging from the gaspers. The passengers were evacuated. No fire or hot spots were found. Maintenance found that the APU enclosure was soaked in oil. Further investigation revealed a ruptured oil line on the APU.						
Jan. 1	Approach	—	Smoke in cabin	Continued with approach	McDonnell Douglas MD-88	Delta Air Lines
During flight, a flight attendant noticed electrical shorting and smoke emitting from row 25. Maintenance found that a light ballast and harness had burned at row 24.						
Jan. 18	Descent	Washington National (DCA)	Smoke in cockpit and cabin	Continued with approach	Bombardier CL-600	Jetstream International
The crew reported smoke in the cockpit and cabin after turning on the APU and switching on bleeds during descent into DCA. The crew landed at DCA without further incident. Maintenance inspected the APU enclosure and the air conditioning cooling ducts. No defects were noted. Maintenance determined the source of the odor and smoke to be the APU.						
Jan. 21	Climb	Manchester, New Hampshire (MHT)	Lavatory fire warning	Return for landing	Embraer 145	Continental Express
The flight crew reported a lavatory fire warning on climb and smoke in the lavatory. The crew returned the aircraft to MHT and landed safely, with no emergency declared. Maintenance inspected the lavatory and no defects were found. The problem could not be duplicated, and the aircraft was returned to service.						
Jan. 25	Taxi/ground hold	Chicago O'Hare (ORD)	Smoke in cockpit and cabin	—	Embraer 145	Continental Express
The crew reported smoke in the cabin after deicing at the gate. Maintenance inspected the aircraft and ran the air conditioning packs and bleed system with both the APU and engines. No smoke was noted. It was suspected that deicing fluid in the APU inlet created the smoke.						
Jan. 29	Takeoff	—	Smoke in cockpit and cabin	Return for landing	Boeing 737	Continental Airlines
On the takeoff roll at about 110 kt, the cabin and cockpit began to fill with smoke. As the aircraft pitched up, smoke increased and filled the cockpit from the ceiling to the extent that the first officer's head was not visible and breathing was impaired. Smoke was coming out of the exhaust light sockets. The flight crew shut off the air conditioning packs to stop the smoke.						
Feb. 3	Cruise	—	Electrical/hot odor in cockpit	Unscheduled landing	Boeing 737	Southwest Airlines
During cruise, the crew smelled what seemed to be electrical smoke and fumes in the cockpit and cabin. The odor seemed to dissipate after the gasper/recirculation was turned off.						
Feb. 17	Takeoff		Burning odor in cockpit	Continued with flight	Embraer 145	American Eagle Airlines
The crew reported a burning odor in the cockpit during takeoff. The odor went away during the climb. The crew made the decision to continue to ORD. The aircraft landed without incident. The aircraft was removed from service. Maintenance replaced the flashlight assembly above a flight attendant jump seat, and the aircraft was returned to service.						
Feb. 18	Descent	Dallas-Fort Worth (DFW)	Electrical/hot odor in cockpit	Continued with descent	Boeing 737	Allegheny Airlines
During descent into DFW, the crew could smell an electrical/hot odor in the flight deck. The right side of the captain's control wheel was almost too hot to touch. The odor was determined to be coming from the right side of the control wheel. The crew pulled the circuit breaker for the panel lighting. The odor stopped, and the control wheel cooled. The flight was landed without further incident. Maintenance found that the reminder light on the right side of the control wheel had melted due to a loose terminal.						

Source: Safety Operating Systems and Inflight Warning Systems.

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